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# GENERAL HYGIENE AND ENVIRONMENTAL HEALTH



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of the Odessa State Medical University  
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Dear Reader,

When in 1999 the lecturers and researchers of the Odessa State Medical University started issuing a series of books united by the collection entitled “Medical Student’s Library” they had several aims before them.

Firstly, they wanted to add new books to the Ukrainian library of medical literature that would be written in Ukrainian, the native language of the country. These books should contain both classical information on medicine and the latest information on the state of the art, as well as reflect extensive experience of our best professionals. Secondly, our lecturers and specialists wanted to write such books which reflected the newest subjects and courses that have recently been introduced into the curricula, and in general there have been no textbooks on these subjects and courses at that time.

These two aims have successfully been coped with. Some dozens of textbooks and workbooks published in these years have become a good contribution of their authors and publishers to the development and making of the Ukrainian national educational literature.

The next step that we decided to undertake was to issue a unique series of books in foreign languages. The foreign students taking their medical education in the Ukraine, our University included, are expecting such books to be published. Other countries are also waiting for them as the Odessa State Medical University is a Fellow Member of the International and European Association of Universities. Our Medical University is over a hundred years old and has long since become a center of various original medical schools and trends. These are headed by well-know medical professionals whose competence is acknowledged not only in this country, but abroad as well.

***Valery ZAPOROZHAN,  
Editor-in-Chief of the Series “Medical Student’s Library”  
the State Prize-Winner of Ukraine,  
Academician of the Academy of Medical Sciences of Ukraine***



# GENERAL HYGIENE AND ENVIRONMENTAL HEALTH

Edited by Professor **M. M. Nadvorny**

*Recommended  
by the Central Methodical Committee  
for Higher Medical Education of the  
Health Ministry of Ukraine as a textbook for English-speaking  
students of higher medical educational establishments  
of the IV level of accreditation*



Odessa  
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The textbook contains information on history, goals and objectives of general hygiene. There are presented modern concepts about the prevention of diseases. Principal parts of the preventive medicine are described, including hygiene of the air environment, hygiene of water supply, hygiene of nutrition, hospital hygiene, hygiene of children and adolescents, etc.

The textbook is intended for the students of high medical schools.

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Підручник містить інформацію про історію, цілі та завдання загальної гігієни. У ньому наводяться сучасні концепції профілактики захворювань. Надані принципи положення профілактичної медицини, у тому числі гігієни навколишнього середовища, водозабезпечення, харчування, а також госпітальної гігієни, гігієни дітей та підлітків тощо.

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## PREFACE

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General hygiene or preventive medicine is rapidly developing branch of medicine. Many different disciplines contributed to the growth of preventive medicine: physicians provided health screening and diagnosed diseases; sanitary engineers built water and sewerage systems; epidemiologists traced the sources of disease outbreaks and their modes of transmission; vital statisticians provided quantitative measures of births and deaths; lawyers wrote sanitary codes and regulations; public health officers provided care and advice to the sick in their home; sanitary inspectors visited factories and markets to enforce compliance with public health ordinances; and administrators tried to organise everyone within the limits of the health departments budgets. General hygiene thus involved epidemiology, sociology, psychology, law, statistics, environmental health and engineering as well as biological and clinical sciences.

Preventive Medicine developed as a branch of medicine distinct from Public Health. By definition, preventive medicine is applied to “healthy” people, customarily by actions affecting large numbers or populations. Its primary objective is prevention of disease and promotion of health. It got a firm foundation only after the discovery of causative agents of diseases and the establishment of the germ theory of disease.

Decades old concept of health care approach has experienced a dramatic change. Today health is not merely an absence of disease; it is related to quality of life instead. Health is considered a means of productivity. Thus health development is essential to socio-economic development as a whole. Since health is an integral part of development, all sectors of society have an effect on health. Scope of medicine has extended from individual to community. Study of health and disease in population is replacing study of disease in man. Germ theory of

disease gave place to newer concepts — multifactorial causation. Social and behavioural aspects of the disease have been accorded a new priority. Contemporary medicine is no longer solely an art and science for the diagnosis and treatment of diseases. It is also the science for the prevention of disease and promotion of health. Today technical sophistication of modern medicine is not an answer to everyday common ailments of the vast poor in the country. Physicians role is no longer confined to diagnosing and treating those who come to the clinic. He is also responsible for those who need his service but can not come to the clinic. Health of the people is not only the concern of health care providers. It is the responsibility of the community also to identify and solve their own health problems through their active participation.

Alma-Ata declaration in 1978 specified that Primary Health Care approach was the way of achieving the goal of Health For All by 2000. Primary Health Care approach stressed that “essential health care should be made universally accessible to individuals and acceptable to them, through their full participation and at a cost the community and the country can afford”.

The represented textbook includes all basic topics of General Hygiene. Authors are recognized authorities in each of these areas and have made the chapters current and practical. They added modern glossary of the terms using in the preventive medicine and general hygiene, modern references and useful Internet URLs.

Authors would like to thank those people who helped with the physical preparations and typing of the manuscript.

We thank you, the Reader, who selected this book for studies.

Enjoy this very interesting and important health science.

# Chapter 1

## HISTORY, SCOPE AND METHODS OF GENERAL HYGIENE

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**Hygiene** is a basic preventive science. It studies influence of the environmental factors on the human organism and social health; it has the goal to determine and substantiate theoretically hygienic norms, sanitary regulations and measures, realization of which provides optimum condition for life and activity of people, improving the health and preventing diseases.

General hygiene is the science of health and embraces all factors that contribute to healthful living. The word “hygiene” is derived from GIGIEIA (the goddess of health in Greek mythology).

This subject studies the factors which influence the human body, create the threshold values and maximum admissible concentrations, levels and doses for these factors. There are psychogenic (information) and material (chemical, physical, biological) factors (Fig. 1). Afferent stimulation causes various emotions (grief, horror, joy, etc.), changes of physical state of the organism. Positive emotions are realized in positive changes: better blood supply of the brain, heart, normalization of blood pressure. Distress, negative emotions can cause disease. They are risk factors for myocardial infarction, hypertension, ulcerous disease, diabetes etc. Great part of afferent loading has a social nature. Chemical compounds are often necessary for vital activity and health, but they can be the cause of disease. For example: iodine deficit causes goitre and cretinism, chemical hazards (pollutants) can cause poisoning.

Physical factors (microclimate, noise, ionising radiation, vibration, air pressure) present various kinds of energies. They form an environment we live in but all these factors can be the hazards too. For example, high air temperature can cause overheating and heat stroke, intensive noise — cochlear neuritis and deafness, etc. Biological factors are microbes, viruses, fungi, and helminthes. They can cause diseases of the man and animals, spoil food products, damage sanitary-technical equipment. In the real life a human being is under the influence of not only one but also a complex of environmental factors. They use the terminology: *combined influence* — influence of several factors of common origin (for example, several chemical compounds); *common influence* means several factors of different origin are acting; *complex influence* is characterized by the situation when only one factor is present but it has different routes of exposure.

The main aim of the subject is the *prevention of diseases*. Successful prevention depends upon knowledge of causation, dynamics of transmission, identification of risk factors and risk groups, an organisation for applying these measures to appropriate persons or group and continuous evaluations and development of procedures applied. Nowadays prevention is defined in terms of three levels:

— primary prevention — identification and control of health and safety risk;

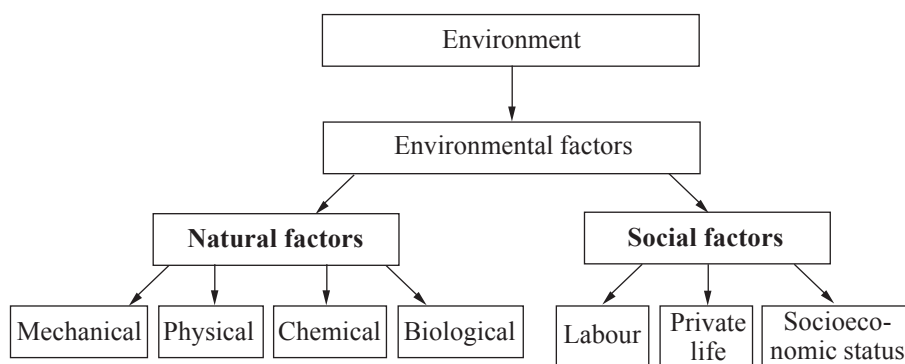


Fig. 1. Main Environmental Factors Influencing Human Health

— secondary prevention — early diagnosis and treatment of medical condition;

— tertiary prevention — reduction of consequences of the medical condition.

Hygiene is dealing with the first level mainly. The aim of primary prevention is to maintain health by removing the precipitating causes and determinants of departures from good health.

The principal topics of the subject are:

- Hygiene of atmospheric air
- Water supply hygiene
- Hygiene of nutrition
- Occupational hygiene
- Radiological hygiene
- Hygiene of children and adolescents
- Hospital hygiene
- Hygiene of extreme situations
- Tropical hygiene, etc.

Hygiene is a science of preserving and promoting the health of both the individual and the community. It has many aspects: personal hygiene (proper living habits, cleanliness of body and clothing, wholesome diet, a balanced regimen of rest and exercise); domestic hygiene (sanitary preparation of food, cleanliness, and ventilation of the home); public hygiene (supervision of water and food supply, control on communicable diseases, disposal of garbage and sewage, control of air and water pollution); industrial hygiene (measures that minimize occupational disease and accident rate); mental hygiene (recognition of mental and emotional factors in healthy living) and so on. The World Health Organisation (WHO) promotes hygienic practices on the international level.

**Health** is derived from the old English word *hal*, meaning *hale, whole, healed, sound in wind and limb*. The preamble to the constitution of the WHO describes health as “*a state of complete physical, mental and social well-being, not merely the absence of disease or infirmity*”.

The hygienic researches methods are following:

1) the method of sanitary examination and description;

2) the experimental methods:

— experiment with simulation of natural conditions;

— laboratory experiment on animals;

— chamber experiment on people;

— “natural experiment”;

3) the sanitary statistic methods:

— the method of mathematical modeling;

— the epidemiological method.

The specific hygienic method is *a method of sanitary examination and describing* which is used for studying the environment. Sanitary examination and describing is carried out according to special programmes (schemes) which contain questions. Answers to these questions characterize the object which is being examined hygienically. As a rule it

is usually supplemented by laboratory analyses (chemical, physical, microbiological and others) which allow to characterize environment from the qualitative side.

There are different widely used kinds of hygienic experiments:

1. *Experiment with simulation of natural conditions* is used for examining and predicting processes which are going on in the surrounding world (for example, for examining the influence of chemical admixtures on the processes of self-clearing of water in reservoirs).

2. *Laboratory experiment on animals* helps to study the influence of environmental factors on the organism which meets the goal to substantiate hygienic norms. In the process of this experiment the following methods are used: physiological, biochemical, immunological, histological, microscopic, radiobiological, genetic and others.

3. *Chamber experiment on people* is used to study the influence of some factors on the human organism and determine the norms. This method is used to study such factors as microclimate, illumination, noise, neuropsychic strain, etc.

4. “*Natural*” *experiment* helps to study influence of environmental factors on the human health in real life conditions, for example, studying health of people (especially children) who live at different distance from enterprises throwing out toxic gaseous substances into the atmosphere. Natural experiment allows to check-up hygienic norms which were determined in the experiment on animals.

One of the main and difficult hygienic problems is studying the influence of environment on the health.

According to the opinion of Ukrainian scientists *health is normal and harmonious physical and psychic development of the human being, normal functioning of all organs and systems which can adapt to unfavourable influences in normal conditions of life, absence of diseases and preconditions to them, high physical and mental ability to work which allows to fulfill his social and biological functions*. A subjective side of the health manifests itself in a good mood, absence of pains, normal functioning of organs of sense, adequate psychic reaction to the environment.

The health of individuals is studied by way of medical examinations with the usage of anthropometric, clinical, physiological, biochemical, immunobiological, roentgenological and other methods of examination. Their participation in labour and other types of activity must be taken into account.

The health of a certain group of people or of all population of the populated area (region, republic, etc.) is studied with the help of the *sanitary-statistic method*. There are different criteria which characterize physical development, demographical indices (birth rate, death rate, average life span and

others), morbidity and pathology of the studied group.

*The epidemiological method* is close to the sanitary-statistic method. It is used for studying incidence of disease (e.g. hypertension, coronary disease, diabetes, peptic ulcer, etc.). They are studied during a certain period (a year, a month), on a certain territory (different regions of the city, republic), among different groups of population (which differ one from another by age, gender, occupation, conditions of water and food supply, conditions of life and others). Analysis of these data is used for determining causes and conditions which favor the development of disease, for liquidation of disease as regional pathology, for planning prophylactic measures.

The methods of *mathematical statistics and modeling* are widely used.

*Complex hygienic methods* are: the *method of theoretical substantiation of hygienic norms*, the *method of studying the health of a certain group of people* (workers, students, etc.) in the connection with their conditions of life, the *method of studying hygienic factor*. Each of these methods uses the complex of above mentioned methods.

The hygiene aim is preserving and promoting the health. Its objectives are:

1. Studying environmental factors.
2. Studying interaction between the human organism and environment.
3. Environmental hygienic standards and guidelines development.
4. Substantiation of sanitary supervision.
5. Prospective analysis of environmental health.

Hygiene has close links with social medicine and public health, clinical epidemiology, paediatrics, occupational health, human ecology and other sciences.

## HYGIENIC STANDARDIZATION

Environmental standards are definite ranges of environmental factors which are optimal or the least dangerous for human life and health. In Ukraine basic objects of hygienic standardization are:

1. MAC — maximum admissible concentration (for chemical admixtures, dust and other hazards) (They use MAC in Canada, MAK in Germany and CMA (“concentration maximale acceptable”) in France).
2. MAL — maximum admissible level (for physical factors).
3. LD — dose limit (for ionising radiation).
4. Optimum and admissible parameters of microclimate, lighting, solar radiation, atmospheric pressure and other natural environmental factors.
5. Optimum and admissible daily requirements in food and water.

Some countries don't have a unified system of standards. In the USA the Permissible Exposure Limits (PELS) are OSHA standards, which must be upheld by the employer at all times. In some cases, the Threshold Limit Value (TLV) established by ACGIH may be lower than the OSHA PEL. Permissible Exposure Limit (PEL) — an exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either a time-weighted-average (TWA) exposure limit (8 hour), a 15-minute short term exposure limit (STEL), or a ceiling (C). Threshold Limit Value (TLV) is airborne concentrations of substances devised by the ACGIH that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLVs are advisory exposure guidelines, not legal standards, that are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLVs: Time Weighted Average (TLV-TWA), Short Term Exposure Limit (TLV-STEL) and Ceiling (TLV-C). Time Weighted Average (TWA), the average time over a given work period (e.g. 8-hour workday) of a person's exposure to a chemical or an agent. This time is determined by sampling for the contaminant throughout the time period. TLV (TWA) is an 8-hour time-weighted average believed to be the average concentration to which most workers can be exposed during an 8-hour workday, day after day, without harmful effects. TLV (STEL) is a 15 minute “short term exposure limit”. Ceiling (C) is a maximum concentration never to be exceeded.

Basic objects which are under the hygienic norms setting can be divided into two groups. The first group contains factors of anthropogenous origin which are unfavourable for a human being, and are not necessary for the normal life activity (dust, noise, vibration, ionising radiation, etc.). MAC, MAL and LD are those parameters which are set for this group of factors. The second group contains factors of natural surrounding which are necessary (in certain amount) for normal life activity (food-stuffs, solar radiation, microclimatic factors and others). For this group the following parameters must be set: optimum, minimum and maximum admissible parameters.

In those cases when factors influence the human not only directly (physiologically) but also indirectly (through the environment) all types of possible influence must be examined at hygienic norms setting. For example setting of hygienic norms for toxic substance in the water of natural reservoirs determination of maximum concentrations must be based on worsening of organoleptic properties of the water (an organoleptic sign), toxic influence (a sanitary-toxicological sign) and disturbance of processes of self-clearing of reservoirs (a general sanitary sign). In this case MAC is set according to that harmful parameter which is characterized by the lowest level of concentration. Such parameter is called limiting.

Important methodological problems of hygienic norms setting are:

1) possibility of application of data got in the experiment on animals to people;

2) conception about levels of harmful influence (MAC and MAL, must be below them).

Possibility of application of results got in the experiment on animals to people and study of toxic influence of chemical substances (and some physical factors) is corroborated by hygienic and toxicological investigations. It was an idea to use the so called reserve coefficients or “coefficients of extrapolation” to increase the safety of hygienic norms. It was made because of different sensitivity of animals and people. It was recommended to decrease experimental MAC 2, 100 and more times as much in dependence on the toxic abilities, cumulative action of substance and type of the experiment on animals. It is possible to apply data of the sanitary-toxicological experiment on an “average animal” to an “average human being”. But it is more difficult to apply these data to human population among which genetic and other differences are present (age, disease, pregnancy, etc.) which stipulate differentiated sensitivity to the agents. This problem is theoretically unsolved today. But in practice solution is found in increase of types of experiments on animals of a different age, on pregnant animals with disease modeling and in increase of reserve coefficient and obligatory checking the hygienic norms reliability (MAC and MAL in natural conditions).

As it was said, one of the main problems of hygienic norms setting was elaboration of correct conception about the level of harmful influence. Some investigators consider that it is necessary to distinguish the level of biological influence and the level of harmful influence. According to their conception all first stages of physiologic and biochemical reactions which occur as a result of influence of a factor are within limits of adaptation possibilities of the organism. Only when they “come out” of their limits, reaction of the organism has a compensatory character. In this case their influence can be considered as harmful because physiologic and biochemical reactions get hygienic significance. But it is too difficult to determine the distinction between adaptation and compensatory processes in the experiment.

To solve this problem the following rules should be used — data got in the experiment can be considered hygienically valuable only if they are stable (for example, during one month), reliable in the comparison with the control group and especially progressive in time. It is recommended to apply loading method which allows to compare adaptation resources of animals being tested with the control group. Besides, it is recommended to orient basically on integral parameters of organism condition (weight, temperature, functionality of CNS, concentration of sugar in the blood, etc.) or changes on the organism level which show the upset of relative

equilibrium between the organism and environment. Degree of different constants of the organism must be taken into account. Changes of stable constants indicate the hygienic significance of changes. Thus, according to these conceptions threshold dosage of toxic substance is that minimum concentration of it in the object of environment influence which brings about changes in the organism that result from physiological adaptation reactions.

But some investigators consider that distinction between adaptation and compensatory processes is conditional. That’s why threshold of action must be considered as any statistically reliable deflection of physiological and biochemical reactions (parameters) in tested animals from animals of the control group. In this case threshold of action and consequently MAC will be some lower. It is considered that such a principle can be used while setting the norms for factors which influence the whole population.

A group of scientists have come to the conclusion that there are no threshold dosages for mutagenous or cancerogenous substances because even the smallest concentration of them can cause mutation (or development of tumour) in the organism. It is known that degree of risk is in proportion to the dosage and quantity of people who were under the influence of cancerogenous (mutagenous) substance. This conception is approved by the International Committee of Radiation Safety (ICRS) in relation to mutagenous and cancerogenous influence of ionising radiation. That’s why MAL of ionising radiation must not bring about more frequent development of tumours or mutations than spontaneous level of this pathology which is typical for people living in normal non-polluted conditions. Conception of ICRP about the non-threshold influence is cruel and, therefore, the best measure is to protect the health of the human being from the influence of such dangerous factors.

But it was found out in experiments on animals with decreasing dosages of cancerogenous substances that there can be such concentration at which tumours occur no more often than in the control group. Besides the following fact is against the conception about non-threshold action of cancerogenous (mutagenous) substances. It was found out that substances differ one from another by dosage which brings to development of tumour (mutation). Supporters of the non-threshold theory consider thresholds imaginary because of small number of animals in the experiment. For example, cancerogenous substance induces tumours with the frequency 2,000 per 1,000,000 animals; it means that probability of tumour development is low — 0.2 per 100 animals. Supporters of the non-threshold theory suggest to set MAC or MAL according to the following way: to determine the dependence of “dosage — effect” for 4–6 dosages of cancerogenous (mutagenous)

substance on animals, extrapolate the obtained data into small dosages and find the dosage which slightly increases the level of spontaneous pathology.

Let's study the methodical scheme of hygienic norms of substantiation using, the example of MAC for some toxic substances. The first stage is to study physical and chemical properties of the substance, elaboration of methods of quantitative determination of this substance in different subjects, determination of its regimen of action on the human (duration, interruption, changes of intensity), ways of getting into the organism, study migration in different elements of the environment, mathematical prediction of factor existence in different surroundings. The second stage is studying direct influence on the organism. It is started from "sharp" experiments, the main goal of which is getting initial toxicometric data about the substance (determination of LD<sub>50</sub>, or LC<sub>50</sub>, threshold of acute action (LIM<sub>ac</sub>) and others. With the knowledge of physical and chemical properties of the substance, its initial toxicological characteristics and approximate level of MAC can be calculated. The third stage is conduction of "subacute" experiment during 1–2 months for determination of cumulating coefficient and the most vulnerable physiologic systems and organs specification of mechanisms of action and metabolism. The fourth (basic) stage is carrying out "chronic" experiment which lasts for 4–6 months in case of modeling of occupational conditions, 8–12 — communal conditions, 24–36 — studying the aging processes and tumours induction.

During the experiment integral parameters are studied. They reflect condition of animals, degree of load of regulative systems, functions and structure of organs which take part in processes of metabolism (activity of enzymes), influence of functional loadings. This study allows to determine hygienically significant threshold of LIM<sub>ac</sub> and subthreshold dosages of the substance. Having knowledge about subthreshold dosages and with the help of extrapolation coefficients, MAC of the substance can be calculated according to the sanitary-toxicological sign.

In laboratory experiments on human threshold of taste, sense of smell, reflexive and irritating influence are examined. These data and results of influence of the factors on the sanitary conditions of life (for example, green plantations, transparency of atmosphere) are compared with MAC according to the sanitary-toxicological sign.

Study of influence of the factor on the organism and health in natural conditions is possible only after introduction of this factor in working surround.

Elaboration of express-methods of norms setting is an important task. They are based on connection between threshold of chronic influence of the substance and its chemical structure (physical and chemical properties, LD<sub>50</sub>, LC<sub>50</sub> or other characteristics).

As it was shown by investigations in most cases there is no interstrengthening or inhibition but summation. So, we can calculate an additive effect of two or more factors. Each factor must be expressed in parts of its MAC or MAL.

$$\frac{C_1}{MAC_1} + \frac{C_2}{MAC_2} + \dots + \frac{C_n}{MAC_n} \leq 1$$

For example, concentration of fluorine in the air is 0.001 mg/m<sup>3</sup> (MAC — 0.005 mg/m<sup>3</sup>) and concentration of benzol is 0.16 mg/m<sup>3</sup> (MAC — 0.8 mg/m<sup>3</sup>), in the sum 2/5 of MAC (1/5 of MAC of fluorine + 1/5 of MAC of benzol) — less than 1 MAC. So, summarized influence of these two chemical substances is safe.

A summarized effect in complex influence can be calculated in the same way.

Numbers of MAC of toxic chemical substances in Ukraine are various: for the air of a working zone — more than 800, water — 700, atmosphere air — 200, food-stuffs — more than 200, soil — more than 30.

At present the theory of biological equivalence is being elaborated. It can be used for substantiation of summarized influence of different factors and setting of norms of maximal admissible loading (maximum admissible intensity of influence of total factors of environment on the humans).

Ideally, regulators would like to eliminate all pollution and its risks, but this is usually not a realistic expectation. Regulators must address the most important risks and decrease them to the level at which they believe the risks are smaller than the benefits of the activity causing the pollution.

This is similar to what millions do each day when they balance the risks of an automobile accident with the convenience and necessity of driving. Just as a driver will buckle up and drive defensively to be safer, agencies take a regulatory action to eliminate as much risk as possible without losing the benefit.

Scientific results may show that certain hazardous substances pose a low health risk to people, but the public may still be concerned about these hazardous substances because of different attributes of risk. Other attributes may affect people's perceptions of risk:

- How serious and dreaded is the illness?
- How certain is scientific knowledge?
- What is the catastrophic potential?
- Who bears the risk?
- Is the risk voluntary?
- Who receives the benefits of the "risky" activity?

Risk analysis describes risks numerically in scientific notation, for example 1×10<sup>-5</sup>, which means that there is one chance in 100,000 of an event occurring. It is important to note that these risk statistics are population averages, while risk analysts usually estimate risk to the maximum exposed individual.

Health risk is the probability, or chance, that exposure to a hazardous substance will make disease. Animal experiments or human studies provide information about how hazardous a substance is. They use the results of such studies to estimate the likelihood of illness at different levels of exposure.

Information on exposure comes from two places: monitors placed on factory smokestacks or at special places in your community, or from mathematical models that estimate exposure based on amounts of chemicals released.

## HISTORY OF HYGIENE

In the development of hygiene we determine the empiric, the descriptive, the experimental and the modern period. Empiric (ancient) period is characterized by the development and accumulation of basic hygienic knowledge.

The first historical data about hygienic practice are known from ancient Egypt, Mesopotamia and India. The practice of hygiene for the community, as distinct from that of the individual, began early, at least in its most simple forms. The Hebrews prescribed for the isolation of lepers, and for the hygienic disposal of human excreta. The Cretans had piped water and flush closets before the siege of Troy (1250 B.C.); and the Chinese, Greeks and later Romans and Arabs had model sanitation in their cities. No sight is more remarkable than that of the water-pipes and sewers, still intact in the foundations of the Aesculapian hospital, where Galen practised in the first century A.D., at the foot of the acropolis of Pergamum in Asia Minor.

The people of Paleolithic Soan survived in the region for a considerable period and transformed themselves gradually from the hunting stage to the conditions of a well-settled life. Excavations at Sarai Khola, Harrapa, Amri, Moenjodaro, Kot Digi and other sites have established that in 2350 B.C., the pre-historic people of the Indus Valley developed a sophisticated base on agriculture economy. The site of Mehargarh situated at the foot of the Bolan Pass (Baluchistan) is believed to be the earliest civilization in the world. It predates the civilizations of Egypt and Mesopotamia. It was occupied from 7000 B.C. to 2000 B.C. and is the earliest Neolithic site where we have first evidence of domestication of animal and cereal cultivation and also the center for craftsmanship as early as 7000 B.C. The ages of settlement goes back to about 8000 B.C. and even that early period there were well developed villages with agriculture, the beginning of animal domestications and evidence of long distance trade. The ruins of Moenjodaro in Sind and of Harrappa in the Punjab, tell the tale of highly cultured people. They lived

an organized civic life, in cities that had layouts, streets and drainage system (Fig. 2).

Moenjodaro is the archaeological site of Indus Civilization, which flourished there some 5000 years ago. Moenjodaro excelled in practically every conceivable facet of town planning. Indus Valley settlements all followed the same basic plan. Streets and houses were laid out on a north-south, east-west grid, and houses and walls were built of standard-size bricks. Even early agricultural settlements were constructed on a grid. Nearly every Harappan home had a bathing platform and a latrine and some Indus Valley cities reached heights of 40 feet in part because of concern about hygiene. Cities often grow upon their foundations over time, but in the Indus Valley, homes were also periodically elevated to avoid the risk of runoff from a neighbor's sewage. Each neighborhood had its own well, and elaborate covered drainage systems carried dirty water outside the city.

By circa 3500 B.C., the Sumerians had developed many of the features that characterized subsequent civilizations. The largest medical treatise from ancient Mesopotamia is known as "Treatise of Medical Diagnosis and Prognoses." Many of the plants incorporated into the "asu" medicinal repertoire had antibiotic properties, while several resins and many spices have some antiseptic value.

The earliest known "hygiene kits" are Sumerian sets made of gold and silver and dated about 3500 B.C. They consist of ear scoops, tweezers and toothpicks. The sets usually fit into decorated gold or silver carrying cases. Two prescriptions from ancient Assyria-Babylonia are important in the history of oral hygiene. The first was intended to remove film and deposits on the teeth, whiten discolored teeth and prevent bad breath. A mixture of "salt of Akkad, ammi, Lolium, and pine turpentine" was applied to the teeth and then rubbed with the finger. Then the mouth was to be rinsed with a mixture of "kurunu-beer, oil and honey". The second prescription describes a method of cleaning the mouth. The first known written mention of soap was Sumerian on clay tablets dating about 2500 B.C. They were found



Fig. 2. Ancient Drainage System in Moenjodaro

in the area of the Tigris and Euphrates river. The tablets spoke of the use of soap in the washing of wool. Another Sumerian tablet, dating 2200 B.C., describes a “soap” formulation of water, alkali and cassia oil.

By contrast with Indu cities, city dwellers in ancient Mesopotamian cities tended to draw water from the river or irrigation canals and they had no drains.

Women and men of Ancient Egypt held appearance in high regard. Good hygiene and grooming habits played an important part of their lives and reflected a person of breeding. Even by today standard Ancient Egyptian women are known for their beauty. Tomb paintings depict the owners in the latest fashions in wigs, clothing, and makeup. Cosmetics were not considered a luxury but a necessity for daily life and many examples of makeup, perfume, and toiletry items are found in tombs. A hairy body was not desired by either sex and shaving was a must for the wealthy. Women kept their hair short and even were known to shave their heads. Elaborate wigs adorn the heads of the wealthy. Henna was used to dye the hair, nails and body.

The Ebers Papyrus, a medical document from about 1500 BC, shows evidence that Egyptians bathed regularly and that they combined animal and vegetable oils with alkaline salts to create a soap-like (sic) substance for washing. Up to now, there have been no artifacts showing any sort of menstrual hygiene in the ancient Egypt. But there is a laundry list from which some researchers infer the existence of pad, belt and tampon-like items.

The Egyptians practiced a form of water management called basin irrigation, a productive adaptation of the natural rise and fall of the river. They constructed a network of earthen banks, some parallel to the river and some perpendicular to it, that formed basins of various sizes.

The earliest evidence of water control in ancient Egypt is the famous historical relief of the mace head of Scorpion King which dates to around 3,100 BC. It depicts one of the last predynastic kings, holding a hoe and ceremoniously cutting a ditch in a grid network. Besides attesting to the importance of these waterworks and the great ceremony attached to them, this picture confirms that Egyptians began practicing some form of water management for agriculture about 5,000 years ago. But they did not use water purification.

Pliny the Elder reports the Phoenicians as preparing soap from goat’s tallow and wood ash in 600 BC. A bible reference of the same age, to soap, may be misleading and reflect the translator’s expectation at the time of King James, as the Hebrew word in question, Borith, properly means any substance which cleanses; some authors speculate that it was a lathering paste of Fuller’s Earth and impure soda mixed with wine, a paste of a kind used by Romans

to cleanse clothes and pots and found in the ruins of Pompeii.

The Bible describes medical and sanitary practices remarkable for the time. It says people should bury their excrement [Deut. 23:13].

*“And thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself abroad, thou shalt dig therewith, and shalt turn back and cover that which cometh from thee. For the LORD thy God walketh in the midst of thy camp.”*

It requires people to wash themselves after touching a dead body. It notes that the eighth day after birth is the safest time to perform circumcisions.

The earliest source of Greek medical knowledge and descriptions of ancient Greek medical practices is Homer. The two epic poems attributed to Homer, the Iliad and the Odyssey, date to around the eighth century BC. Beyond the description of wounds, to a lesser extent Homer also recorded the care given to an injured warrior. Among the warriors, however, there were a few who were considered to be specialists in the art of healing through means of herbal remedies and bandaging. One of these doctors was Machaon, the son of the legendary healer Asclepius who later became deified. When Machaon was wounded himself, however, he was treated by being given a cup of hot wine sprinkled with grated goat cheese and barley [Iliad XI. 638].

Greek physician **Hippocrates** (c. 460 – c. 370 B.C.) was the first to recognize the environment’s role in disease etiology (*traite On Airs, Waters, And Places*); recognized early epidemics. He based medicine on objective observation and deductive reasoning. He taught that medicine should build the patient’s strength through diet and hygiene, resorting to more drastic treatment only when necessary.

Romans deeply believed that transcendental practices such as superstition, rituals, and a belief in spells would rid the country of disease. This was based on the idea that disease came from the anger of the gods. In 90 BC Roman general Gaius Marius transformed the Roman army into the incredibly disciplined, professional, highly trained entity. The practical professional army was much less concerned about pleasing the gods and much more concerned about keeping their men in battling condition. Thus, medical practitioners in the army felt the same way and operated on a trial-and-error basis, passing whatever they learned on to others and to future generations.

Romans did not yet really understand how germs related to disease, but they did use many of the techniques that killed germs, techniques that were not reinvented until much later. For example, they boiled their tools before use and would not reuse the same tool on a patient before reboiling. Wounds were washed with “acetum”. Over the years, Roman war doctors also learned how to prevent many battlefield



epidemics. They accomplished this by placing forts away from insect infested swamps. They also installed drains and sewers to transport sewage away from the men. Similarly, they invented sophisticated permanent hospitals, with specialized rooms for different tasks, and with isolation of some patients from others to reduce the spread of disease. Central heating and good ventilation also helped patients.

Some authors indicate that hygiene in the Roman World was limited to the rich and famous, except for those who could afford the public baths or *thermae*, as running water did not reach the poor's tenements from the aqueducts; these lesser folks relieved themselves in pots or commodes which were emptied into vats located under staircases and these emptied into cesspools throughout the city. The rich and famous, from the emperor on down, enjoyed running water in palaces and mansions from lead pipes connected to the aqueducts. At Pompeii, for instance, all houses except the poorest had water pipes fitted with taps, and the waste water was piped away into sewer or trench.

It was for reasons of ritual that the Romans washed frequently. Romans, including women and slaves, would wash every day and would have a thorough bath on every feast day if no more often. At Rome itself, baths were taken daily.

Romans learned of soap from the Germans some time in the first century CE, and that previous to that they used urine (*ammonia*) for clothes. Using the two in combination, of course, would be even more effective. Urine was apparently treated in some way before use. It may have been either a chemical process or a distillation.

Ovid's advice on grooming includes hair removal, and not just men's beards. Whether this was accomplished by shaving, plucking or other depilatory practices is sometimes hard to tell. Julius Caesar was noted by Suetonius to have been meticulous in hair removal. Pervasive hair removal was characteristic of Egyptian priests, maybe as a form of purification; for practical purposes, it reduces susceptibility to lice, for instance.

Romans used an instrument (*strigil*) for scraping the skin. Bear in mind that oil was used in classical times for removing grime, and unlike soap which forms a lather with water and can be rinsed off, the oil had to be scraped off; thereafter, in a water-rich area a bath could be taken, and in other cases clean (scented) oils could be used to finish off the job. The *strigil* at first glance looks a bit like a clasp-knife, handle and blade being in total about 8 inches in most cases. The blade is gently curved to accommodate the curves of the body and the handle is sometimes of another material such as bone or ivory.

Most of Rome's dwellings were ill-supplied with heat, light, and water. The sanitary arrangements, if judged by modern standards, were inadequate. The

typical Roman must have lived almost entirely outside of his tenement house, in the streets, shops, latrines, baths, and arenas of the city. The domicile must have served principally as a place to sleep and store possessions.

Rome's water supply system was one of the marvels of the ancient world. Romans, at first, turned to the Tiber River, local springs, and shallow wells for their drinking water; but water obtained from these sources grew polluted and became inadequate for the city's growing population. It was this necessity that led to the development of aqueduct technology. The date of the first aqueduct is assigned to the year 312 B.C. During the time of Frontinus, nine aqueducts conveyed water from distant springs and streams to Rome. The water in the aqueducts descended gently through concrete channels. Multi-tiered viaducts were used to cross low areas. Inverted siphons were employed (sparingly) when valleys were particularly deep. Tunnels, burrowed through hill too difficult to skirt, were equipped with vertical shafts for inspection and cleaning. Debris cleaned from the tunnels was dumped beside the openings to the vertical shafts. Modern archaeologists have been able to locate long abandoned conduits by finding the piles of debris. Various vestiges of aqueduct bridges are still in evidence in and around modern Rome (Fig. 3).

As one might expect, Roman water quality standards were remedial, taking into consideration only such factors as taste, temperature, smell, and appearance. Since the quality of water from the nine aqueducts varied, the worst waters were used for artificial lakes and irrigation, and the best for drinking. Early opinions on the amount of water delivered by the aqueducts varies from a low of 322,000 cubic meters per day to a high of 1,010,623.

Water from the baths, latrines, palaces, fountains, etc., as well as other urban runoff was discharged into Rome's drainage and wastewater collection system. Several centuries before the birth of Christ, Etruscan engineers built the initial drainage system (*Cloaca Maxima*) whose main outlet into the Tiber River still exists 28 centuries later. The covered drains were designed on such a large scale that in certain sections wagons loaded with hay could drive through with ease. Rome's sewers and drains emptied directly into the Tiber, whose polluted state must have been a constant problem for the Roman populace.

The Roman sewers have been overpraised. Despite their longevity, they ignored basic sanitary principles. They carried sewage, urban runoff, and drainage water together. This multiple employment made it necessary to have large openings along the streets. These openings exposed Rome's populace to the effluvia of the sewers. To mitigate this danger to public health, Romans had only two protections: the masses of water from infiltration and the



Fig. 3. Ancient Aqueduct in Tunisia

aqueducts which constantly flushed the drains, and the hilly nature of the city which gave the drains a steep slope.

The Roman sewer system probably carried off at least as much water as the aqueducts provided. Consumptive use in Rome was not high and there was a lot of infiltration into the drains from groundwater (parts of Rome are constructed over swamps). The flow of the Tiber River was greatly increased by discharges from Rome's sewers.

Romans without indoor toilet facilities were forced into one of two options. For a relatively small charge they could enter one of the city's public latrines or they could use chamberpots. (The Roman latrine system must represent one of history's earliest employments of the pay toilet, or more correctly, pay latrine, since the modern toilet was not invented until the sixteenth century.) According to historical data there were 144 public latrines in Rome in the later Empire. Apparently mostly concomitant of the public baths, which only makes sense as they could share water and sewerage. Public urinals consisted of buckets, *dolia curta*. The contents were regularly collected and sold to the fullers for cleaning wool, etc.

**Galen**, the physician and philosopher, was born at Pergamum in 129 A.D. He was educated at Smyrna (modern Izmir), Corinth, and Alexandria. In 157 he returned to his native city and got a prestigious appointment: physician to the gladiators. From autumn 157 to autumn 161 he gained a valuable practical experience in trauma and sports medicine, and he continued to pursue his studies in theoretical medicine and philosophy. By 161 A.D. Galen, that time 32, may have realized that even a great and prosperous provincial city like Pergamum could not offer the opportunities his talents and ambition demanded. He left, returning only for a three-year span from 166 until some time in 169. The rest of his career was spent in Rome. Galen's works fall into three main categories: medical, philosophical, and

philological. His medical writings encompass nearly every aspect of medical theory and practice in his era. In addition to summarizing the state of medicine at the height of the Roman Empire, he reports his own important advances in anatomy, physiology, and therapeutics. His philosophical writings cannot be easily separated from his medical thought. It is difficult to overstate the importance of Galen for European medical thought in the centuries between the fall of Rome and modern times. Even as late as 1833, the index to Karl-Gottlob Kühn's edition (still the only nearly complete collection of Galen's Greek works) could be designed for working medical practitioners as well as for classical scholars. The book "De sanitate tuenda" (On Hygiene) described hygienic requirements and was used by Galen's followers: Avicenna and Maimonides.

In Medieval Europe hygiene was not always a priority and medieval diets were lacking in vital nutrition. Barbers doubled as surgeons, and a good bleeding was often the cure prescribed. Overcrowded and polluted cities were common. In 1257 Queen Eleanor of Provence is forced to leave Nottingham Castle for Tutbury Castle because heavy coal smoke fouls the air. Before this case unendurable air pollution from wood smoke led Henry II's wife Elaenor of Aquitaine to flee Tutbury Castle in 1157. In 1306 the king Edward I forbids coal burning in London when Parliament is in session. Like many attempts to regulate coal burning, it has little effect. In 1347–1350s bubonic plague decimates Europe, creating the first attempts to enforce public health and quarantine laws.

The idea that medieval people rarely bathed is a persistent but false one. Most people washed themselves on a regular basis. Going without washing was considered a penance even in the early Middle Ages. Soap, possibly invented by the Gauls sometime before Christ, was in widespread use throughout Europe by the end of the ninth century, and made its first appearance in cake form in the twelfth cen-

tury. Public bathhouses were not uncommon, although their ostensible purpose was often secondary to their clandestine use by prostitutes.

The earliest Italian medical school opened in Salerno in the ninth century A.D., and as the place where the streams of classical, Arab and Jewish medicine flowed together was the predecessor of the medical renaissance.

**Avicenna**, or in Arabic, **Abu Ali al-Husain ibn Abdallah ibn Sina** or simply **Ibn Sina** (as he is called by Persians) (980–1037), was a physician, philosopher, and scientist. He was the author of 450 books on many subjects, many on philosophy and medicine. His most famous works are *The Book of Healing* and *The Canon of Medicine*, also known as the *Qanun*. He is considered “The Father of modern medicine” and is one of the greatest physicians of all time (Fig. 4).

A number of medical texts have survived from the Salerno school on various aspects of medicine. The best known is the *Regimen Sanitatis Salernitanum*, the *Salerno Book of Health*. The book is filled with practical suggestions for maintaining health, at a time when medicine was largely ineffective in curing sickness.

The study of occupational disease was virtually ignored until 1473 when **Ulrich Ellenbog** published his pamphlet on occupational diseases and injuries among gold miners. He also wrote about the toxic action of carbon monoxide, mercury, lead and nitric acid. The field of industrial hygiene was boosted by his instruction in hygiene and other preventive measures. This period is a start of of descriptive hygienic science development.

**Georg Bauer (Georgius Agricola)** was born in Glauchau, in the province of Saxony (now Germany); Agricola studied classics at the Leipzig University, taught Latin and Greek for a few years, and then in 1522 began to study medicine, first at Leipzig and then at Bologna and Padua in Italy. He took his degree in 1526 and became a practicing doctor; however, he never seems to have been terribly enthusiastic about his profession, devoting most of his energy to studies of mining and geology. He died in 1555, one year before the posthumous publication of *De Re Metallica* (“On the Nature of Metals”). In this book Agricola reviewed everything then known about mining, including equipment and machinery, means of finding ores and occupational diseases of miners (Fig. 5).

**Bernardo Ramazzini** (1633–1714), the father of occupational medicine, publishes *De Morbis Artificum Diatriba* (English title, printed in 1764 was *The Diseases of Artificers, which by their Particular Callings they are most Liable to, with the Method of Avoiding them, and their Cure*). The book describes the hazards of 52 occupations, including leather tanning, wrestling, and grave-digging. Ramazzini says that with a general improvement in diet and less arduous work, people would be better able to resist attacks on their health. Ramazzini also noticed that nuns tended to have a higher incidence of breast cancer and that lead miners and workers often had skin the same color as the metal (Fig. 6).

**Johann Peter Frank** (1745–1821) was born in Rotalben in Bavaria. He studied medicine at Heidelberg University. After taking a French degree at Pont à Mousson to enable him to practise medicine in Lorraine, he lived at Bitsch with his German wife for two years before returning to Germany and joining a practice in Baden. In his spare time he worked at his book on preventive medicine, *System einer vollstandigen medicinischen Polizey*, but when he was unable to find a publisher he threw the volume on the fire. In 1773 he found a patron in the Prince-Bishop of Speyer and rewrote his manuscript on

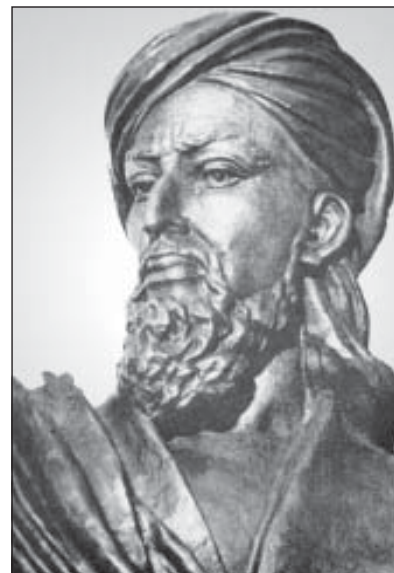


Fig. 4. Abu Ali al-Husain ibn Abdallah ibn Sina



Fig. 5. Georgius Agricola



Fig. 6. Bernardo Ramazzini

public health, which was published by Schwan of Mannheim. Despite the Bishop's patronage his book was frowned on by the church because it disapproved of his criticism of celibacy but he went on to publish five more volumes. Frank conducted a medical "grand tour" of Europe holding chairs at Göttingen, Pavia, Vienna and St Petersburg. In these universities he revolutionized the teaching of medicine and earned the devotion of his pupils. In Vienna, he implemented Jenner's discovery of the value of vaccination and, despite retiring to Freiburg with a pension in 1808, returned to practice in Vienna in 1811 and ended his life there (Fig. 7).

True development of hygiene started with implementing an experimental method.

**Max von Pettenkofer** (1818–1901), a German chemist and hygienist. Pettenkofer is considered to be a founder of hygiene and he is known for his researches in the ventilation of dwellings, sewage disposal, and spread of cholera. He developed a reaction for the detection of bile acids and a method of the quantitative determination of carbon dioxide (Fig. 8).

**Carl von Voit** (1831–1908). A German physiologist whose definitive measurements of gross metabolism in mammals, including humans, helped to establish the study of physiology of metabolism and laid the foundation for modern nutritional science. He is also one of the "fathers" of hygiene of nutrition.

**Carl von Fluegge** (1847–1923) established the first German Institute for Hygiene at Goettingen, and was its first director. He became a professor of hygiene at the University of Goettingen in 1885, in Breslau in 1887, and eventually in Berlin. In 1886, together with Robert Koch, he began publishing the *Zeitschrift für Hygiene* (abbreviated *Z. Hyg.*), under their joint editorship.

**Max Rubner** (1854–1932) studied with Voit; constructed the first accurate respiration calorimeter in Marburg (1889); professor of hygiene (1891) and physiology (1909) in Berlin; developed concepts of proportionality of body surface areas to energy requirements; collaborated with Heubner to measure energy needs of infants.

**Edmund Alexander Parkes** (1819–1876) is a founder of the British hygienic scientific school. During the Crimean war he investigated the sanitary condition of British army. In 1860 he was invited to become the first Professor of the Military Hygiene in the Royal Army Medical School. In 1863 Parkes produced his manual of Practical Hygiene which was to run to four editions within nine years (Fig. 9).

The second half of the XIX century occupies a peculiar place in the world history of formation and development of prophylactic medicine. It was the period when empirical hygiene whose sources had become a thing of the past obtained experimental-scientific substantiation and became one of the leading fields of the contemporary medical science and health care of the population. It was favoured by certain objective conditions, in particular, negative results of industrialization and urbanization, population migration and distribution of mass infectious diseases.

Hygiene had not been delivered at medical faculties in Russia before the 60-s of the XX century. It was a part of various departments and disciplines. There were no practical and separate examination in hygiene, the volume and content of teaching hygiene was not regulated but depended on general education and professional trends of the professor whose department was responsible for teaching hygiene. Hygiene was delivered at the Department of Medical Police that united forensic medicine, medical law, veterinary police with epizootic diseases and hygiene. Due to the objective circumstances listed above and proceeding from the society requirements most competent medical scientists thought it expedient to create a special department of hygiene.

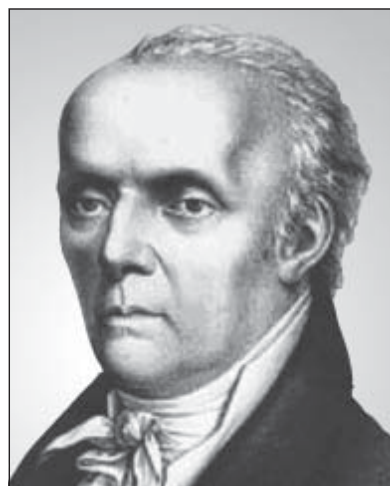


Fig. 7. Johann Peter Frank

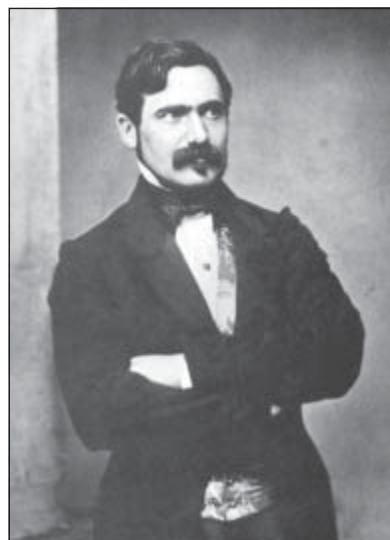


Fig. 8. Max von Pettenkofer

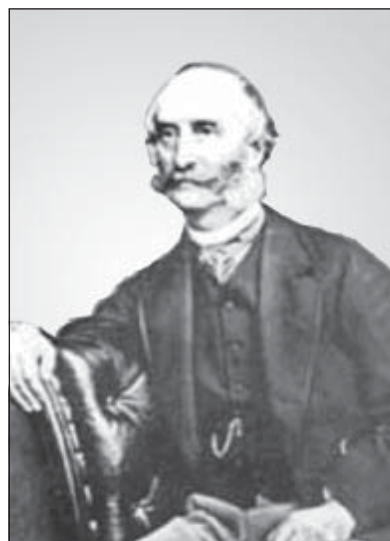


Fig. 9. Edmund Alexander Parkes

**Fedor Erisman (Guldreich Friedrich)** (1842–1915) is a founder of scientific hygiene in Russia and New Independent States. He's Swiss by origin. In 1869–1896 he lived in Russia. Professor of the Moscow University (since 1882), in 1896 he was withdrawn because of political views. He developed classical traits and guidelines in all principal parts of hygiene. In 1891 he organized the first sanitary-epidemiological station in Russia (now — the Moscow Erisman Research Institute of Hygiene) (Fig. 10).



Fig. 10. Fedor Erisman

**Alexey Dobroslavin** (1842–1889) is a founder of experimental and military hygiene in Russia. He created the first hygienic laboratory in St.-Petersburg (Fig. 11).



Fig. 11. Alexey Dobroslavin

**Viktor Subbotin** (1844–1898) is the first Ukrainian professor of hygiene. During 1870 and in early 1871 V. Subbotin, who knew German, worked mainly in Munich in the laboratories of M. Pettenkofer and K. Voit. In 1871, V. Subbotin was elected an assistant-professor of the Kyiv University and soon appointed the Head of the Department of Hygiene, Medical Police, Medical Geography and Statistics. The introductory lecture of the course of hygiene was delivered by V. Subbotin on December 4, 1871 (the first analogous lecture at the Department of Hygiene of the Peterburg Medical-Surgical Academy was read by O. P. Dobroslavin on November, 19 of the same year). The Department of Hygiene at the Medical Faculty of the Kyiv University was the first department of such kind in Ukraine. A credo of V. Subbotin as a teacher was elucidated by the thought that the “task of hygiene teaching cannot and shall not be restricted by the stating of a certain amount of information to the students, it should also consist in the training of physicians who can really be practical specialists in the development of hygienic truth in the personal and social human life”. The results of Subbotin’s investigation have been presented elucidated in 50 publications on various problems of preventive medicine. The works by V. Subbotin are mainly devoted to the problems of general and communal hygiene. Problems of hygiene of hospitals, sanitary protection of water bodies, medical geography occupied the leading place among them (Fig. 12).



Fig. 12. Viktor Subbotin

The modern period of hygiene development is characterised by development of risk assessment and management in environmental science and integration with other branches of preventive medicine.

### HISTORY OF THE GENERAL HYGIENE DEPARTMENT OF THE ODESSA STATE MEDICAL UNIVERSITY

The General Hygiene Department of the Odessa Medical Faculty was founded in 1903 by **Grigory Khlopin**. His scientific works promoted the experimental direction in hygiene. The equipment of department was very contemporary, it used the best technical and scientific achievements of that time. Khlopin was the head of the department in 1903–1904. He investigated the influence of sanitary state of city and sea port on morbidity and mortality. 146 scientific works were written by Khlopin. His themes were environmental health, sanitary microbiology, epidemiology, hygiene of nutrition, occupational and military hygiene (Fig. 13).

In 1904 the head of the department was **Magnus Blauberg**. He made the fundamental researches in the problems of wine falsification and other aspects of hygiene of nutrition.

**Ivan Kiyanitzin** was the head of the General Hygiene Department in 1905–1915. He's written over 30 scientific works about chemical analyses of water, air, food.

57 scientific works on hygiene of nutrition, military hygiene were the result of **Nickolay Kostyamin's** activity. He was the Head of the



*Fig. 13.* Grigory Khlopin

Department in 1915–1952. The Odessa regional society of hygienists and epidemiologists was founded by him in 1938.

**Alexander Stoyanovsky** was the Head of the General Hygiene Department in 1952–1966. He was the author of 60 scientific works. He wrote the theme “Water and Water Supply” in the hygiene textbook that had many editions. The book “The Influence of Surrounding Conditions upon Immune-Biologic Reactivity of the Organism” was one of the first in the USSR on theme of methatotoxic action of harmful determinants of environment and immunologic changes in the human organism.

The way from a post-graduate student to the head of general hygiene department was gone by **Dmitry Babov**. He was the Head of the Department from 1966 to 1983. His scientific interests were based mainly on elaboration of communal hygiene.

In 1983–1996 and since 2004 Nickolay Nadvorniy is the Head of the General Hygiene Department. He is considered to be a founder of maritime hygiene in Ukraine. His 214 works dedicated to the problems of environmental and occupational health.

### CLIMATES AND HEALTH

The human organism exists constantly interacting with the environment, one of the most important components of which is climate. Tropic hygiene is marked out as a special field of hygiene owing to the fact, the climate of tropics has a great influence upon the hygienic life conditions and the conditions of human health.

Climate is a long-term weather regimen, corresponding to the geographical country and repeating appropriately.

Main climate-forming factors are: the latitude of the country and the intensity of solar irradiation, the appropriateness of atmospheric circulation, the type of land surface (dry land, relief, water and so on), the closeness of seas and oceans.

Climate-weather conditions have a direct or mediated influence upon people. The examples of a direct influence are: the action of weather conditions upon human heat exchange, ultra-violet rays of solar radiation — upon the exchange of calcium. The latter is a very important thing for the prophylaxis of rickets.

Mediated action of climate is connected with the influence upon the character of human household and working activity, upon the pathological agents of infectious diseases and their carriers. The latter fact conditions the geographical specificity of spread of different diseases. That's why regional climatic conditions must be taken into consideration while working out hygienic recommendations for the civil (dwelling houses, hospitals) and industrial buildings, rational nourishment and way of life, for the choice of adequate clothes and footwear, work and rest regimen, prevention of diseases and education of the future generations. In his "Aphorisms" Hippocrates said, that the diseases proceeded differently in different climatic conditions. He offered the climate therapy for the treatment and health improvement, which is widely practiced at present.

Usually a certain climate is spread over the large area about hundreds and even thousands kilometers. However, some regions of this large area can differ by their climate-weather conditions from each other. That's why such a notion as microclimate was approved in climatology (the science about the Earth's climate). It means the features of physical condition of the near land layer above a relatively small plot of the land. So, we can speak about the microclimate of the wood, field, sea-coast, mountain slopes, oriented to the parts of the world differently, about the microclimate of a vale, a town, a street and so on.

Now, many sciences adjoining to the climatology are developed. Medical climatology studies the influence of climate-weather conditions upon the human organism and works out the methods of using climatic factors with the treatment and prophylactic aim. Medical geography studies the appropriateness of influence of climatic and social-economic conditions upon hygienic life conditions, health conditions and features of infectious and non-infectious diseases spread in different geographical regions. The materials of investigations are widely used in the working out and planning of corresponding programs and prophylaxis.

From the medico-geographical point of view tropics are the part of earth's surface, situated in the equatorial (from latitude 10 degrees North to latitude 20 degrees South), torrid (from latitude 10 to 20 degrees North and from latitude 10 to 20 degrees South) and subtorrid zones (from latitude 20 to 30 degrees North and from latitude 20 to 30 degrees South).

Medical climatology considers the climate of these zones as tropical. Tropics contain a considerable part of dry land, almost the whole Africa, Southern Asia and the south of East Asia, a large part of Latin America, Oceania. More than a half of people live in this part of the Earth. The transitional zone adjoins the torrid zone (Mediterranean

region, the Front and the Middle Asia, the south of the USA, some regions of the Far East). They are characterized by the features of torrid and temperate zones.

**The Köppen Climate Classification System** is the most widely used for classifying the world's climates. Most classification systems used today are based on the one introduced in 1900 by the Russian-German climatologist Wladimir Koeppen. He divided the Earth's surface into climatic regions that generally coincided with world patterns of vegetation and soils.

The Koeppen system recognizes five major climate types based on the annual and monthly averages of temperature and precipitation. Each type is designated by a capital letter (Fig. 14).

**A** — Moist Tropical Climates are known for their high temperatures a year round and for their large amount of a year round rain.

**B** — Dry Climates are characterized by little rain and a huge daily temperature range. Two subgroups, **S** — semiarid or steppe, and **W** — arid or desert, are used with the **B** climates.

**C** — In Humid Middle Latitude Climates land/water differences play a large part. These climates have warm, dry summers and cool, wet winters.

**D** — Continental Climates can be found in the interior regions of large land masses. Total precipitation is not very high and seasonal temperatures vary widely.

**E** — Cold Climates describe this climate type perfectly. These climates are part of areas where permanent ice and tundra are always present. Only about four months of the year have above freezing temperatures.

Further subgroups are designated by a second, lower case letter which distinguish specific seasonal characteristics of temperature and precipitation.

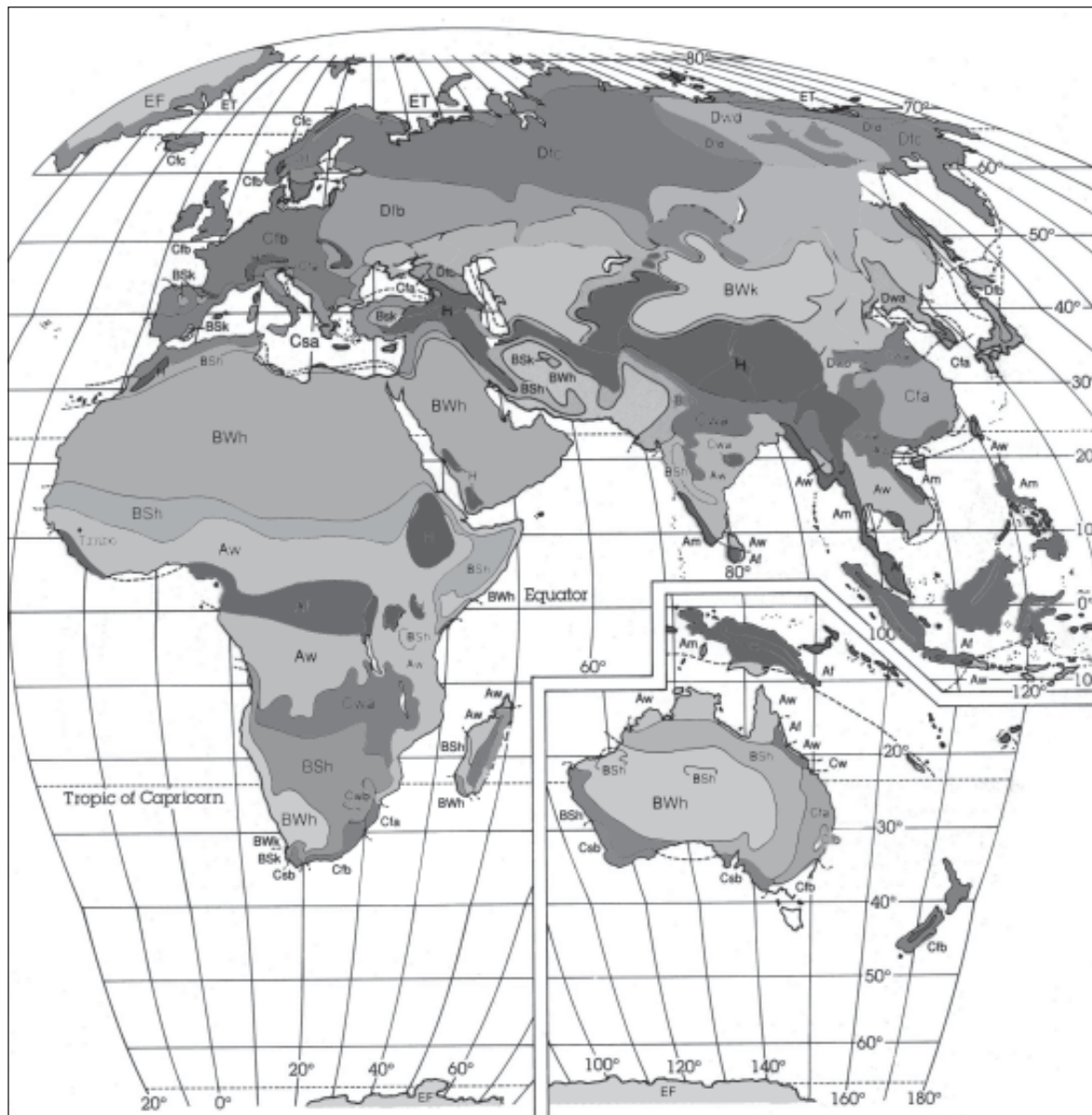


Fig. 14. Climate Classification by Koeppen



**f** — Moist with adequate precipitation in all months and no dry season. This letter usually accompanies the **A**, **C**, and **D** climates.

**m** — Rainforest climate in spite of short, dry season in monsoon type cycle. This letter only applies to the **A** climates.

**s** — There is a dry season in the summer of the respective hemisphere (a high-sun season).

**w** — There is a dry season in the winter of the respective hemisphere (a low-sun season).

To further denote variations in climate, a third letter was added to the code.

**a** — Hot summers where the warmest month is over 22°C. These can be found in the **C** and **D** climates.

**b** — Warm summer with the warmest month below 22°C. These can also be found in the **C** and **D** climates.

**c** — Cool, short summers with less than four months over 10°C in the **C** and **D** climates.

**d** — Very cold winters with the coldest month below — 38°C in the **D** climate only.

**h** — Dry-hot with a mean annual temperature over 18°C in the **B** climates only.

**k** — Dry-cold with a mean annual temperature under 18°C in the **B** climates only.

Heat and precipitation extremes are presented in Tables 1–3.

**Hygienic Meaning of Solar Radiation in Tropical Conditions.** The sun is the origin of heat, light and power for the biosphere. Solar power forms air currents and the change of weather connected with them. It determines the climate of the country and makes the existence of organic life possible. Food contains the power of the sun, at the expense of which we live.

Table 1. **Highest Temperature Extremes**

Continent	Highest temp., °C	Place	Altitude, m	Date
Africa	57.8	El Azizia, Libya	110.1	September 13, 1922
North America	56.7	Greenland Ranch. Death Valley. CA	-53.4	July 10, 1913
Asia	53.9	Tirat Tsvi, Isreal	-216.6	June 21, 1942
Australia	53.4	Cloncurry, Queensland	186.6	January 16, 1889
Europe	50.0	Seville, Spain	7.8	August 4, 1881
South America	48.9	Rivadavia, Argentina	202.8	December 11, 1905
Antarctic Region	15.0	Vanda Station, Scott Coast	14.7	January 5, 1974

Table 2. **Highest Annual Precipitation Extremes**

Continent	Highest average, cm	Place	Altitude, m
South America	1331	Lloro, Columbia	156.0
	894	Quibdo, Columbia	36.0
Asia	1186	Mawsynram, India	1.4
Pacific Ocean	1168	Mt. Waialeale, Kauai, HI	1.5
Africa	1029	Debundscha, Cameroon	9.0
Australia	864	Bellenden Ker, Queensland	1.5
North America	650	Henderson Lake, British Columbia	3.6
Europe	465	Crkvica, Bosnia-Hercegovina	1.0

Table 3. **Lowest Annual Precipitation Extremes**

Continent	Lowest average, cm	Place	Altitude, m
South America	0.1	Arica, Chile	28.5
Africa	0.3	Wadi Halfa, Sudan	123.0
Antarctic Region	2.0	Amundsen-Scott South Pole Station	2.8
North America	3.0	Batagues, Mexico	4.8
Asia	4.6	Aden, Yemen	6.6
Australia	10.3	Mulka, South Australia	48.0
Europe	16.3	Astrakhan, Russia	13.5
Pacific Ocean	22.7	Puako, Hawaii, HI	1.5

Solar irradiation, reaching the surface of the earth, consists of 59% of infra-red irradiation, 40% of visible one and 1% of ultra-violet rays. Ultra-violet irradiation is divided into 3 parts: A (the length of the wave is 400–315 nm), B (315–290 nm), C (290–180 nm). The irradiation from the part C doesn't reach the surface of the earth, as it is absorbed by ozone, placed at a height of 20–30 km.

Infra-red irradiation penetrates deeply through the skin and provokes heat effect, the following increase of tissue temperature, hyperemia and the increased metabolism in the skin. It strengthens biological action of ultra-violet irradiation. This feature is used in medicine.

Visible solar irradiation performs the same biological action as infra-red one. Besides, it has photochemical effect. This effect is weaker than ultra-violet one, as the power of its quanta is enough only for the molecules of some matters. These matters are optic pigments. Under the influence of visible irradiation the biochemical reactions, generating electrical impulses, proceed in retina. They form light sensation.

The light is an important physiological irritant, which activates the processes of excitation in brain cortex. That's why in good lighting the activity of the visual and other analyzers is improved. The matters, formed in retina during photochemical action stimulate the function of hypophysis and the cells of the central nervous system. That's why the light has a positive influence upon the emotional sphere, improves organism condition and metabolism. It means that visible irradiation stimulates the organism not only by visual analyzer, but also by the skin, as we can find some protoporphyrin in blood, which is a photosensibilisator. By pellagra, porphyrins quantity in blood is increased, that's why photodermatitis and the following pigmentation develop in the parts of the skin, irradiated intensively (skin, face). Sulphanile amides and some other medicines are also photosensitizers. During treatment by these medicines we must avoid intensive solar irradiation.

Ultra-violet irradiation, in particular of the part B, is characterized by the strong photochemical action. It provokes the decay of albuminous molecules (protein photolysis), as a result physiologically active compounds are formed (choline, acetyl choline and so on). They activate the sympathetic-adrenal system, metabolic and atrophic processes. UV-rays stimulate tissue growth and regeneration (including postoperational measures), blood production, immunogenesis, organism resistance to infectious, toxic and carcinogenic agents. They improve physical and mental working ability.

So, certain doses of ultra-violet irradiation are a strong adaptogenic factor, which increases health level. Stimulated diseases (hypertension, arteriosclerosis, cancer, nephritis) develop in the irradiated animals more slowly. Besides, ultra-violet rays

of the part B have an anti-rachitic action as vitamin D<sub>3</sub> is formed from 7.8-dehydrocholesterol under their action.

The thickening and the hardening of epidermis and the formation of melanin are very important protective reactions, which condition the adaptation of the organism to the solar irradiation. The thickened horny layer of epidermis protects from the most active ultra-violet irradiation. Melanin is formed in the cells of the deepest layer of epidermis, it protects the cells of derma, vessels and nerves from visible and infra-red rays, which can provoke their overheating. Melanin is accumulated in the lowest layers of the skin in the people with the white skin. The people with the dark skin have more melanin and it is placed in the more superficial layers too. Melanin is not only a passive shield. Owing to its chemical structure it extinguishes the surplus of free radicals, formed during solar irradiation in the skin. This protective function isn't less important than the absorption of heat rays for the people, who live in tropics. Skin cancer occurs more seldom in people with dark skin than in people with white skin in tropics.

Ultra-violet rays (the part B) have bactericidal feature, connected with its photochemical action, which damages nucleic compounds of the bacterial cell. Vegetative forms of bacteria, viruses, worms eggs die under the direct sun rays in 10–15 min., spores — in 40–60 min. It is of great importance for the sanitation of the environment in the conditions of hot climate. Short-wave ultra-violet irradiation (the part C) has the most expressed bactericidal action. It is generated by mercury-quartz lamps and special bactericidal (luminescent) lamps. They are used for the disinfection of water, air, rooms, surgical instruments and so on.

Lately it has been found out, that very toxic compounds could be formed during the irradiation of matters, polluting air and ground. So, the complex of compounds, called photooxidators, is formed as a result of solar irradiation action upon the components of exhaust gases in the atmosphere of towns. They provoke strong irritation of mucous membranes of the eyes and upper respiratory ways (epiphora, unbearable cough), the death of plants, accumulating in the streets of towns in sunny weather. The poisonous photochemical mists are observed in towns with the expressed solar irradiation (Los Angeles, Mexico, Tokyo)<sup>1</sup>. Hard poisonings of country-men, who worked in the fields, had been treated by polychlorpinen, in sunny weather were observed in Iran and some other countries. Very poisonous compounds, formed from polychlorpinen, were found out in the near-land layer of atmosphere. The photochemical activity of solar irradiation is 2–9 times more in tropical countries than in European ones.

<sup>1</sup>See section "Air Pollution".

The biological method is widely used to measure the intensity of ultra-violet irradiation. The unit of measurement is biodose. It is the smallest quantity of ultra-violet irradiation, provoking hardly visible hyperemia of untanned skin in 6–20 h after the irradiation. The minimum daily prophylactic dose preventing rickets in white people is 1/8 of biodose. The optimal dose with the adaptogenic meaning is 1/4–1/2 of biodose. The minimum and optimum dose in aboriginals of hot countries is 2.5–5 times more and it depends on the color of the skin. Ultravioletmeter is a special device used in medicine. Ultra-violet irradiation is absorbed by photoelement and the generated electrical current is registered by galvanometer. The scale of galvanometer is graduated by mcW/cm<sup>2</sup>. One biodose is equal to 600–800 mcW/cm<sup>2</sup>. Consequently, minimum physiological request of a white man is 100 mcW/cm<sup>2</sup>, optimum — 200–400 mcW/cm<sup>2</sup>. These indices make 250–500 and 500–2,000 mcW/cm<sup>2</sup> correspondingly for a black man. The intensity of UV-irradiation makes 15–20 mcW/cm<sup>2</sup> per minute at a noon in a bright sunny day in tropics. So, a white man will get his prophylactic dose in 5–10 min, and a black man — in 15–20 min.

The total flow of solar irradiation consists of the direct radiation, coming directly from the sun, and the dispersed one from the whole sky. If the sky is clear, the intensity of the dispersed radiation isn't considerable, but it contains a large percentage of UV-rays. So, if the total intensity of UV-irradiation is 20 mcW per min. on a bright sunny day, then the direct irradiation makes 12 mcW per min and the dispersed one — 8 mcW per min. (40%). This fact is used in medicine. People, whom the long stay in the sun is contraindicated, can get their prophylactic dose of ultra-violet irradiation by the dispersed radiation in the shade. In cloudy sky, the part of the dispersed radiation makes 0.4–0.5 cal/cm<sup>2</sup> per min., but it is poor in UV-rays (especially B rays).

Due to the air pollution by the dust and smoke in the settlements we lose 20–40% of UV-radiation. Owing to the admixture of iron and titanium window glass keeps about 80–90% of valuable UV-radiation of the part B. The glass free of this admixture makes way for the most part of UV-rays and it can be used in hospitals and children's institutions.

The deficient irradiation of the organism by necessary UV-radiation ("sun starvation") is observed in the north latitudes and in winter — in the middle latitudes. It is connected with the increased number of cloudy days, short stay in the open air, warm clothing. It decreases the organism adaptation, leads to anemia, worsens tissue regeneration, resistance for toxic, cancerogenic, mutagenic, infectious agents. The deficient synthesis of vitamin D<sub>3</sub> and accompanying disturbance of calcium and phosphorous metabolism provokes rickets in children and osteoporosis, insufficient regeneration of bones af-

ter the fracture, the increase of teeth decay rate in adults. In the northern latitudes the prophylactic irradiation by UV-rays is widely used to prevent "sun starvation" (pregnant women, miners). These measures are carried out with the help of erythemaluminous lamps, their spectrum is 20% of visual irradiation, 45% of UV-irradiation of the part A and 35% of the part B.

Endemic rachitis among young children was found out even in Greece and the Mohammedan countries. It is connected with the traditions. Pregnant women, nursing mothers and young children don't leave the rooms. The woman's body is clothed, the skin is irradiated weakly and their milk have almost no cholecalciferol. The resistance of the diseased children to the action of harmful factors is decreased. When the children become older, they stay in the open air more often and become cured from rickets. The food containing enough calcium is necessary for a quick recovery.

Some people suffer from symptoms of depression during the winter months, with symptoms subsiding during the spring and summer months. This may be a sign of Seasonal Affective Disorder (SAD). SAD is a mood disorder associated with depression episodes and related to seasonal variations of light. SAD was first noted before 1845, but was not officially named until the early 1980-s. As sunlight has affected the seasonal activities of animals (i.e. reproductive cycles and hibernation), SAD may be an effect of this seasonal light variation in humans. As seasons change, there is a shift in our "biological internal clocks" or circadian rhythm, due partly to these changes in sunlight patterns. This can cause our biological clocks to be out of "step" with our daily schedules. The most difficult months for SAD sufferers are January and February, and younger persons and women are at higher risk. Symptoms include:

- regularly occurring symptoms of depression (excessive eating and sleeping, weight gain) during the fall or winter months;
- full remission from depression occur in the spring and summer months;
- symptoms have occurred in the past two years, with no nonseasonal depression episodes;
- seasonal episodes substantially outnumber nonseasonal depression episodes;
- a craving for sugary and/or starchy foods.

Melatonin, a sleep-related hormone secreted by the pineal gland in the brain, has been linked to SAD. This hormone, which may cause symptoms of depression, is produced at increased levels in the dark. Therefore, when the days are shorter and darker the production of this hormone increases.

Phototherapy or bright light therapy has been shown to suppress the brain's secretion of melatonin. Although, there have been no research findings to definitely link of this therapy with an antidepress-

sant effect, many people respond to this treatment. For mild symptoms, spending time outdoors during the day or arranging homes and workplaces to receive more sunlight may be helpful. One study found that an hour's walk in winter sunlight was as effective as two and a half h under bright artificial light.

Naturally, the pathology, connected with the hyperirradiation, is more urgent for the tropics. The stay in the open sun with the uncovered head leads to sun stroke. This affection is observed by the local irradiation of the head and neck. Hyperthermia promotes it. The cause of the local over-heating is infra-red and partially visible irradiation, heating cranial bones (sun stroke). The clinical course presents headache, the disturbance of cardiovascular activity, loss of consciousness, convulsions and death in severe cases.

Heat stroke is the most dangerous for children. The prophylaxis consists of the covering of the head and prevention of total hyperthermia. Besides, solar irradiation can increase hyperthermal action of high temperature of air and can promote the appearance of heat stroke. The stay in the open sun is equivalent to the increase of air temperature by 5–6°C.

The prolonged stay of undressed man in the open sun can provoke the skin inflammatory reaction — photoerythema. If most part of the skin is irradiated, photoerythema is accompanied by increase of the body temperature and total indisposition. The cause of photoerythema is a surplus irradiation by UV-rays. Infra-red and visible irradiation increase the action of ultra-violet radiation. The latent period lasts for some h. Then at the place of irradiation we can observe the dilation of vessels, swelling of epidermal cells, the appearance of infiltration, the increased pigmentation. The skin becomes less sensitive to UV-rays.

The experiments showed that chronic large doses of UV-radiation provoked the decrease of organism resistance to the harmful factors in laboratory animals (the doses exceed 0.5–1.0 biodose). It is confirmed by the experiments with people. We can observe the worsening of self-condition, the decrease of resistance to the harmful agents, progression of cardiovascular diseases and chronic inflammations (tuberculosis), disposition to the allergic reactions.

It is known that surplus solar irradiation provokes the increased rate of face and lips skin cancer (Fig. 15). So, cancer increases from the north to the south. It doubles every 4–6 degrees of latitude. Skin cancer makes 20–22% from other forms of cancer in the hot regions and only 4–7% in the north. The newly arrived are affected by cancer of the facial skin 10–12 times more than inhabitants, who defend their face better. The aboriginals of South Africa are affected by skin cancer 27 times less than white people.

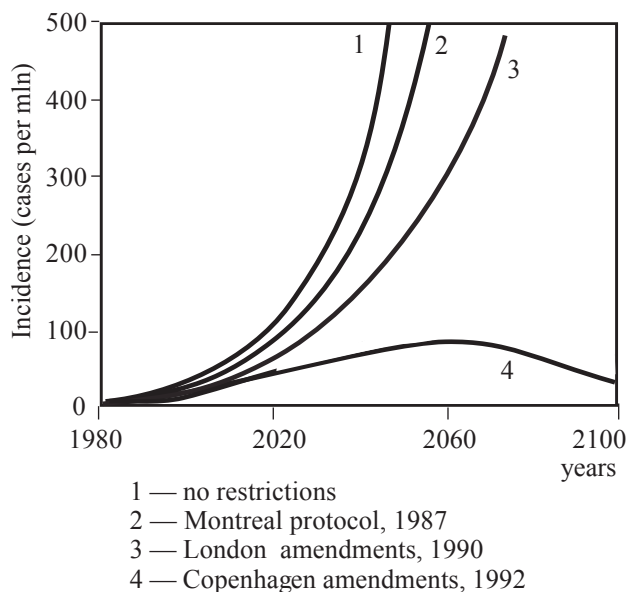


Fig. 15. Skin Cancer Incidence

It is not difficult to prevent hyperirradiation. It is necessary to carry out medical recommendations as to sun baths and work in the open air. Young children, old men, people suffering from cardiovascular, chronic inflammatory, allergic diseases should get their prophylactic dose in the shade, avoid hyperirradiation and the progression of chronic pathology.

## HOT CLIMATE IMPACT ON HEALTH

Most of people gradually adapt to every climate. The adaptative physiological reactions are based on reflexes, which are mobilized under the action of heat or cold. The development of human pathological conditions under the influence of hot tropical climate can be caused by some interconnected factors:

- 1) the disturbance of thermoregulation;
- 2) the disturbance of regulation of water-electrolyte balance;
- 3) the disturbance of cardiovascular regulation.

Under the influence of heat, mainly physical and partially chemical phases of thermoregulation are activated. Heat emission increases and heat-production decreases. Both processes act at the same time. But in hot conditions the chemical thermoregulation isn't as powerful as the physical one.

In dry hot climate the evaporation proceeds easily. By 29°C heat emission increases from 12% to 70%. But if the humidity grows on, the air cannot absorb water and heat. The thermoregulation becomes disturbed and the overheating develops. In such conditions the air movement is very important for the comfort.

*Acclimatization* for the hot climate is a process of adaptation to increased heat loads. It is shown as the lowering of muscular tone, intensification of

thermoregulation, an ability to make much sweat in proportion to heat load and to lower salt concentration in sweat, by the inadequate liquid intake.

It is found out that the acclimatization has some phases:

- Stage of “alarm” (the first h in a new environment)
- Replacement of the old dynamic stereotype
- Incomplete acclimatization
- Complete acclimatization

Physiological changes can turn into pathological ones under certain conditions. Mental health has a great importance for the acclimatization.

Most of people, being in tropical countries, are able to acclimatize in 3 weeks. Some people with good thermoregulatory abilities can acclimatize in 5–7 days. But there are some people very sensitive to the heat stress, who cannot acclimatize at all.

There are some clinical and experimental data, which are evidence of the advisability of human preliminary training to the action of high temperature to get quick acclimatization. It is realized by daily staying in a heat chamber, where we can model different types of hot climate. Muscular work facilitates the adaptation to heat.

The clothes, the formation of artificial microclimate (air conditioning) have a great importance for the organism protection from surplus heat and solar irradiation.

The breach of water-salt exchange under the influence of surplus heat is characterized by the next syndromes: (1) hyposodiumaemia (the syndrome of salt insufficiency) and (2) simple dehydration without salt loss.

In hot climate we usually meet dehydration, but sometimes we can observe both syndromes. There isn't a common classification of *heat exhaustion*. Most of authors mark out the following basic forms:

#### 1. Heat exhaustion with salt insufficiency.

The most considerable predisposing factors are abundant perspiration with the unrestored water and salt loss, gastro-intestinal disorders with vomiting and diarrhea. This type of heat exhaustion is usually met during hard physical work in hot conditions. The disturbance of water-salt balance (hyposodiumaemia) and vascular insufficiency occur in the first place.

*Clinical course.* The patient complains of headache, the absence of appetite, sickness, vomiting. Gradually, painful muscular spasms mainly in the muscles of calves and feet develop. It is typical of the patients with the repeated vomiting. Other symptoms are oliguria, vertigo, ataxia, and hallucinations. In severe cases the excitement, turning into the sharp inhibition of mental activity and even coma develop. We can observe the signs of the organism dehydration, orthostatic unsteadiness, vascular insufficiency with the decrease of circulating blood vol-

ume, the increase of its viscosity, hematocrit, the number of RBC. In this case the condition could be accompanied by anuria and necrosis of renal canals. Chlorides concentration in urine is lowered. Hyposodiumaemia and hypochlorideaemia are found out in blood.

#### 2. Heat exhaustion with mainly water insufficiency.

Slight cases are met in the everyday life in tropics (when water loss isn't restored). The expressed forms occur seldom (for example, when the man stays in a desert for a long time). In mild cases the patient complains of headache, vertigo, weakness, oliguria, a little increase of the body temperature. In severe cases, the complaints are: thirst, vascular collapses, difficult swallowing. The tongue and the mucous membranes of the oral cavity are dry. The body weight is decreased. Other symptoms are dyscoordination, coma quickly leading to death. Sometimes, the fit of hyperpyrexia precedes the death.

*Prophylaxis.* The regulation of water regimen should be followed during the whole hot season. Daily quantity of water is determined by the conditions of environment, the intensity of muscular work, the peculiarities of metabolism, the quantity and quality of food. The surplus and irregular drinking leads to the ineffective perspiration. It is recommended to use: 0.5% solution of sodium chloride, green tea, iced acidulated tea, mineral water, fizzy water. It is advisable to add some condensed milk to drinking water. Tomato juice with the table salt, raw fruits, water-melon, melon; grape-fruit, lemon, orange juice, tamarind juice, soft mineral drinks slake the thirst. The shower, bathing promote the prophylaxis of over-heating. It is necessary to avoid use alcohol and it is very important to follow the rules of personal hygiene and the day regime.

**Heat Fever.** Hyperpyrexia — is an acute over-heating of the organism, caused by the disturbance of thermoregulation in hot climate, in hot period of the year, during stay in overheated premises (hot shops). Usually it is observed in untrained newly arrived in tropics or hot countries. Under the influence of heat, their thermoregulatory system becomes exhausted. Hyperthermal diseases (malaria, tropical jungle), alcohol intoxication, vegetative dystony, etc. have an influence upon the occurrence of heat hyperpyrexia.

*Clinical course* is variable. The symptoms of *heat stroke* occur during the maximum insolation and sometimes after the patient has come from the sun to the shade. If you bring the patient out of a hyperthermal zone in the prodromal period of the disease, help him quickly, the reaction is characterized by faint, feeling of closeness, weakness, a little increase of temperature, the dilation of pupils, dyspnoe.

In severe cases, the symptoms grow quickly. After the repeated faints with the dramatic adynamia,

a severe headache, weakness in legs, tachycardia, sleepiness, sickness, frequent, superficial breathing, the squeezing in the chest develop. The skin is dry. Other symptoms are oliguria, photophobia, the hyperaemia of the face and conjunctives, narrow pupils. Salt insufficiency does not always occur. Then, we can observe a severe neurological condition: the increasing headache, excitement. Muscular fibrillations, epileptoid convulsions often occur. The breathing is superficial, frequent, and irregular. The body temperature increases up to 41–43°C. The patient loses consciousness, his pupils are dilated and don't react to the light, the pulse is faint, filiform, the peripheral blood supply is decreased. The skin is dry, hot or covered with sticky sweat. The face is pale, cyanotic. The defecation is irregular. Abdominal reflexes are lowered or absent. Usually we can reveal albuminuria. The shock develops.

*Prophylaxis.* It is necessary to avoid the prolonged stay in the open sun with the uncovered head. The next measures are: rational work conditions, clothes, right water regimen, the training of acclimatization.

## CLIMATE CHANGE AND HEALTH

Climate influences many of the key determinants of health: temperature extremes and violent weather events; the geographical range of disease vectors; the quantity of air, food, and water; and the stability of the ecosystems which we depend on.

Because climate affects us in so many ways and because the details of how the global climate may change are so uncertain, prediction of the health effects of climate change is vague. But given what is already known about the connection between climate and health and the magnitude of the global warming that scientists project, predict that future health effects can be substantial. These effects are likely to vary widely from region to region, because climate itself is predicted to change differently in various regions. For instance, temperatures are expected to rise more in some areas than others; some places will likely get drier, while others will get more rain than they do nowadays.

Health impacts of climate change include direct effects from temperature and weather extremes and from sea-level rise. A number of indirect impacts are also likely to arise from changes in precipitation and temperature patterns, which may disturb natural ecosystems, harm agriculture and freshwater supplies, exacerbate air pollution level, and cause large-scale reorganisation of plant and animal communities. These indirect effects may, in the long run, have greater cumulative impacts on human health than the direct effects.

**Direct Impacts.** One of the most easily imagined impacts of global warming is an increase in the

number and severity of heat waves. Heat stress is a well-known danger during prolonged bouts of hot weather, especially in cities, which tend to trap heat. In both New York and Shanghai, for instance, records show that daily mortality rates increase sharply once temperatures exceed a certain threshold. During intense heat waves, the death toll attributed to heat stress can be surprisingly high, as occurred in Chicago in July 1995, when heat stress killed 726 people during a 4-day heat wave.

Midlatitude cities including Washington, Athens, and Shanghai seem to be at greatest risk for deadly heat waves. In these cities, residents (especially elderly, very young and poor ones) are not acclimatized to extremely hot weather and are thus more vulnerable to heat stress.

Among these vulnerable groups, the existence of previous health problems, greater heat exposure due to substandard housing, and lack of access to air conditioning are all factors leading to higher heat-related mortality. By the middle of the next century, climate change could increase the frequency of very hot days. The normally hotter average temperatures in tropical and subtropical cities seem to help residents accommodate heat waves better, so they suffer fewer heat-stress problems, although heat-related deaths during a 1995 heat wave in New Delhi indicate that even residents in the tropics can be susceptible to extreme temperatures.

Conversely, a potential health benefit of warmer global temperatures could be fewer cold-related deaths as winters become milder. A recent British study estimated that by 2050 an increase in the average wintertime temperature by 2.0°C to 2.5°C, as predicted by some climate models, might result in as many as 9,000 fewer cold-related deaths per year in England and Wales. Yet, this decrease in winter mortality would probably only partially offset additional heat-related deaths; studies indicate that higher mortality is generally associated with heat waves than cold spells.

In addition to more frequent heat waves, global climate change is expected to result in greater weather variability overall. In particular, climatologists believe that relatively small changes in the average global climate in the future could produce large changes in the frequency of extreme weather events, such as hurricanes (cyclones), violent thunderstorms, and windstorms. Through flood and wind damage, these natural disasters already exact a heavy burden in the destruction of lives and property.

Rising sea levels, another expected consequence of global warming, could adversely affect the health and well-being of coastal inhabitants. Sixteen of the world's largest cities with populations of more than 10 million are located in coastal zones, and coastal populations are increasing rapidly worldwide. Some projects predict that sea level will rise between 0.3 and 1.0 meter by 2100, with a best-guess estimate of 0.5 meter.

The most immediate threat from such a rise would be to those who live directly on the coast, in low-lying areas such as river deltas, or on small island nations such as the Maldives, the Marshall Islands, Kiribati, and Tonga, where land is virtually all within a few meters of sea level already. Rising seas would inundate many of these islands, increase storm damage to the remaining land, and contaminate the freshwater supplies found in island aquifers.

Delta regions such as the Ganges-Bramaputra delta in Bangladesh, the Nile delta in Egypt, or the Niger delta in Nigeria could also suffer a similar fate. The situation in Bangladesh's densely settled Ganges-Bramaputra delta is probably the most serious. A recent study projects that a 1-meter sea rise could inundate 17% of Bangladesh's total land area and displace about 11 million of people (at current population densities). In the Nile delta, a 1-meter rise would displace around 6 mln of people unless costly protection efforts were mounted; and in the Niger delta, a similar rise would inundate 15,000 km<sup>2</sup> of land and force about a half million people to relocate.

According to the United Nations' Intergovernmental Panel on Climate Change (IPCC), anthropogenic greenhouse gas emissions are significantly altering the Earth climate. By the year 2100, average global temperatures are projected to rise by 2.0–2.5°C (range 1.5–4.0°C). This projected rise in temperature represents a five-fold faster rate of warming than that observed over the past century. These IPCC figures even assume a reduction in global economic growth rate slowed population growth over the next half century and improved conservation measures. These projections are consistent with climate sensitivity to atmospheric CO<sub>2</sub> concentrations observed from ice core data extending over 158,000 years. Sea level also is expected to rise by about 34–52 cm by the year 2100 as a result of ocean thermoexpansion and by melting of glaciers.

Nowadays the medical community is beginning to examine the consequences that these projections may portend for public health, and the World Health Organisation considers global warming as a serious public health challenge for the future.

Under the conditions of global warming, direct hazards to human health (e.g. urban heat-island effect and harmful air pollution) may become significant public health problems given current trends in urbanization. Warmer temperatures combined with increased ambient UV radiation could worsen photochemical smog, especially over urban areas. Elevated night-time temperature readings are the most significant meteorological variable contributing to heat-related mortality; the greenhouse effect is predicted to especially affect these minimum temperatures, and studies estimate a 3 to 4-fold increase in heat-mortality in large temperate cities under a dou-

bled atmospheric CO<sub>2</sub> scenario (which could occur by the year 2040 if current fossil fuel emission trends continue).

Infectious agents which cycle through cold-blooded insect vectors to complete their development are quite susceptible to subtle climate variations. In temperate regions, climate change would affect vector-borne diseases by altering the vector's range, reproductive and biting rates, as well as pathogen development rate within the vector host.

Malaria and dengue fever serve as prime examples of climate sensitive diseases. The geographic range of malaria is generally limited to the tropics and subtropics because the Plasmodium parasite requires an average temperature above 16°C to develop. Freezing temperatures kill overwintering eggs of *Aedes aegypti*, the mosquito carrier of dengue and yellow fever. Warming trends, therefore, can shift vector and disease distribution to higher latitudes or altitudes, as was observed in Mexico when dengue reached an altitude of 1,700 meters during an unseasonably warm summer in 1988. In an earlier study in Mexico, the most important predictor of dengue prevalence in communities was found to be the median temperature during the rainy season. Temperature also drives epidemic dynamics of dengue transmission. Viral development time inside the mosquito also shortens with higher temperatures, increasing the proportion of mosquitoes that become infectious at a given time. Thus, mosquitoes bite more frequently and are potentially more infectious at warmer temperatures.

Climate-related increases in sea surface temperature can lead to higher incidence of water-borne cholera and shellfish poisoning. Marine phytoplankton blooms include red tides that cause diarrheal and paralytic diseases. *Vibrio cholerae* has been found to be associated with marine zooplankton, and blooms from warmer sea surface temperatures could expand this important reservoir from which cholera epidemics may arise.

Human migration and damage to health infrastructures from the projected increase in climate variability and severity of storms could threaten human shelters and public health infrastructures and indirectly contribute to disease transmission. Human susceptibility to disease might be further compounded by malnutrition due to climate impacts on agriculture.

We need to understand better the linkages between climatological and ecological change as determinants of public health. Addressing this newly recognized threat will require interdisciplinary cooperation among health professionals, climatologists, biologists and social scientists, and will necessitate research beyond conventional dose-response linear relationships to address complex systems-based ecological processes.

## WEATHER AND HEALTH

Weather is a complex of physical features of the nearland atmospheric layer during a relatively short period of time (hours, days, weeks). The weather is characterized by the complex of meteorological elements: solar irradiation, temperature, humidity, air speed and direction, atmospheric pressure, electrical condition of the atmosphere, cloudiness and the presence of precipitations.

Consequently, the weather is a changeable process, as the climate is stable one and it has a prolonged influence upon the human organism.

Weather has a profound effect on the human health and well-being. It has been demonstrated that weather is associated with changes in birth rates, and sperm counts, with outbreaks of pneumonia, influenza and bronchitis, and is related to other morbidity effects linked to pollen concentrations and high pollution levels.

Large increases in mortality have occurred during previous heat and cold waves.

Hot weather extremes appear to have a more substantial impact on mortality than cold wave episodes. Most researches indicate that mortality during extreme heat events varies with age, sex, and race. Factors associated with increased risk from heat exposure include alcoholism, living on higher floors of buildings, and the use of tranquilizers. Factors associated with decreased risk are use of air conditioning, frequent exercising, consumption of fluids, and living in shaded residences.

The importance of determining the role of weather in human health cannot be understated. There are a number of other impacts of weather on the general health of the population, including morbidity, short-term changes in mood, emotional well-being, and aberrations from normal behavior. For example, asthma attacks, many of which occur from inhalation of airborne agents such as spores and molds, appear to be related to various meteorological variables. Morbidity attributed to pneumonia, influenza, bronchitis, and probably many other illnesses is also weather-related.

Probably the most intensively-studied weather element that affects human mortality is air temperature, especially the impact of summer heat. The impact of temperature on morbidity and mortality can be assessed at both the seasonal and daily level. The variability in occurrence of numerous illnesses is linked to somewhat predictable seasonal trends in temperature, although significant year-to-year differences do occur. Medical disorders such as bronchitis, peptic ulcer, glaucoma, goiter, eczema, and herpes zoster are related to seasonal variations in temperature. Heart failure (most often myocardial infarction) and cerebrovascular accidents represent two general mortality categories that have been cor-

related many times with ambient monthly temperatures. Complications from these disorders can be expected at higher temperatures since the body responds to thermal stress by forcing blood into peripheral areas to promote heat loss through the skin. This increases central blood pressure and encourages vasoconstriction. However, increases in heart disease are also noted at very cold temperatures as well.

A number of studies have also found relationships between the numbers of reported migraine attacks and rapid changes in barometric pressure. They found that migraines were most likely to occur on days with falling pressure, rising humidity, high winds, and rapid temperature fluctuations.

The reduction of solar radiation by cloud cover may also have effects on well-being. By increasing the brightness level, the autonomic nervous system is affected by constriction changes in the eye pupil. This increases the rate of physical activity and leads to a general feeling of well-being. Sun rays cause chemical changes in neurotransmitter or hormone synthesis in the brain, perhaps stimulating production of the hormone epinephrine, which stimulates the mind and body. Conversely, very low light intensities are often associated with states of relaxation, tiredness, and sleepiness.

To characterize weather changeability they often use "index of the weather changeability":

$$K = \frac{N}{n} \times 100\%$$

where K — index of weather changeability

N — number of days with contrast changes of weather

n — number of days in a studied period

If K is more than 30%, the weather regimen is changeable.

They use for predicting weather impacts on human health and for prevention of weather-related (meteo-tropic) diseases some medical classifications of weather. The most known are the Fedorov's and the Grigoriev's classifications (Tables 4, 5).

"Acute weather" is risky for heart attacks, strokes and developing complications of chronic diseases. "Irritative weather" causes exacerbations of chronic and infectious diseases.

Table 4. The A. Fedorov's Weather Classification

Weather types	Temperature overfalls, °C	Atmospheric pressure overfalls, mm Hg	Air movement velocity, m/s
Optimum	< 2	< 4	2–3
Irritative	3–4	5–8	6–7 m/s
Acute	> 4	> 8	> 9 m/s



Table 5. The I. Grigoriev's Weather Classification

Weather types	Atmospheric pressure, mm Hg	Wind, m/s	Temperature overfalls, °C	Pressure overfalls, mm Hg	Oxygen content, mg/l
Very favorable	>760	0–3.0	–	0–5	> 315
Favorable	755–760	4.0–7.0	1–5	6–8	> 315
Medical control need	745–754	8.0–10.0	6–9	9–14	289–260
Strict medical control need	< 745	Storm	> 10	> 15	< 260

## AIR POLLUTION

There are a number of atmospheric gases which make up the air. The main gases are nitrogen and oxygen, which make up 78% and 21% of the volume of air respectively. Oxygen is utilised primarily by animals, including humans, but also to a small degree by plants, in the process of respiration. The remaining 1% of the atmospheric gases is made up of trace gases. These include the noble or inert gases, the most abundant in which is argon. Hydrogen is also present in trace quantities in the atmosphere. The remaining trace gases include the greenhouse gases, carbon dioxide, methane, nitrous oxide, water vapour and ozone, so-called because they are involved in the Earth natural greenhouse effect (Fig. 16).

Air pollution is the presence of noxious substances in the air. Air pollution is the hygienic and ecological problem. The pollutants cause the diseases, change the ecological system condition.

Air pollution can cause health problems including burning eyes and nose, itchy irritated throat, and breathing problems. Some chemicals found in polluted air can cause cancer, birth defects, brain and nerve damage, and long-term injury to the lungs and breathing passages in certain circumstances. Above certain concentrations and durations, certain air pollutants are extremely dangerous and can cause severe injury or death. Air pollution can also damage the environment and property. Trees, lakes, and animals have been harmed by air pollution.

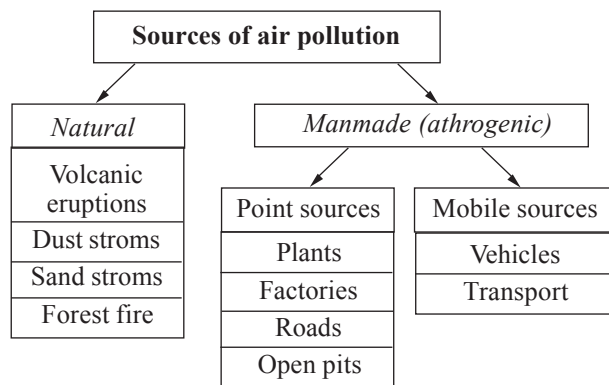


Fig. 16. Air Pollution Impact on Health

imals have been harmed by air pollution. Air pollution has thinned the protective ozone layer above the Earth. Air pollution can damage buildings, monuments, statues, and other structures.

**Outdoor Air and Health** For more than a century, severe air pollution incidents in such cities as London have shown that breathing the dirty air can be dangerous and sometimes deadly. In 1880 2,200 Londoners died in such an incident when coal smoke from home heating and industry combined to form a toxic smog of sulfur dioxide gas and airborne combustion particles. But concern about the health effects of outdoor air pollution did not effectively coalesce until the late 1940s and early 1950s, when air pollution disasters on two continents raised an alarm. Both the 1948 “killer fog” in the small town of Denora, Pennsylvania, that killed 50, and the particularly virulent London “fog” of 1952, in which about 4,000 died, were associated with widespread use of dirty fuels and were catalysts for government efforts to tackle urban air pollution (Fig. 17).

Since then, many nations have adopted ambient air quality standards to safeguard the public against the most common and damaging pollutants. These include sulfur dioxide, suspended particulate mat-

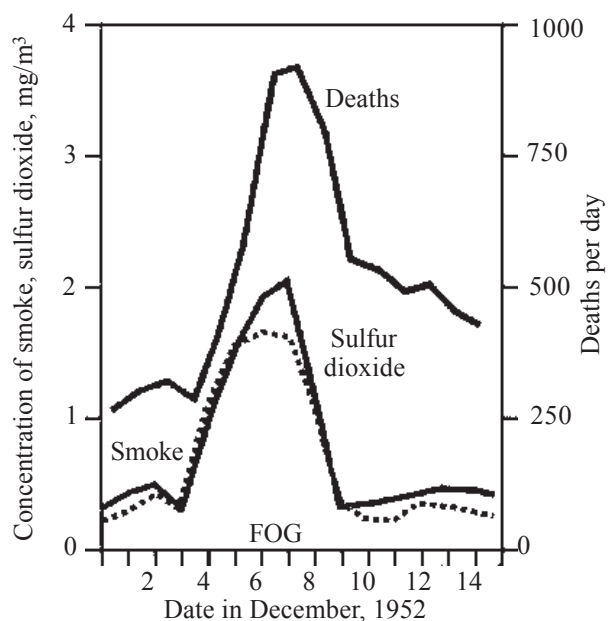


Fig. 17. The Consequences of London Smog, 1952

ter, ground-level ozone, nitrogen dioxide, carbon monoxide, and lead all of which are tied directly or indirectly to the combustion of fossil fuels. Although substantial investments in pollution control in some industrial countries have lowered the levels of these pollutants in many cities, poor air quality is still a major concern throughout the industrial world. A recent assessment by the European Environment Agency found that 70 to 80% of 105 European cities surveyed exceeded WHO air quality standards for at least one pollutant. In the United States, estimated 80 million of people live in areas that do not meet U.S. air quality standards, which are roughly similar to the WHO standards.

Meanwhile, urban air pollution has worsened in most large cities in the developing world, a situation driven by population growth, industrialization, and increased vehicle use. Despite pollution control effects, air quality has approached the dangerous levels recorded in a number of megacities, such as Beijing, Delhi, Jakarta, and Mexico City. In these cities, pollutant levels sometimes exceed the WHO air quality standards by a factor of three or more. In some of China's major cities, particulate levels are as much as six times the WHO guidelines. Worldwide, the WHO estimates that as many as 1.4 billion urban residents breathe air exceeding the WHO air guidelines.

The health consequences of exposure to dirty air are considerable. On a global basis, estimates of mortality due to outdoor air pollution run from around 200,000 to 570,000, representing about 0.4 to 1.1% of total annual deaths. As the range of these estimates indicates, it is difficult to quantify the toll of outdoor air pollution. The health impacts of urban air pollution seem likely to be greater in some of the rapidly developing countries where pollution levels are higher. The World Bank has estimated that exposure to particulate levels exceeding the WHO health standard accounts for roughly 2 to 5% of all deaths in urban areas in the developing world.

However, only these mortality estimates do not capture the huge toll of illness and disability that exposure to air pollution brings at a global level. Health effects span a wide range of complications from coughing and bronchitis to heart disease and lung cancer. Vulnerable groups include infants, the elderly, and those suffering from chronic respiratory conditions including asthma, bronchitis, or emphysema. For example, air pollution in developing world cities is responsible for about 50 million cases per year of chronic coughing in children younger than 14 years. However, even healthy adults can suffer negative effects. Many of air pollution health effects, such as bronchitis, tightness in the chest, and wheezing are acute, or short-term, and can be reversed if air pollution exposures decline. Other effects appear to be chronic, such as lung cancer and cardiopulmonary disease.

**Particulate Pollution.** Suspended particulate matter is a nearly ubiquitous urban pollutant. Although particulate levels in North America and Western Europe rarely exceed  $50 \mu\text{g}/\text{m}^3$  of air, the levels in many Central and Eastern European cities and in many developing nations are much higher, often exceeding  $100 \mu\text{g}/\text{m}^3$ . Particulate air pollution is a complex mixture of small and large particles of various origin and chemical composition.

Dust is the most frequent pollutant of the air. It represents itself as a disperse system, in which the disperse phase is a crushed hard substance, and the disperse medium — air. The dust is the dispersion system with a solid phase. It is classified into aerosuspension and aerodispersion according to sizes of particles.

Dust may be organic (of vegetable or animal origin), non-organic (metallic, mineral) and mixed. In the atmospheric air usually mixed dust is observed.

Main sources of dust pollution of the atmosphere are industrial enterprises.

Capability of the dust particles to remain in the suspended condition depends on their sizes and specific gravity. The size of the particle is long, it will remain longer in the air.

The fate of dust in the respiratory tracts is related with the disperseness of dust, which determines its behavior in the air. On this depends the depth of penetration into the respiratory tracts and their detention in the different parts of the respiratory tract. Minute dust particles (less than  $5 \mu$ ) can penetrate into the lungs and can harm the pulmonary parenchyma. Large particles ( $10\text{--}100 \mu$ ) are nearly completely held in the upper respiratory tract, causing irritation of the mucous and chronic inflammatory process. The particles with the size  $2\text{--}5 \mu$  (middle-dispersing dust) can be passing to the lower respiratory tract (alveoli and terminal bronchioles) and to cause the diseases.  $5 \mu$  — 82% adsorbed (in the upper respiratory tract),  $1.6 \mu$  — 46%;  $1.3 \mu$  — 27%;  $0.9 \mu$  — 16%.

Besides of disperseness, an important role is played by chemical composition of dust pollution in the character and degree of influence on the person. It has been established, that aerosol of lead, manganese, arsenic, fluorine and many other elements may cause some specific manifestations of chronic poisoning. Dust containing cancerogenic substances may cause malignant neoplasms.

Non-toxic dust basically causes mechanical damage of the respiratory organs, skin, eyes. Meanwhile large dust particles subsiding on the mucous layer of nose, nasopharynx, trachea and bronchi, irritate them. Presence of conditionally pathogenic microorganisms in the organs as well as penetration of pathogenic bacteria into them lead to the development of acute and chronic catarrhal processes in the form of rhinitis, laryngitis, pharyngitis, tracheitis and bronchitis.

Inhalation of highly dusty air may serve as a cause of pneumoconiosis development — a disease of the lungs based on sclerotic and other pathological changes.

They are caused by the deposition of different types of dust and further interaction with the pulmonary tissue. One of the most dangerous types of pneumoconiosis is silicosis, caused by the influence of dust particles of silicon, possessing free silicon dioxide in its composition.

The atmospheric air pollution intensity is determined by many conditions, such as: character of fuel, degree of ashes in it, quantity of emission, meteorological factors which determine the condition of dust dilution in the atmospheric air and its falling on the soil surface. These processes are natural processes of self-purification of the atmosphere.

Larger particles, ranging from about 2.5 mc to 100 mc in diameter, usually comprise smoke and dust from industrial processes, agriculture, construction, and road traffic, as well as plant pollen and other natural sources. Smaller particles those less than 2.5 mc in diameter generally come from combustion of fossil fuels. These particles include soot from vehicle exhaust, which is often coated with various chemical contaminants or metals, and fine sulfate and nitrate aerosols that form when SO<sub>2</sub> and nitrogen oxides condense in the atmosphere. The largest source of fine particles is coal-fired power plants, but auto and diesel exhaust are also prime contributors, especially along busy transportation corridors. Air pollutants called particulate matter include dust, dirt, soot, smoke and liquid droplets directly emitted into the air by sources such as factories, power plants, cars, construction activity, fires and natural windblown dust. Based on studies of human populations exposed to high concentrations of particles and laboratory studies of animals and humans, there are major effects of concern for human health. These include effects on breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to the lung tissue, cancerogenesis and premature death.

The major subgroups of the population that appear to be most sensitive to the effects of particulate matter include individuals with chronic obstructive pulmonary or cardiovascular disease or influenza, asthmatics, elderly and children. Numerous studies associate particulate pollution with acute changes in lung function and respiratory illness, resulting in increased hospital admissions for respiratory disease and heart disease, school and job absences from respiratory infections, or aggravation of chronic conditions such as asthma and bronchitis. But the more demonstrative and sometimes controversial evidence comes from a number of recent epidemiological studies. Many of these studies have

linked short-term increases in particulate levels, such as the ones that occur during pollution episodes, with immediate (within 24 h) increases in mortality. This pollution-induced spike in the death rate ranges from 2 to 8% for every 50- $\mu\text{g}/\text{m}^3$  increase in particulate levels. These basic findings have been replicated on several continents, in cities as widely divergent as Athens, São Paulo, Beijing, and Philadelphia. During major pollution events, such as those involving a 200- $\mu\text{g}$  increase in particulate levels, an expert panel at the WHO estimated that daily mortality rates could increase as much as 20%. These estimates should be viewed with caution, however, because some of those who die during a pollution episode have been already sick, and the pollution may have hastened the death by only a few days.

In the aggregate, pollution-related effects like these can have a significant impact on community health. The WHO has identified particulate pollution as one of the most important contributors to poor health within Europe. In those cities where data on particulates were available, the WHO estimated that short-term pollution episodes accounted for 7 to 10% of all respiratory diseases in children, with the number rising to 21% in the most polluted cities. Furthermore, 0.6 to 1.6% of deaths were attributable to short-term pollution events, climbing to 3.4% in the cities with the dirtiest air.

Atmospheric pollution is capable of rendering direct influence on the surrounding medium and human organism. First of all they may aggravate microclimate of populated places. For example, sulfur dioxide gas, falling into atmosphere, transforms into ions of sulfate or particles of ammonium sulfate, forming hard aerosol. These particles may be scattered or may absorb sun radiation, promoting in this way cooling or heating the lower layers of atmosphere.

Dust plays an important role in the change of microclimate of populated places. By raising above the industrial centers, dust particles may form smoke cover above them, often named as city haze.

Dust pollution, first of all causes loss of part of sun radiation due to its absorption by dust particles. As a result of this, integral intensity of sun radiation in the city is less by 15–25%, than in the villages. Loss takes place primarily due to ultraviolet part of the spectrum, and exactly due to rays of wave length from 315 to 290 nm (by 20–30%, and in winter time by 50–60% and more), which has huge significance for growth and life activity of the organism, particularly in the child age.

**Sulfur Dioxide** (SO<sub>2</sub>) is emitted largely from burning coal, high-sulfur oil, and diesel fuel. As this gas is usually found in association with particulate pollution as SO<sub>2</sub> is the precursor for fine sulfate particles separating the health effects of these two pollutants is difficult. Together, SO<sub>2</sub> and particulates make up a major portion of the pollutant load in

many cities, acting both separately and in concert to damage health.

SO<sub>2</sub> affects people quickly, usually within the first few minutes of exposure. Epidemiological studies indicate that SO<sub>2</sub> exposure can lead to an acute health effects typical of particulate pollution. Exposure leads to an increase of hospitalizations and deaths from respiratory and cardiovascular causes, especially among asthmatics and those with preexisting respiratory diseases. The severity of these effects increases with rising of SO<sub>2</sub> levels, and exercise enhances the severity by increasing the volume of SO<sub>2</sub> inhaled and allowing SO<sub>2</sub> to penetrate deeper into the respiratory tract. Asthmatics may experience wheezing and other symptoms at much lower SO<sub>2</sub> levels than those without asthma. When ozone pollution is also present, asthmatics become even more sensitive to SO<sub>2</sub> which is a good reminder that air pollutants generally do not occur in isolation, but in complex mixtures that create the potential for synergistic effects among pollutants. High concentrations of sulfur dioxide affect breathing and may aggravate existing respiratory and cardiovascular disease. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children and old people. SO<sub>2</sub> is also a primary contributor to acid deposition, or acid rain, which causes acidification of lakes and streams and can damage trees, crops, historic buildings and statues.

Ambient SO<sub>2</sub> results largely from stationary sources such as coal and oil combustion, steel mills, refineries, pulp and paper mills and non-ferrous smelters. There are three NAAQS (USA) for SO<sub>2</sub>:

- an annual arithmetic mean of 0.03 ppm (80 µg/m<sup>3</sup>);

- a 24-hour level of 0.14 ppm (365 µg/m<sup>3</sup>); and

- a 3-hour level of 0.50 ppm (1,300 µg/m<sup>3</sup>).

Sulfur dioxide is an indicator of anthropogenic atmospheric air pollution. Its MAC (NIS) is 0.05 mg/m<sup>3</sup> (MAC<sub>max</sub> is 0.5 mg/m<sup>3</sup>).

**Ozone (O<sub>3</sub>).** Ground-level ozone is the major component of the photochemical smog that blankets many urban areas. It is not emitted directly but is formed when nitrogen oxides from fuel combustion react with so-called volatile organic compounds (VOCs) such as unburned gasoline or paint solvents in the atmosphere. Sunlight and heat stimulate ozone formation, so peak ozone levels generally occur in the summer.

Ozone pollution has become widespread in cities of Europe, North America, and Japan as auto and industrial emissions have increased. Many cities in developing countries also suffer from high ozone levels, although few monitoring data exist.

A powerful oxidant, ozone can react with nearly any biological tissue. Breathing ozone concentrations of 0.012 ppm levels typical in many cities can irritate the respiratory tract and impair lung function, causing coughing, shortness of

breath, and chest pain. Exercise increases these effects, and heavy exercise can bring on symptoms even at low ozone levels (0.08 ppm). Evidence also suggests ozone exposure lowers the body's defenses, increasing susceptibility to respiratory infections.

As ozone levels rise, hospital admissions and emergency room visits for respiratory diseases such as asthma also increase. On average, studies show that hospital admissions rise roughly 7 to 10% for a 0.05 ppm increase in ozone levels.

Ozone is a photochemical oxidant and the major component of smog. While O<sub>3</sub> in the upper atmosphere is beneficial to life by shielding the earth from harmful ultraviolet radiation from the sun, high concentrations of O<sub>3</sub> at ground level are a major health and environmental concern.

The reactivity of O<sub>3</sub> causes health problems because it damages the lung tissue, reduces the lung function and sensitizes the lungs to other irritants. Scientific evidence indicates that ambient levels of O<sub>3</sub> not only affect people with impaired respiratory systems, such as asthmatics, but healthy adults and children as well. Exposure to ozone for several h at relatively low concentrations has been found to reduce significantly lung function and induce respiratory inflammation in normal, healthy people during exercise. This decrease in lung function generally is accompanied by symptoms including chest pain, coughing, sneezing and pulmonary congestion.

Ozone MAC in Ukraine is 0.1 mg/m<sup>3</sup>.

**Carbon monoxide (CO)** is a colorless, odorless and poisonous gas produced by incomplete burning of carbon in fuels. When CO enters the bloodstream, it reduces the delivery of oxygen to the body's organs and tissues. Health threats are most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Exposure to elevated CO levels can cause impairment of visual perception, manual dexterity, learning ability and performance of complex tasks. 77% of the nationwide CO emissions are from transportation sources. The largest emissions contribution comes from highway motor vehicles. Thus, the focus of CO monitoring has been on traffic oriented sites in urban areas where the main source of CO is motor vehicle exhaust. Other major CO sources are wood-burning stoves, incinerators and industrial sources.

Carbon monoxide MAC in Ukraine is 1 mg/m<sup>3</sup>.

**Chlorofluorocarbons (CFCs)** are chemicals used in great quantities in industry, for refrigeration and air conditioning, and in consumer products. CFCs, when released into the air, rise into the stratosphere. In the stratosphere, CFCs take part in chemical reactions that result in reduction of the stratospheric ozone layer, which protects the Earth's surface from the sun. Reducing the release of CFCs emissions and eliminating the production and the use

of ozone-destroying chemicals is a very important task.

**Hazardous Air Pollutants (HAPs)** are chemicals that cause serious health and environmental effects. Health effects include cancer, birth defects, nervous system problems, and death due to massive accidental releases, such as the disaster that occurred at a pesticide plant in Bhopal, India. Hazardous air pollutants are released by sources such as chemical plants, dry cleaners, printing plants, and motor vehicles including cars, trucks, buses, planes.

**Volatile Organic Compounds (VOCs)** produce vapors easily. At room temperature vapors readily escape from volatile liquid chemicals. VOCs include gasoline, industrial chemicals such as benzene, solvents such as toluene and xylene, and perchloroethylene (principal dry cleaning solvent). VOCs are released from burning fuel, such as gasoline, wood, coal, natural gas and from solvents, paints, glues, and other products used at home or work. Vehicle emissions are an important source of VOCs. Many VOCs are hazardous air pollutants; for example, benzene causes cancer.

**Nitrogen Oxides (NO<sub>x</sub>)** are major contributor to smog and acid rain. Nitrogen oxides react with volatile organic compounds to form smog. In high doses, smog can harm humans by causing breathing difficulty for asthmatics, coughs in children, and general illness of the respiratory system. Acid rain can harm vegetation and run into lakes and rivers which changes the chemistry of the water, and makes it potentially uninhabitable for all except acid-tolerant bacteria. Nitrogen oxides are produced from burning fuels, including gasoline and coal.

Nitrogen dioxide (NO<sub>2</sub>) is a brownish, highly reactive gas that is present in all urban atmospheres. NO<sub>2</sub> can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections. Nitrogen oxides are an important precursor both to ozone (O<sub>3</sub>) and acid rain, and may affect both terrestrial and aquatic ecosystems. The major mechanism for the formation of NO<sub>2</sub> in the atmosphere is the oxidation of the primary air pollutant nitric oxide (NO). NO<sub>x</sub> plays a major role, together with VOCs, in the atmospheric reactions that produce O<sub>3</sub>. NO<sub>x</sub> forms when fuel is burned at high temperatures. The two major emissions sources are transportation and stationary fuel combustion sources such as electric utility and industrial boilers. The first two standards are primary (health-related) standards, while the 3-hour NAAQS is a secondary (welfare-related) standard. The annual mean standard is not to be exceeded, while the short-term standards are not to be exceeded more than once per year. During prolonged inhalation of small concentrations of nitrogen oxides, bronchitis, loss of appetite, anemia, destruction of teeth, disorders of gastric secretion, activation of tuberculous process, aggravation of course of cardiac diseases are observed.

Nitrogen dioxide MAC in Ukraine is 0.06 mg/m<sup>3</sup>.

Exposure to **lead** can occur through multiple pathways, including inhalation of air and ingestion of lead in food, water, soil or dust. Excessive lead exposure can cause seizures, mental retardation and/or behavioral disorders. This dramatic decline can be attributed to the reduction of leaded gasoline and to the removal of lead from soldered cans. Although this study shows great progress, infants and young children are especially susceptible to low doses of lead, and this age group still shows the highest levels. Low doses of lead can lead to central nervous system damage. Recent studies have also shown that lead may be a factor in high blood pressure and in subsequent heart disease in middle-aged males. Lead gasoline additives, non-ferrous smelters, and battery plants are the most significant contributors to atmospheric lead emissions.

Dust admixtures are the basic of formation of *mist*. In the places with raised dustiness quantity of dull days increases. As a result, the unfavorable influence of climate on the population grows, related with insufficiency of sunny days, with lowering of general sunlit, with high humidity of air, etc.

In definite meteorological conditions, and to be more precise during anticyclone weather, windless temperature inversion and during entrance of oxides of sulfur into the atmosphere, toxic mists may form. In the days of these mists mortality of population considerably exceeds normal mortality.

Besides toxic mists, receiving the name of smokes, photochemical smokes may also form. Sources of their formation are the presence of oxides of nitrogen, toxic organic substances, carbohydrates. In the definite meteorological conditions, favorably preventing accumulation of these substances in the air, specific mist is formed, causing decrease in the visibility, development of unpleasant smell and irritation of mucous of the eyes, of the upper respiratory tracts, which causes tearing of the eyes, torturing cough. Molecules of nitrogen oxide present in the emitted gases are excited by the energy of ultraviolet rays of the sun, and thereafter by reacting with the oxygen of the air, form ozone. The latter by reacting with carbohydrates of the emitted gases or of the outlets (wastage) of oil processing enterprises, forms a complex of compounds — photooxidants: of organic peroxides, free radicals, aldehydes, ketoses, which lead to this indicated pathology.

The problem of disorders of health in relation with air pollution of by chemical substances arose long back. One of the first signals of threatening danger are toxic mists. In 1930, in Belgium, the whole town population felt sick. In a short time 63 persons died. Around this city there were factories producing phosgene and diphosgene. As it is proved, the air of the city contained large quantities of SO and SO<sub>2</sub>. Weather was windless during deep anticyclone, pressure decreased, there were high humid-

ity, temperature inversion. This led to the development of toxic mist and death of the people. Desquamation of epithelia of respiratory tracts, high eosinophilia and hemorrhages were revealed in the deads.

Besides of London smog (1952), toxic mists and photochemical smokes occurred even in the following years. As the press informs, life of the citizens of Ankara, the capital of Turkey, was intolerable when the air in between the mountains surrounding them was saturated smoke of the furnaces, heated by low quality coal and mineral oil. Content of carbon dioxide exceeded 24 times more than the permissible sanitary norms. Sometimes even during daytime the city seemed to be submersed into gray suffocating mist. Hospitals of Ankara were overfilled with people, admitted with serious poisonings, with exacerbations of cardiovascular and hepatic diseases. In these conditions extraordinary measures were adopted by the government. All schools were closed. In spite of cold heating of living premises was prohibited until stabilization of the weather, limitations on use of private transport were introduced. Children up to 12 and people over 50 were recommended not to go out of doors.

### **INDOOR AIR: STILL A MAJOR THREAT**

As dangerous as polluted outdoor air can be to health, indoor air pollution actually poses a greater health risk on a global level. Indoor air pollution is a concern in developed countries, where, for example, energy efficiency improvements sometimes make houses relatively airtight, reducing ventilation and raising indoor pollutant levels. In such circumstances, even small pollution sources emanating from a furnace, a new carpet, or from naturally occurring radon gas can lead to significant human exposures.

By far the greatest threat of indoor pollution, however, still occurs in the developing countries, where about 3.5 billion people mostly in rural areas, but also in many cities continue to rely on traditional fuels for cooking and heating. Burning such fuels produces large amounts of smoke and other air pollutants in the confined space of the home a perfect recipe for high exposures. (Liquid and gaseous fuels such as kerosene and bottled gas, although not completely pollution-free, are many times less polluting than these unprocessed solid fuels.) In these circumstances, exposure to pollutants is often far higher indoors than outdoors. Indeed, the World Bank has designated indoor air pollution in developing countries as one of the four most critical global environmental problems.

Concentrations of indoor pollutants in households burning dirty fuels are excessive. These esti-

mates must be viewed with some caution, however, because monitoring in developing countries has been limited. Daily averages often exceed current WHO guidelines by factors of 10, 20, or even more. Peak levels during cooking may exceed these levels by a further factor of five or so. Indeed, these data suggest that many tens of millions of people in developing countries routinely encounter pollution levels reached during the infamous London killer fog of 1952, leading to a huge disease elevation and premature death incidence. One researcher estimates that as many as 2.8 million deaths per year result from breathing elevated levels of indoor smoke from dirty fuels (i.e. in excess of the WHO particulate standard). This finding results in about 6% of all deaths each year. If this kind of effect is confirmed, indoor air pollution would be one of the largest single risk factors for poor health in the world.

Epidemiological studies in developing countries concern the exposure to indoor air pollution from dirty fuels with at least four major categories of illnesses: acute respiratory infections (ARI) in children; chronic obstructive lung diseases such as asthma and chronic bronchitis; lung cancer; and stillbirths and other problems at birth. Of these, ARI appears to have the greatest health impact in terms of the number of people affected and the time lost due to illness, especially in children younger than 5 years old.

Studies in a number of different countries and settings have examined a connection between exposure to smoke from cook stoves with the development of ARI in children. In South Africa, investigators found that Zulu children living in houses with woodstoves were almost five times more likely to develop a respiratory infection severe enough to require hospitalization. In Nepal, researchers observed a significant relationship between the number of h spent near the fire and the incidence of moderate and severe cases among 2-year-olds. Likewise, a recent study in Gambia found that children carried on their mother's backs as they cooked over smoky cookstoves contracted pneumococcal infections one of the most serious kinds of respiratory infections at a rate 2.5 times higher than nonexposed children.

Many respiratory infections in the developing world result in death, and evidence shows that exposure to cookstove smoke may contribute to higher mortality rates. For example, a study in Tanzania found that children younger than 5 years of age who died of ARI were 2.8 times more likely to have been sleeping in a room with an open cookstove than healthy children. Overall studies indicate that exposure to wood smoke from cook fires in poorly ventilated conditions may increase the risk of a young child contracting a serious respiratory infection from 2 to 6 times.

Adults suffer from ill effects of severe indoor pollution as well. Several studies found strong links between chronic lung diseases in women and exposure to smoke from open cookstoves. One recent Colombian study found women exposed to smoke during cooking were more than three times more likely to suffer from chronic lung disease. Other studies suggest that this risk increases in response to the years of exposure to smoke. A study in Mexico showed that women who had been exposed to wood smoke for many years faced 75 times more risk of acquiring chronic lung disease than unexposed women about the level of risk that heavy cigarette smokers face. Lung cancer, too, is associated with high levels of smoke, especially coal smoke, which contains a plethora of carcinogenic compounds. Most studies of coal-smoke exposures have been conducted in China, where residential use of coal is still common. More than 20 studies suggest that urban women who use coal for cooking and heating over many years are subjected to a risk of lung cancer 2 to 6 times higher than women who use gas. Rural coal-smoke exposures, which tend to be higher, seem to increase lung cancer risks 9 and more times as much.

Exposure to high indoor smoke levels has also been connected with pregnancy-related problems like stillbirths and low birth weight. One study in western India found a 50% increase in stillbirths associated with the exposure of pregnant women to indoor smoke. Indoor air pollution most likely contributes to excess of heart disease in developing countries as well.

Indoor air microbial pollution characterizing the risk of disease spreading upon people and animals. The infectious air-borne diseases are:

- viral infections: influenza, mumps, rubella, measles, ARVI (acute respiratory viral infections) (caused by Adenoviridae, Coronaviridae, EBV, HSV, Paramixoviridae, Rhino-synthicial virus, polio and other Enteroviridae etc.), smallpox, Bolivian hemorrhagic fever, etc.;

- chlamydial infections: ornithosis;

- bacterial infection: anthrax, tuberculosis, pertussis, diphtheria, plaque, legionellosis, epidemic meningitis, scarlet fever, tularemia, etc.

*Carbon dioxide* is an indicator of indoor air pollution. Its MAC is 0.1% (optimum concentration for a human being is as low as 0.07%). Carbon dioxide, by lifting up above the industrial centers, creates conditions for absorption of reverse infrared radiation of the Earth, which leads to gradual decrease in cooling of its surface. Exactly with this feature many scientists relate global changes of Earth climate to warming up (“greenhouse effect”). For determination of carbon dioxide methods of volume analysis (Lunge-Zeckendorf’s (sodium), Reberg’s methods) and colometric analysis (with automatic gas-analysator) are used.

## AIR POLLUTION CONTROL

There are used some directions in prevention of air pollution:

- 1) technological methods;
- 2) technical methods (fabric filters: baghouses; dust collectors; weld fume collector; electrostatic precipitators; scrubbers; NO<sub>x</sub> Control — SNCR; NO<sub>x</sub> Control — SCR; flue gas conditioning);
- 3) architecture-planning measures;
- 4) administrative measures.

### Technological Methods

*Process Change.* This technique involves a modification of an existing process or the introduction of a new process. Since 90-s the process change has been known as “pollution prevention”; considering the example of painting operations in automobile industry. Large quantities of volatile organic compounds and hazardous air pollutants were released as a result of these operations. After many operations have substituted water based, low HAP paints for oil based paints for reducing emissions. Some operations have implemented such processes as electro-deposition, dip tank and powder coating. Process modification is a popular technique to control air pollution. Major efforts are underway in all industries to modify processes to reduce pollution.

Changes in industrial processes to reduce raw materials and fuels also lead to reduction in air emissions. The promotions to use fluorescent lights and to conduct energy audits by electric utilities are examples of less electricity demand. This results in less fuel use at the power plant and hence less air pollutants are emitted.

The use of wind energy, geothermal energy, hydroelectric power and solar energy is increasing and helps in reducing air pollution. The purpose is to “prevent” pollution rather than control it at the point of release. The goal is not to produce solid or hazardous waste.

*Change in Fuel.* This technique involves the use of less polluting fuel to reduce air pollution. Use of low sulfur fuel instead of high sulfur fuel by electric utilities is an example of this method. Remember that low sulfur fuel is much more expensive than high sulfur fuel. The other choice for an electric utility can be the use of natural gas as a fuel.

Use of oil with low ash content or natural gas for a dryer at an asphalt plant to reduce particulate matter is another example of this method. Introduction of compressed natural gas, propane, ethanol and oxygenated fuels for automobiles have helped in the reduction of air pollutants. The use of natural gas in North America and Europe for winter heating brought significant improvement in air quality in

most cities. Nuclear power plants are relatively pollution free when compared to the coal fired power plants.

Technical methods include the using of special equipment to control the pollution, e.g. fabric filters (baghouses, dust collectors), weld fume collectors, electrostatic precipitators, scrubbers, etc.) (Fig. 18).

Architectural planning measures include the proper planning of residential and industrial areas. There are established the different sanitary spaces between the industrial objects and residential areas: 1000 m for I class of the enterprises, 500 m — for II, 300 m — for III, 100 m — for IV and 50 m — for V.

Administrative measures include regulations of traffic, codexes and standards of clean air, etc.

The prevention of indoor pollution includes technical measures, e.g. ventilation, source control and air cleaning. Air cleaning can be maintained with the use of the mechanic filters, HEPA, ozone emitting air cleaning, electrostatic filters, sorbent filters (for removing VOC), UV duct cleaning system, etc.

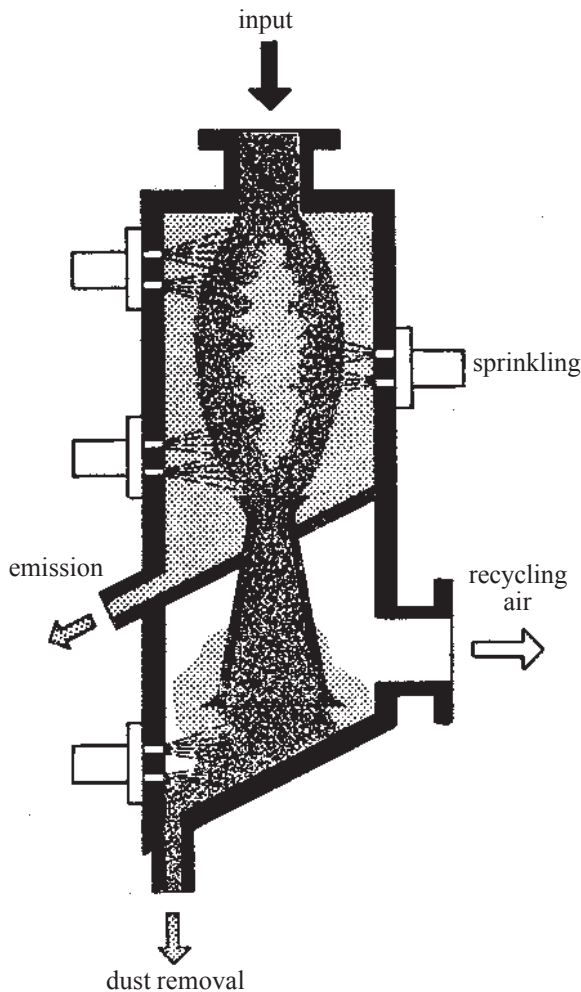


Fig. 18. Scrubber

## AIR ENVIRONMENT AND HUMAN HEALTH

The air is a vital component of our everyday life. Microclimate is a thermal status of the limited space. It is a combined action of air temperature, radiation heat, air humidity and air movement velocity. Microclimate defines the heat state of the organism. Sometimes they mean microclimate as variations of the climate within a given area, usually influenced by hills, hollows, structures or proximity to bodies of water. The warmth and humidity of the air in close proximity to a plant or heat/moisture source may differ significantly from the general microclimate of the premise.

*The air temperature* is a measure of the heat content of air. Its value depends on the convection — air movement. Comfort air temperature for rooms of resident houses is 18–20°C.

*The air humidity* is a content of evaporation in the air. It is used:

1. *Maximal humidity* — maximal concentration of moisture for this air temperature and pressure (in ppm or mm Hg).

2. *Absolute humidity* — moisture content in analyzed conditions.

3. *Humidity deficit* — difference between maximal and absolute humidity.

4. *Relative humidity* — ration between absolute and maximal humidity in the percentage.

5. *Dew point temperature* — the temperature below which moisture will condense out of the air.

6. *Physiological deficit of saturation* — difference between maximally possible saturation of air with moist at the temperature of the skin and absolute humidity.

A psychrometric chart graphically illustrates the relationships between the air temperature and relative humidity as well as other properties. A better understanding of air properties and the psychrometric chart can aid in the selection and management of the building ventilation system (Fig. 19).

As the name implies, relative humidity is a measure of how much moisture is present compared to how much moisture the air could hold at that temperature. Relative humidity, which is expressed as a percent, is given in weather reports. Lines representing conditions of equal relative humidities sweep from the lower left to the upper right of the psychrometric chart. The 100% relative humidity (saturation) line corresponds to the wet bulb and the dew point temperature scale line. The line for zero percent relative humidity falls along the dry bulb temperature scale line.

The fact is indoor temperatures are very often variable. Humans find the temperature range of 18–20°C comfortable. Large rooms, hallways, and different exposures along with doors and windows can effect the temperature.



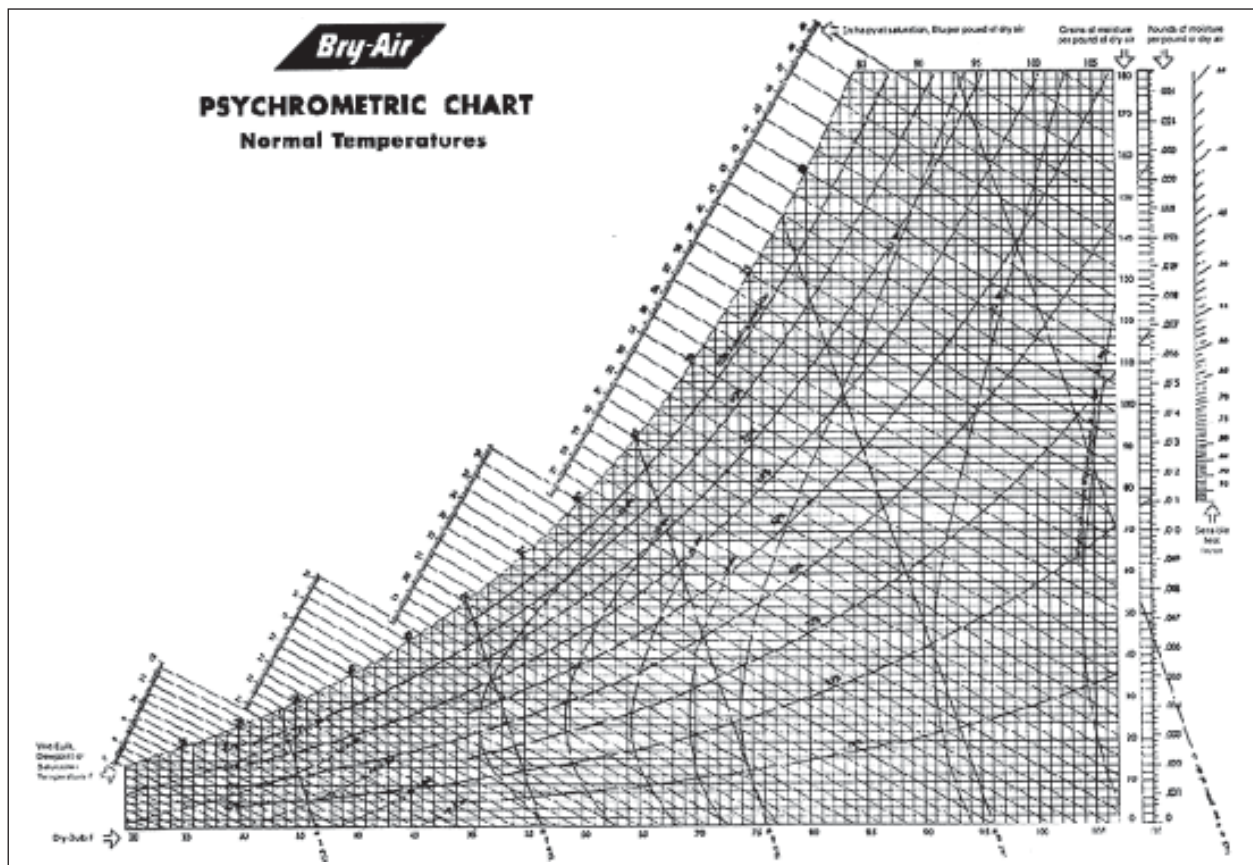


Fig. 19. The Psychrometric Chart (a model)

Atmospheric temperatures will vary with respect to the distance from a building. Microenvironments near walls with a southern exposure will be significantly warmer while microenvironments near walls with a northern exposure will be cooler.

The energy balance of the organism could be calculated by the formula:

$$M + Q_a = R + C + E + G + X$$

- M — Metabolic energy
- $Q_a$  — absorbed radiation
- R — emitted radiation
- C — energy exchanged by convection
- E — latent heat energy
- G — energy exchanged by conduction
- X — net energy loss or gain

The most of the heat (40%) organism loses by the emitted radiation, 30% — by convection and conduction. The heat lost by irradiation can be defined with the formula:

$$Q_{ir} = 4.4 [t_{body} - t_r \text{ (kcal/m}^2\text{h)}]$$

for conduction:  $Q_{cond} = 4.5 (t_{skin} - t_{air}) \cdot v^{0.6}$

for evaporation:  $Q_{evap} = 16 pv$ ,

where  $v$  — air velocity;  $p$  — air pressure.

For heat state assessment they use:

- 1) skin temperature (forehead, forearm, hands);
- 2) perspiration of sweat (Minore's test, electrical conductivity assessment, exact weight methods);
- 3) pulse and breath rate;

- 4) subjective sensations (EET scale);
- 5) body temperature;
- 6) neurosensoric signs.

The action of overheating microclimate can cause chronic and acute overheating (heat stress). Overcooling microclimate can cause local (frost-bites, frostnip, chilblains (pernio), "immersion foot" (trench foot)) and general (common cold) overcooling. Chronic overcooling manifests itself in decreasing ability to work and the lowered organism's resistance to unfavourable agents.

Operations involving high air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities have a high potential for inducing heat stress in employees engaged in such operations. Such places include: iron and steel foundries, nonferrous foundries, brick-firing and ceramic plants, glass products facilities, rubber products factories, electrical utilities (particularly boiler rooms), bakeries, confectioneries, commercial kitchens, laundries, food canneries, chemical plants, mining sites, smelters, and steam tunnels.

Outdoor operations conducted in hot weather, such as construction, refining, asbestos removal, and hazardous waste site activities, especially those that require workers to wear semipermeable or impermeable protective clothing, are also likely to cause heat stress among exposed workers.

Age, weight, degree of physical fitness, degree of acclimatization, metabolism, use of alcohol or

drugs, and a variety of medical conditions such as hypertension all affect a person's sensitivity to heat. However prior heat injury predisposes an individual to additional injury.

It is difficult to predict just who will be affected and when, because individual susceptibility varies. In addition, environmental factors include more than the ambient air temperature. Radiant heat, air movement, conduction, and relative humidity all affect an individual's response to heat.

**Heat stroke** occurs when the body's temperature regulation system fails and body temperature rises to critical levels. This condition is caused by a combination of highly variable factors, and its occurrence is difficult to predict. Heat stroke is a medical emergency. The primary signs and symptoms of heat stroke are confusion; irrational behavior, loss of consciousness, convulsions, a lack of sweating (usually); hot, dry skin; and an abnormally high body temperature, e.g. the rectal temperature of 41°C. If the body temperature is too high, it causes death. The elevated metabolic temperatures caused by a combination of work load and environmental heat load, both of which contribute to heat stroke, are also highly variable and difficult to predict.

If a person shows signs of a possible heat stroke, professional medical treatment should be obtained immediately. He should be placed in a shady area and the outer clothing should be removed. His skin should be wetted and air movement around should be increased to improve the evaporative cooling until professional methods of cooling are initiated and the seriousness of the condition can be assessed. Fluids should be replaced as soon as possible. The medical outcome of an episode of heat stroke depends on the victim's physical fitness and the timing and effectiveness of first aid treatment.

**Heat Edema.** Lower extremities edema is commonly reported by individuals from the temperate regions as well as from the tropics. The pathophysiology is unclear but could seem to be due to a combination of vascular pooling and cutaneous vasodilatation. The important point to take is that these patients should rarely be treated with urethics as this does little besides increase their risk for hydration. Simple reassurance and elevation of the affected part should suffice.

**Heat Exhaustion.** The signs and symptoms of heat exhaustion are headache, nausea, vertigo, weakness, thirst, and giddiness. Fortunately, this condition responds readily to prompt treatment. Heat exhaustion should not be dismissed lightly, however, for several reasons. One is that the fainting associated with heat exhaustion can be dangerous because the victim may be operating machinery or controlling an operation that should not be left unattended; moreover, the victim may be injured when he or she faints. Also, the signs and symptoms seen in heat exhaustion are similar to those of heat stroke,

a medical emergency. Persons suffering from heat exhaustion should be removed from the hot environment and given fluid replacement. They should also be encouraged to get an adequate rest.

**Heat Cramps** usually caused by performing vigorous physical activities in a hot environment. These cramps have been attributed to an electrolyte imbalance caused by sweating. It is important to understand that cramps can be caused by both too much and too little salt. Cramps appear to be caused by the lack of water replenishment. Because sweat is a hypotonic solution (0.3% NaCl), excessive salt can build up in the body if the water loss through sweating is not replaced. Thirst cannot be relied on as a guide to the need for water; instead, water must be taken every 15 to 20 minutes in hot environments.

Under extreme conditions, such as working for 6 to 8 h in heavy protective gear, a loss of sodium may occur. Recent studies have shown that drinking commercially available carbohydrate-electrolyte replacement liquids is effective in minimizing physiological disturbances during recovery.

**Heat Collapse.** In heat collapse, the brain does not receive enough oxygen because blood pools in the extremities. As a result, the exposed individual may lose consciousness. This reaction is similar to that of heat exhaustion and does not affect the body's heat balance. However, the onset of heat collapse is rapid and unpredictable. To prevent heat collapse, the person (e.g. worker) should gradually become acclimatized to the hot environment.

**Heat rashes** are the most common problem in hot environments. *Prickly* heat is manifested as red papules and usually appears in areas where the clothing is restrictive. As sweating increases, these papules give rise to a prickling sensation. Prickly heat occurs in skin that is persistently wetted by unevaporated sweat, and heat rash papules may become infected if they are not treated. In most cases, heat rashes will disappear when the affected individual returns to a cool environment.

**Heat Fatigue.** A factor that predisposes an individual to heat fatigue is lack of acclimatization. The use of a program of acclimatization and training for work in hot environments is advisable. The signs and symptoms of heat fatigue include impaired performance of skilled sensorimotor, mental, or vigilance jobs. There is no treatment for heat fatigue except to remove the heat stress before a more serious heat-related condition develops.

Health impact of the microclimate could be evaluated by the indices presented in Table 6.

**Environmental Measurement.** Environmental heat measurements should be made for each area and for each level of environmental heat to which people are exposed.

**Wet Bulb Globe Temperature (WBGT)** should be calculated using the appropriate formula. The

Table 6. **Changes of the Forehead and Hands Skin Temperature in Dependence on the Air Temperature, °C**

Air temperature	Forehead skin temperature	Hand back skin temperature	Difference*
10	31.2	24.2	7.7
20	33.5	28.1	5.4
30	35.3	33.1	2.2
35	35.8	35.6	0.2
45	37.0	—	—

\* — if difference is 2–3°C, man feels warm, 1.8°C and less — hot, more than 6°C — cold.

WBGT for continuous all-day or several hour exposures should be averaged over a 60-minute period. Intermittent exposures should be averaged over a 120-minute period. For indoor and outdoor conditions with no solar load, WBGT is calculated as:

$$\text{WBGT} = 0.7\text{NWB} + 0.3\text{GT}$$

For outdoors with a solar load, WBGT is calculated as:

$$\text{WBGT} = 0.7\text{NWB} + 0.2\text{GT} + 0.1\text{DB}$$

where: WBGT = Wet Bulb Globe Temperature Index

NWB = Nature Wet-Bulb Temperature

DB = Dry-Bulb Temperature

GT = Globe Temperature

When the WBGT calculating the man's clothing is taken into account (Table 7).

**The Effective Temperature Index (ET)** combines the temperature, the humidity of the air, and air velocity. This index has been used extensively in the field of comfort ventilation and air-conditioning. ET remains a useful measurement technique in mines and other places where humidity is high and radiant heat is low.

**The Heat-Stress Index (HSI).** Although the HSI considers all environmental factors and work rate, it is not completely satisfactory for determining an individual worker's heat stress and is also difficult to use.

Ventilation, air cooling, fans, shielding, and insulation are the five major types of engineering controls used to reduce heat stress in hot environments. Heat reduction can also be achieved by using power assists and tools that reduce the physical demands placed on a worker. He should be allowed to take frequent rest breaks in a cooler environment.

**General ventilation** is used to dilute hot air with cooler air (generally cooler air that is brought in from the outside). This technique clearly works better in cooler climates than in hot ones. A permanently installed ventilation system usually handles large areas or entire buildings. Portable or local exhaust systems may be more effective or practical in smaller areas.

**Air conditioning** is a method of air cooling, but it is expensive to install and operate. An alternative

Table 7. **WBGT Correction Factors, °C**

Clothing type	Clo* value	WBGT correction
Summer lightweight working clothing	0.6	0
Cotton overalls	1.0	-2
Winter work clothing	1.4	-4
Water barrier, permeable	1.2	-6

Notes: Deleted from the previous version are trade names and "fully encapsulating suit, gloves, boots and hood" including its clo value of 1.2 and WBGT correction of -10;

\* — Clo: Insulation value of closing. One clo = kcal/m<sup>2</sup>/h of heat exchange by radiation and convection for each degree °C difference in temperature between the skin and the adjusted dry bulb temperature.

to air conditioning is the use of chillers to circulate cool water through heat exchangers over which air from the ventilation system is then passed; chillers are more efficient in cooler climates or in dry climates where evaporative cooling can be used.

**Local air cooling** can be effective in reducing air temperature in specific areas. Two methods have been used successfully in industrial settings. One type, cool rooms, can be used to enclose a specific workplace or to offer a recovery area near hot jobs. The second type is a portable blower with built-in air chiller.

Another way to reduce heat stress is to increase the air flow or *convection* using fans, etc. in the working area (as long as the air temperature is less than the person's skin temperature). If the dry bulb temperature is higher than 35°C, the hot air passing over the skin can actually make the person hotter. When the temperature is more than 35°C and the air is dry, evaporative cooling may be improved by air movement, although this improvement will be offset by the convective heat. When the temperature exceeds 35°C and the relative humidity is 100%, air movement will make the person hotter. Increases in air speed have no effect on the body temperature of workers wearing vapor-barrier clothing.

**Heat conduction** methods include insulating the hot surface that generates the heat and changing the surface itself. Simple engineering controls, such as shields, can be used to reduce radiant heat. Surfac-

es that exceed 35°C are sources of infrared radiation that can add to the heat load. Flat black surfaces absorb heat more than smooth, polished ones.

Shields should be located so that they do not interfere with air flow, unless they are also being used to reduce convective heating. The reflective surface of the shield should be kept clean to maintain its effectiveness.

**The HVAC** (heating, ventilating and air conditioning) system defines indoor microclimate (Fig. 20).

**Analyses of Urban Heat Environment.** Various kinds of urban activities have impacts on the urban climate. Higher temperature is observed in the urban area. Such temperature shift makes the urban area more uncomfortable. Energy consumption for space cooling would increase, in other words, more CO<sub>2</sub> is emitted due to locally hotter climate condition in summer. Environmentally sound city aims at maintaining high amenity inside the city with giving less impact to the external environment. The urban climate should be mitigated from this viewpoint.

The factors which influence the urban heat environment are anthropogenic heat discharge, change of land surface and geometric change of the urban area. The anthropogenic heat becomes direct input of heat to the atmosphere. Change of land surface from vegetation to pavement or building area reduces latent heat release through evaporation. Construction of the buildings gives fluid dynamic effects.

The impact of anthropogenic heat is dominant in the night time and the impact of land use is dominant in the day time.

Effect of relocation of urban infrastructure and buildings on heat environment is simulated to evaluate candidate of environmentally sound city.

**Sick Building Syndrome.** The term “sick building syndrome” (SBS), first employed in the 1970-s, describes a situation in which reported symptoms among the building occupants can be temporally associated with their presence in that building. Typically, though not always, the structure is an office building.

Generally, a spectrum of specific and nonspecific complaints is involved. Typical complaints, in addition to the signs and symptoms already listed, may also include eye and/or nasopharyngeal irritation, rhinitis or nasal congestion, inability to concentrate, and general malaise-complaints. The key factors are of common character and absence of symptoms among building occupants when they are not in the building.

The sick building syndrome should be suspected when a substantial proportion of those spending extended time in a building (as in daily employment) report or experience acute on-site discomfort. It is important, however, to distinguish SBS from problems of building related illnesses. The latter term is reserved for situations in which signs and symptoms of diagnosing illness are identified and can be attributed directly to specific airborne building contaminants. The Legionnaires’ disease and hypersensitivity pneumonitis, for example, are building related diseases.

There has been extensive speculation about the cause or causes of SBS. Poor design, maintenance, and/or operation of the structure’s ventilation system may be at fault. The ventilation system itself can be a source of irritants. Interior redesign, such as the rearrangement of offices or installation of partitions, may also interfere with efficient functioning of such systems and discomfort microclimate.

Another theory suggests that very low levels of specific pollutants may be present and may act synergistically, or at least in combination, to cause health effects. Humidity may also be a factor: while high relative humidity may contribute to biological pollutant problems, an unusually low level — below 20 or 30% — may heighten the effects of mucosal irritants and may even prove irritating itself. Other contributing elements may include poor lighting and adverse ergonomic conditions, temperature extremes, noise, and psychological stresses that may have both individual and interpersonal impact.

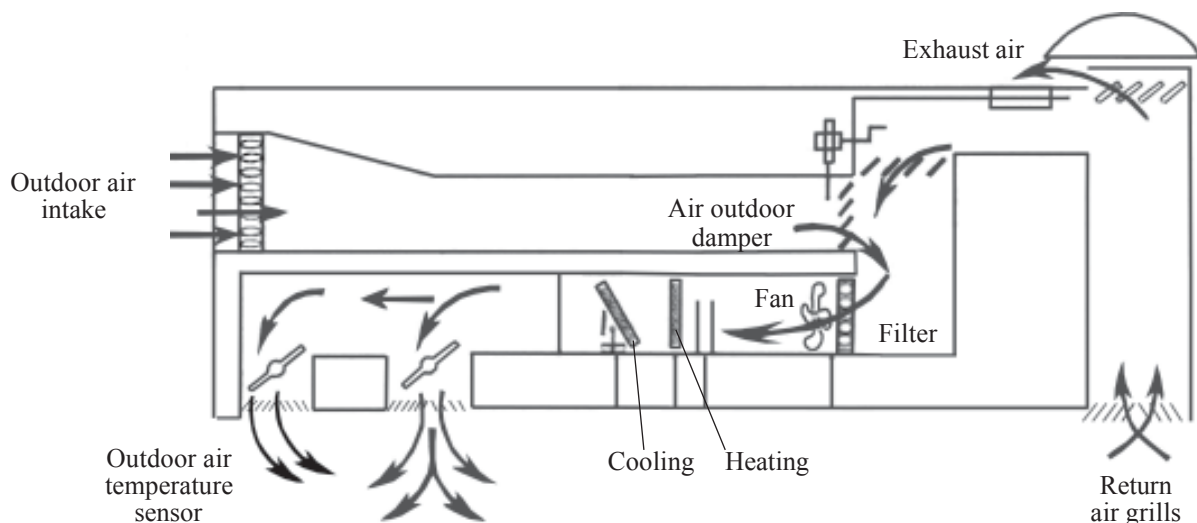


Fig. 20. HVAC System

The prevalence of the problem is unknown. The World Health Organisation (1984) report suggested that as many as 30% of new and remodeled buildings worldwide may generate excessive complaints related to indoor air quality.

## VENTILATION

Ventilation is a system of intake and exhaust that creates a flow of air.

Air exchange is the system of intake and exhaust that occurs with effective air circulation.

Ventilation may be deficient in: confined spaces; facilities failing to provide adequate maintenance of ventilation equipment; facilities operated to maximize energy conservation; windowless areas; and areas with high occupant densities. Any ventilation deficiency must be verified by measurement.

There are two basic types of ventilation systems: natural ventilation or airtation and artificial ventilation. Combination of both is called *mixed ventilation*.

Artificial ventilation can be general or local, plenty, exhaust or balanced. Combination of general and local ventilation is called *combined ventilation*. They used plenty ventilation for prevention of indoor pollution in the operating room, aseptic boxes, etc.

Industrial ventilation generally involves the use of supply and exhaust ventilation to control emissions, exposures, and chemical hazards in the working place. Traditionally, nonindustrial ventilation systems commonly known as HVAC systems were built to control temperature, humidity, and odors. Inadequate or improper ventilation is the cause of about half of all indoor air quality (IAQ) problems in nonindustrial places. Indoor pollutants include but are not limited to particulates, pollen, microbial agents, and organic toxins. People exposed to these agents may develop signs and symptoms related to "humidifier fever", "humidifier lung", or "air conditioner lung". In some cases, indoor air quality contaminants cause clinically identifiable conditions such as asthma, reversible airway disease, and hypersensitivity pneumonitis.

Volatile organic and reactive chemicals often contribute to indoor air contamination. The facility's ventilation system may transport reactive chemicals from a source area to other parts of the building. Tobacco smoke contains a number of organic and reactive chemicals and is often carried this way. In some instances the contaminant source may be the outside air. Outside air for ventilation or make-up air for exhaust systems may bring contaminants indoor.

General exhaust ventilation (dilution ventilation) is appropriate when:

1. Emission sources contain materials of relatively low hazard. (The degree of hazard is related to toxicity, dose rate, and individual susceptibility).

2. Emission sources are primarily vapors or gases, or small, respirable-size aerosols (those not likely to settle).

3. Emissions occur uniformly.

4. Emissions are widely dispersed.

5. Moderate climatic conditions prevail.

6. Heat is to be removed from the space by flushing it with outside air.

7. Concentrations of vapors are to be reduced in an enclosure.

8. Portable or mobile emission sources are to be controlled.

Local exhaust ventilation is appropriate when:

1. Emission sources contain materials of relatively high hazard.

2. Emitted materials are primarily larger-diameter particulates (likely to settle).

3. Emissions vary over time.

4. Emission sources consist of point sources.

5. Employees work in the immediate vicinity of the emission source.

6. The plant is located in a severe climate.

7. Minimizing air turnover is necessary.

Exhaust ventilation systems require the replacement of exhausted air. Replacement air is often called make-up air. Replacement air can be supplied naturally by atmospheric pressure through open doors, windows, wall louvers, and adjacent spaces (acceptable), as well as through cracks in walls and windows, beneath doors, and through roof vents (unacceptable). Make-up air can also be provided through dedicated replacement air systems. Generally, exhaust systems are interlocked with a dedicated make-up air system. Other reasons for designing and providing dedicated make-up air systems are that they:

- avoid high-velocity drafts through cracks in walls, under doors, and through windows;

- avoid differential pressures on doors, exits, and windows;

- provide an opportunity to temper the replacement air.

If make-up air is not provided, a slight negative pressure will be created in the room and air flow through the exhaust system will be reduced.

HVAC includes cooling, humidifying or dehumidifying, or otherwise conditioning air for comfort and health. HVAC also is used for odor control and the maintenance of acceptable concentrations of carbon dioxide. Improved human productivity, lower absenteeism, better health, and reduced house-keeping and maintenance almost always make air-conditioning cost effective.

Table 8. Criteria of Ventilation Effectiveness

Indirect criteria	MAC
Carbon dioxide	0.1% 0.07% in the hospitals, OPDs, kindergartens, etc.
Dust pollution	0.15 mg/m <sup>3</sup>
Germ pollution	2,500 microbes per m <sup>3</sup> 16 Str. haemolitycus per m <sup>3</sup> (Summer) 4,000 microbes/m <sup>3</sup> 36 Str./m <sup>3</sup> (Winter)

Mechanical air-handling systems can range from simple to complex. All distribute air in a manner designed to meet ventilation, temperature, humidity, and air-quality requirements established by the user. Individual units may be installed in the space they serve, or central units can serve multiple areas.

HVAC engineers refer to the areas served by an air handling system as zones. The smaller the zone, the greater the likelihood that good control will be achieved; however, equipment and maintenance costs are directly related to the number of zones. Some systems are designed to provide individual control of rooms in a multiple-zone system.

Considerations in designing an air-handling system include volume flow rate, temperature, humidity, and air quality. Although not generally recommended, recirculation is an alternative to air exchanging.

For ventilation assessment they use direct and indirect criteria.

The indirect criteria of ventilation effectiveness are pollution indicators. There are carbon dioxide concentration, dust and germ pollution rate, subjective odometric scales, etc. (Table 8).

Direct criteria are ventilation volume, air replacement frequency and air cube. Needed ventilation volume depends on amount of people:

$$L = \frac{kn}{p - p_1};$$

where

L — ventilation volume (cmh — cubic meters per hour)

k — carbene dioxide volume producing by one man per hour (16 l — during sleeping, 22.6 l — at rest, 40 l — at hard work)

n — number of people in the room

p — MAC of CO<sub>2</sub> (0.1%)

p<sub>1</sub> — concentration of CO<sub>2</sub> in the atmospheric air (0.04%)

For example: needed ventilation volume for room with 5 people is:

$$L = \frac{22.6 \text{ dm}^3 \times 5}{0.1\% - 0.04\%} = 188 \text{ [m}^3/\text{h]}$$

Real ventilation volume can be assessed by the formula:

$$Q = S_{nv} \times 3,600$$

Air changes per hour (ACH) can be assessed by the formula:

$$K = \frac{S_{nv} \times 3,600}{abc},$$

where

K — ACH

S — area

n — number of fans

v — air velocity in fan

3,600 — number of seconds in an hour

a — height of the room

b — width of the room

c — length of the room

Usually K is 1–3 for resident houses, 3–5 — for workshops of enterprises.

Minimal room volume per man is called air cube. It depends on the room type. Thus bedroom air cube can be 25 m<sup>3</sup>. Air cube can be evaluated on a room area basis. There is 13.5 m<sup>2</sup> per man as a standard room area in Ukraine. Height of resident premises should be no less than 2.7 m, in hot climate — more than 3 m.

As physiological cube they use 37.6 m<sup>3</sup>:

$$\frac{k}{p - p_1} = \frac{22.6 \text{ dm}^3}{0.1\% - 0.04\%} = 37.6 \text{ [m}^3/\text{h]}$$

## LIGHTING

Lighting (illumination) is a system of providing the proper luminous flux per unit area on an intercepting surface at any given point of premise.

Illumination of the premises is an important achievement of civilization. Our vision state depends on a quality of illumination, our life is closely connected with illumination usage.

Hygienic demands for illumination are following:

— *sufficient light*. There should be enough light to enable us to see details of objects and surroundings without strain. Fifteen to twenty foot candles is the accepted minimum light required for satisfactory vision.

— *distribution should be even*. Light of the same intensity is required over the whole field of work. Proper dispersal of light without shadows is required for efficient vision.

— *avoid glare*. Glare is excessive contrast. This causes annoyance and reduces critical vision. Automobile headlights at night give off such a glare that pedestrians feel discomfort and are unable to adjust visually to the surroundings in the presence of glare. The disappearance of trees from roadsides, and the increase of glass fronted buildings, has increased the glare factor on roads. The same happens with polished floors, tabletops, or mirrors in houses. When direct rays of sunlight from windows or doors hit these surfaces, they give off a discomforting glare.

— *avoid shadows*. Shadows are inevitable. But too many sharp shadows confuse vision.

— *no flicker*. The light should be steady. Flickering causes eye strain.

The optimal lighting is natural. The colour of light is not as important as its intensity. But since natural light has a soothing effect, the closer the colour to natural light, the better its influence on us. During physical examination a physician should use day light — it will not mask dangerous signs of diseases (jaundice, cyanosis, etc.).

The amount of light received inside a building is usually only a small fraction of that required — because of modifications imposed by the size and position of openings — and will also constantly vary owing to the influences imposed on the “whole sky”, illumination level by clouds, buildings and/or other reflecting planes. Therefore, it is impracticable to express interior day lighting in terms of the illumination actually obtainable inside a building at any time, for within a few minutes that figure is liable to change with corresponding changes in the luminance of the sky.

The background, usually walls and ceilings, should be of lighter colours and the floor, darker. Day lighting is influenced by the general structure of a building, the design of facades, windows and skylights, and can be further extended by the use of special devices for redirecting or transporting light. Enhancing natural illumination could be provided by correct position of house and windows placing.

**Position of the House.** It is better the house *faces* oriented to the north or the south. The light is not uniform through the day in the east or the west. The north-south oriented house has a better chance for uniform lighting in the moderate climate.

**Windows.** A tall window facilitates greater penetration of light. A broad window enables better diffusion of light. The natural lighting is further influenced by the extent of sky that is visible. The ideal window size should be 10% of the floor space.

Light colours of the walls and the ceiling reflect more light and make the room brighter. The lower portion of the walls and the floor should be darker.

Overcrowded constructions hamper natural illumination. Buildings stand in the way of light. Apart-

ment blocks pack as many dwellings together as possible. Walls are shared and window spaces are reduced. For reasons of privacy, windows are smaller and curtains are used. We have begun to air-condition and soundproof rooms, where there is no scope of an open window. Therefore we have to resort to artificial lighting even in during the day-time. Filament lamps and fluorescent tubes are the two common options in household illumination. The filament lamp is usually in the shape of a bulb, producing yellowish light. Hotter filaments emit white light. Filament lamps are available for a range of brightness. This light is good for working or studying in. But this is unsuitable for decorative purposes.

Filament (bulb) lamps emit plenty of heat. The fluorescent tube is cool, efficient and consumes less power. It simulates natural light. The inner walls of the tube are coated with illumination agent that is close to darkness as well as bright daylight. Bright moonlight is measured as 0.1 lx and bright sunshine is measured as 100,000 lx.

They use following light-technical units in hygiene:

Light power: candela (cd) /LP of point light sources of monochromatic waves ( $\nu=540\cdot 10^{12}$  Hz) with energy 1/683 W/sr.

Light stream: lumen (lm) /for point light sources with LP=1 cd in 1 sr.

Illumination: lux (lx) [=1 lm/m<sup>2</sup>]

Luminance of light source: cd/m<sup>2</sup>

Direct lighting provided from a source without reflection from other surfaces. In daylight this means that the light has travelled on a straight path from the sky (or the sun) to the point of interest. In electrical lighting it usually describes an installation of ceiling mounted or suspended luminaires with mostly downward light distribution characteristics.

Indirect lighting provided by reflection usually from wall or ceiling surfaces. In daylight, this means that the light coming from the sky or the sun is reflected on a surface of high reflectivity like a wall, a window sill or a special redirecting device. In electrical lighting the luminaires are suspended from the ceiling or wall mounted and distribute light mainly upwards so it gets reflected off the ceiling or the walls.

Local lighting means a light fixture or array of fixtures that provides illumination over a small area such as a service counter in a warehouse, without providing any significant general lighting in the surrounding area (Table 9).

For hygienic evaluation of indoor illumination you should know the purpose of the building, its special location, shady surrounding, number and shape of windows, type and cleanness of glasses, presence of curtains, flowers and items on window-sills, size of rooms, etc.

Table 9. Methods of Illumination Assessment

Methods	Natural illumination	Artificial illumination
Geometrical methods	angle of falling rays aperture angle coefficient of depth light coefficient	not used
Light-technical "Method of Watts"	day light factor not used	photometry used

Widely using *light coefficient* can be determined with a formula:

$$LC = S_1/S_2$$

were  $S_1$  — area of window and  $S_2$  — floor area

In Fig. 21 determination of other geometrical indices is shown.

To know falling rays angle it is divided the distance between the window and the opposite wall to the window height:  $tg\alpha = AB/BC$ . Similar calculations could be used to determine shadow angle  $tg\beta = BD/BC$ . Difference between falling and shadow angles is aperture angle.

All geometrical indices give only partial information about day lighting. These indices do not take into account the weather conditions, window construction and room design. For practical purposes the *daylight factor (DLF)* is used. This is a percentage ratio of the instantaneous illumination level at a reference point inside a room to that occurring simultaneously outside in an unobstructed position. For assessment of illumination rate photometers are used (Fig. 22).

$$DLF = E_{\text{internal}}/E_{\text{external}} \cdot 100\%$$

where:

- E internal — indoor illumination rate (in lx);
- E external — outdoor illumination rate (in lx).

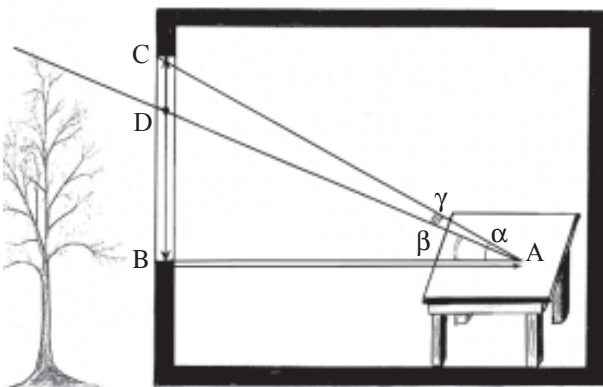


Fig. 21. Determination of Falling Angle and Aperture Angle

Lighting levels from 300 to 500 lx are generally considered to be the most appropriate. However, paper-based work often requires more light (Table 10).

Generally, maximum levels should not exceed 750 lx. People usually find levels above this too bright. Excessive light levels may "mask" (or partly hide) characters or whatever is shown on the screen and create more and brighter sources of glare. Glare is caused by large differences in light levels within the visual field. The eyes try to adapt to these large differences and visual fatigue and discomfort may result. In addition, the video display terminal (VDT) operator may adopt a poor posture while trying to reduce the glare by changing his or her orientation to the screen. This may result in neck and back pain. There are three types of glare.

Indirect glare occurs when light from windows or overhead lighting is reflected off shiny surfaces



Fig. 22. Photometer

Table 10. Norms of Illumination Rates for Various Premises

Index	Value	Premises
Aperture angle	5°	all
Angle of falling rays	27°	all
Coefficient of deepness	2	all
Light coefficient	1/2–1/4	operating-room
	1/5–1/6	classroom
	1/6–1/8	hospital ward
	1/10–1/12	lodgings store room
DLF	0.5%	lodging
	1%	hospital ward
	1.5%	classroom
	2.5%	operating-room
General illumination, lx	for reading and writing	300 (150*)
	lodging	75 (30)
	kitchen	100 (30)

\* — for illumination by bulb lamps.



in the field of view, such as terminal screens, desks and other office equipment. Light from sources directly overhead causes *masking glare* on the screen, partly obscuring what the operator is trying to focus on. *Direct glare* occurs when there are bright light sources directly in the operator's field of view. Windows are often a source of direct glare.

Ways of reducing both direct and indirect glare include using light-absorbing curtains and blinds and positioning terminals so the operator's line of sight is parallel to windows and overhead fluorescent lights. Workstations should be located between rows of overhead lights. Window curtains must be thick enough to block most of the light, or they can be used

with Venice blinds. Blinds with vertical slats are also effective. General lighting levels should not be excessive. If a worker needs more light for a job, adjustable task lighting should be provided. Direct and indirect glare from overhead lights can also be controlled by parabolic filters. These are light-fixture covers that allow light to travel only straight down and not to disperse at an angle, providing sufficient light while minimizing reflection on VDT screens.

Another option is an indirect lighting system designed so that light from fixtures does not shine into the work area directly but only after being reflected off ceilings and walls. This provides even lighting and minimizes glare.

### HYGIENIC IMPORTANCE OF WATER

Water is one of the most important elements of the environment. It is necessary for human, animal and plant life. It takes part in the formation of human body structural elements. It makes up to 65% of the body weight.

Water has a great importance as a dissolver: all physico-chemical processes take place in water solutions of the organism. Body tissues are water colloidal systems. Water participates in oxidation, hydrolysis and other reactions of the metabolism, in digestion and the transport of nutrient and metabolic products in the organism. It takes part in thermoregulation (evaporation from the skin and respiratory organs). In moderate latitudes water requirement of the adult is about 2 litres daily. Water loss by the perspiration can make 5–12 litres daily during hard physical work and in hot climate. At the same time the loss of sodium chloride, iron and other microelements and vitamins increases too.

The human organism is intolerant to dehydration. The loss of 1–1.5 l of water needs to restore water balance by the appearance of the thirst. If water loss cannot be restored disability for work decreases, the man feels worse at high temperature water-salt exchange and thermoregulation become impaired. It leads to the organism overheating. The following clinical manifestations are observed in human dehydration in tropics, depending on the level of water loss: the loss of 1–5% water (of the body weight) — the thirst, indisposition, the loss of appetite, skin hyperemia, irritability, drowsiness, the increase of body temperature. The loss of 6–10% of water cause confusion, dyspnoea, the decrease of blood volume, the stoppage of salivation, cyanosis, dysphasia, unsteady gait. The loss of 11–20% of water — hallucination, swollen tongue, the difficulty of swallowing, deafness, reduction of vision, flabbiness of the skin, painful urination, anuria. The loss of 15–20% of water at the temperature of 30°C is

lethal. The loss of 25% of water is lethal even at low temperature.

The improvement of cultural and hygienic conditions of life is associated with the increase of water consumption by a man. It makes about 150–500 l daily.

The world faces a water crisis. About one billion people lack access to safe water and three billion — to appropriate sanitation. There will probably be two billion extra people on the planet by 2025; so while today's shortages are for fresh water and sanitation, tomorrow's are predicted to be for growing crops. Already, 10% of world food production is drawing down underground water faster than the recharge rates. Water also threatens to cause conflicts between regions a state of affairs that is expected to worsen as this century progresses. To raise public awareness of these issues and made politicians to act, the World Water Commission (WWC) held a Forum in March, 2000 in The Hague. The Forum collected together a huge range of people from governmental, non-governmental organisations (NGOs), workers for the environment and development, private sector water providers, trades unions and scientific institutes. They all discussed a document (World Water Vision: A Water Secure World) drawn up by the WWC as a basis for action. The Forum culminated in a meeting of ministers from over 140 governments.

**The Physical Structure of Water.** Lately it was found out, that the structure of water had a certain physiological significance. It is proved by the experiments, that fresh water, gradually losing its ice structure, is characterized by the stimulating (adaptagenous) action, which decreases 2 times for 12 h. It explains the refreshing action of frozen water.

Organoleptic features of water are characterized by its transparency, color, taste and smell. Water with bad organoleptic features slakes the thirst poorly.

**The Chemical Content of Water.** Natural waters differ from each other by their chemical content and the degree of mineralization. The total con-

tent of dissolved salts in natural waters is from some dozens to 1,000 mg/L. However, there are some places in tropics, where water, containing 3,000–5,000 mg/L of salts, is suitable. Salt content is mainly represented by cations of Ca, Mg, Na, K, Fe and anions of  $\text{HCO}_3^-$ ,  $\text{Cl}^-$  and  $\text{SO}_4^{2-}$ .

Water, containing more than 1,000 mg/L of mineral salts, can have salt, astringent taste, worsens secretion and increases motor function of the stomach and intestines, influences negatively upon the assimilation of nutrients and provokes dyspepsia. Hard water containing many salts of calcium and magnesium almost unsuitable for everyday use.

People, who constantly live in the places without fresh water are adapted to the water containing 1,500–3,000 mg/L of salts. There are no physiological or biochemical deviations from the norm in the inhabitants.

Nitrates ( $\text{NO}_3$ ) have the most expressed toxically features. If water containing more than 45 mg/L of nitrates is used for infants, it leads to water nitrate methemoglobinaemia.

The increase of some microelements more than admissible level can lead to geochemical endemics. They are fluorosis, provoked by high content of fluorine (more than 1–1.5 mg/L) in water. If fluorine content is less than 0.5 mg/L, the rate of teeth decay increases 2–4 times.

The use of water rich in iodine (30–100 mg/L) promotes the decrease of endemic goiter, provoked by the insufficient intake of iodine.

There were observed the diseases, provoked by high content of lead, mercury, arsenic and other microelements at the placements of fossilized ores.

Owing to the use of chemicals in agriculture, stable pesticides can get water of the open reservoirs. Toxic products can be accumulated in water animals (fish, shellfish) in concentrations 3 times exceeding their content in water.

Lately considerable attention has been paid to the radioactivity of water. The use of water with the increased radioactivity can lead to the negative genetic consequences (congenital anomalies), the increase of malignant tumours, blood diseases and so on.

#### **The Epidemiological Significance of Water.**

Water is an important factor of transfer of infectious diseases. Bad conditions of water supply, sanitary cleaning of settlements and low level of sanitary culture, mainly in the rural population, lead to 43.7% of lethal cases caused by infectious diseases, in the developing countries, in contrast to 10.8% — in the developed countries. About 2/3 of patients are hospitalized because of infectious diseases, caused by the use of impured water, in the rural areas of tropics and subtropics.

The pathologic agents of cholera, typhoid fever, bacterial and amoebic dysentery and some other diseases can even multiply in the water in hot coun-

tries. Moreover, many hot countries are situated in the regions with water deficit. Frequent use of water from the bad reservoirs increases the possibility of infection. The predisposing factor is impairment of water-electrolyte balance, leading to the decrease of gastric acidity and its barrier function for some pathologic agents. The spread of helminthoses has a great importance for the decrease of human resistance. Endameba histolytic provokes dysentery-like clinical picture and is complicated by abscesses of the liver and other organs.

Acute intestinal infections (cholera, typhoid fever, paratyphuses, bacterial and amoebic dysentery, acute infectious enteritis) belong to water infections in the first place.

The way of transmission of these infections is fecal-oral. The agents of these diseases get water from human faces and everyday sewage from the settlements. Due to the latent carriers pathogenous microorganisms exist in sewage even in the interepidemic period. The sewage of the infectious hospitals is the most dangerous. The cause of water infection can be the navigation, the places of mass swimming, washing in the small reservoirs, the soiling from the lavatories, the infection of wells by dirty baskets.

Amoebic dysentery is limited by hot climate. It is considered that about 10% of people are infected by this disease. From 14 to 30% of people are carriers of this amoeba in different tropic countries, mainly they are children. Daily the carrier discharges to 600 millions of amoebic cysts, which live in the environments as long as 0.5–3 months in feces and to 8 months in water. They die at the temperature of 55°C. Water outbreaks of amoebiasis were observed after the contamination of reservoir by sewage.

Now about 100 viruses discharging by human feces are known. Some of them can provoke water-borne diseases. Viruses preserve their pathogenous features in the reservoirs and drinking water for a long time (up to 200 days). Besides, many of them are stable to the action of disinfectants.

Leptospirosis, tularemia, brucellosis are also spread by water. Water can be the factor of spread of viral conjunctivitis. Trachoma is less spread in the regions with the sufficient water supply.

Lamblias cysts, worm eggs, ankilostoma, dracunculosis, schistosomes can get into the human organism by water. They provoke diseases, widespread in hot countries.

The peculiarities of climate have an importance for the spread of infections in hot countries. During downpour the soil it is washed away to rivers, lakes, beaches, infecting them by pathogenic microorganisms. During drought the number and capacity of reservoirs is decreased. The quantity of microorganisms increases, so the possibility of the disease increases too.

## HYGIENIC REQUIREMENTS FOR THE QUALITY OF DRINKING WATER AND ITS SANITARY ESTIMATION

Water used for drink and everyday needs, must correspond to the following demands:

— good organoleptic features: refreshing temperature, transparency, colorless, no smell and no taste;

— the suitability by its chemical content (from the physiological point of view harmful matters mustn't be there in dangerous for health and everyday life concentrations;

— the absence of pathogenous microorganisms.

The grounded conclusion about water quality and sanitary condition of the reservoir can be made only during the comparison of the data of water analyses with the hygienic norms and the results of sanitary-topographical investigation.

**Active reaction (pH)** varies from 6.5 to 9.2. The most acid are swampy waters, the most alkaline are subsoil waters rich in bicarbonates. Dry residue characterizes the degree of mineralization. It should not exceed admissible quantity of 1,000 mg/L. In some hot countries they should use water, containing to 2,000–3,000 mg/L if it hasn't any unpleasant taste and doesn't provoke diarrhea.

**Total hardness** is conditioned by salts of calcium and magnesium such as carbonates, bicarbonates, chlorides and sulphates. If the hardness is up to 3.5 mg-eq/L, the water is soft, from 3.5–7.0 mg-eq/L — of middle hardness, more than 7.0 — hard and more than 14 mg-eq/L — very hard. Very hard water is unsuitable for hygienic needs — temporary dyspepsia can occur in the sharp change of soft water to hard one. The etiological role of hard water in the occurrence of urinary stones isn't proved but some authors consider that the use of hard water especially in hot countries can provoke the development and growth of urinary stones.

The epidemiological investigations in England, the USA, Japan, and other countries show the opposite dependence on water hardness and the mortality from cardiovascular diseases. The artificial increase of hardness in some regions had positive consequences whereas the artificial softening had negative results. The mechanism of protective action of hard water is unknown. Is it a result of the presence of calcium, magnesium or some other microelements (fluorine) or the absence of some matters. Now the scientists put down the protective role to calcium, which together with magnesium is a component of myocardium enzyme system and regulates electrolyte balance. If calcium level in blood decreases, QT interval in ECG becomes longer, it's risky for arrhythmia, and the risk of sudden death

increases. The level of calcium is decreased in the blood serum of people, using soft water. Calcium of nutrient matters is assimilated only by 30%; but calcium of drinking water — by 90%.

Recommended hardness of water is 2 mg-eq/L and MAC is 10 mg-eq/l. However, nowadays, the optimum hardness should be 5–7 mg-eq/L, calcium content — 150 mg/L and magnesium can form a special taste and provoke the irritation of the intestines and the increase of peristalsis. If water contains to 250 mg/L of sulphates, the admissible magnesium concentration is to 150 mg/L. But, if the concentration of sulphates is higher, magnesium content mustn't exceed 30 mg/L.

*Iron* usually exists in the form of iron bicarbonate  $\text{Fe}(\text{HCO}_3)_2$ . But in contact with air this compound is oxidized with the brown flakes of  $\text{Fe}(\text{OH})_3$ . It makes water turbid and coloured. Subsoil waters of Northern India and other countries have large concentrations of iron.

The concentration of iron more than 0.3–0.5 mg/L worsens the appearance of water. The concentration of total iron in the water-pipe should be no more than 0.1 mg/L.

The concentration of *chlorides* is 20–30 mg/L in running water, 30–50 mg/L — in the clean well water of the places with saltless soils. Fresh water filtered through saline soils, rich in chlorides can contain hundreds and even thousands milligrams of chlorides. Water, containing more than 350–500 mg/L of chlorides, has a salt smack and can influence negatively upon gastric secretion. The recommended concentration of chlorides mustn't exceed 250 mg/L.

If sulfates concentration is more than 400–500 mg/l, water has a brackish smack. It influences negatively upon the secretion of the alimentary canal and provokes dyspepsia. The highest concentrations of sulfates are typical of subsoil waters of Northern Africa and Middle East. The recommended level of sulfates is no more than 250 mg/L.

High concentrations of *nitrites* are met in well water, polluted by the components of nitric fertilizers and products of organic decay. The concentration of nitrites should not exceed 45 mg/L to prevent water-nitrite methemoglobinaemia.

The concentration of *fluorine* varies from 0.01 to 20 mg/L. Usually water of the open reservoirs contains less fluorine (no more than 0.5 mg/L). High concentrations are observed in deep subsoil waters and in the superficial waters, water supply from deep reservoirs which is rich in fluorine. The evaporation of water in lakes promotes the increase of fluorine concentration in hot climate.

Certain quantities of fluorine are necessary for the normal mineralization of bones and teeth. If the concentration of fluorine increases the rate of tooth decay appropriately decreases. The concentration of fluorine should be 1–1.5 mg/L. But high concentrations of fluorine provoke fluorosis. Many cases of

fluorosis were found out in Northern Africa, Asia, Southern America.

Fluorine, absorbed in the alimentary canal, acts upon sensitive dental rudiments, disturbs the formation and mineralization of enamel. The manifestation of this disease is a spotted enamel of permanent and milk teeth. In the concentration of 1.5–2 mg/l, chalk-like and porcelain-like spots appear in symmetric teeth, sometimes they are yellowish (the first or the second degree). The spots may be brown with erosion. Such teeth are destroyed early and it leads to bleeding (the 3rd and 4th degree of fluorosis). Lesions of teeth aren't only manifestation of fluorosis. In some regions of Africa, China, India, Southern America people use water containing 5–18 mg/L of fluorine. The long-term use of such water for 10–30 years leads to generalized osteosclerosis, calcination of ligaments and some disorders of the nervous system and internal organs.

**Radioactivity** is determined by the presence of indices which are evidence of the increased natural activity of water or its anthropogenous pollution by radionuclides. The least active are atmospheric waters. The increased radioactivity is observed in the volcanic regions and large industrial centres (at the expense of potassium-40, uranium-238 and so on).

The most intensive radioactive pollution is observed in the location of the electric power stations and other enterprises using radionuclides, in cases of damages or bad functioning of sanitary-technical equipment, or improper radioactive waste disposal. The natural radioactivity of subsoil waters depends on the number of dissolved radionuclides, which are included in washed rocks and soils. The radioactivity is mainly conditioned by potassium-40, radium-226, radon-222, natural uranium and so on. The least radioactive are subsoil water located in sedimentary rocks. Usually their activity extends due to increase of mineralization.

Medicinal mineral waters have high activity too (up to 2–3 Bq/L). Waters placed closely to the sources of radioactive ore and interspatial waters in the sources of oil have very high radioactivity. When they come out during drilling, they contaminate soil and superficial reservoirs.

When radionuclides get water, they are carried by the current, absorbed by the bottom, where they are accumulated. They can get water from the bottom or by passing through the biological chains. The concentrations of radionuclides in hydrobionts can  $10^2$ – $10^4$  times exceed their concentration in water.

Chemical indices of possible pollution, which have epidemiological value are marked for water from the sources of water supply. They are organic matters and the products of their decay: ammonium salts, nitrites and nitrates. Except of nitrates, the afore said compounds in usual concentrations (ammonium salts — to 0.1 mg/l, nitrites — to 0.002 mg/L) don't influence the human organism negatively. Their

presence is evidence only of soil through which water is filtered, and of possible presence of pathogenic microorganisms. The main cause of ammonium nitrogen and nitrites in natural waters is a decay of albuminous matters, animal corpses, urine, and feces. Ammonium salts and nitrites can be formed from nitrates in deep subsoil waters. Nitrates are products of oxidation of ammonium salts. Their presence in water and absence of ammonia are evidence of old contamination by nitrogenous matters which have been already mineralized. The use of nitrogenous fertilizers also leads to the increase of nitrates in soil waters.

The index of organic matters in water is its *oxidability*. It is expressed by milligrams of oxygen, spent on the oxidation of organic matters. Artesian waters have the least oxidability to 2 mg/L. In mine wells it reaches 3–4 mg/L. The oxidability increases by the extending of water colour. This index is higher in open reservoirs. The increase of oxidability more than the afore said norms is evidence of possible contamination.

Chlorides are one of the evidences of water pollution, because they contain urine and other waste. But their high concentration can be a result of washing out from salt soils.

Consequently, every chemical index can have another nature. Thus, the reservoir can be considered contaminated by following conditions:

- 1) there are several evidences of pollution;
- 2) there is bacterial pollution evidence at the same time;
- 3) the possibility of contamination confirmed by the sanitary investigation of the water.

**Bacteriological Investigation of Water.** Previously pathogenic microorganisms have importance from the epidemiological point of view. But this investigation is very complicated. The investigations are carried out by the epidemiological indications, for example during the outbreaks of water-borne diseases.

Pathogenic organisms occur in low numbers, it is technically difficult to count them and have a long incubation period (several days). This means the procedures are expensive, slow and can be hazardous to laboratory workers (pure cultures of pathogens). Therefore the concept of indicator organisms is used, which is not possibly pathogenic itself but occurring in large numbers and acting as a tracer or index of water quality.

Criteria for choosing the indicator microorganism. It should:

- respond to environmental conditions (or treatment) in a similar manner to the pathogen type of interest;
- occur in larger numbers and therefore always be present with the pathogen;
- come from the same source as the pathogen type of interest;

— be easy to isolate and enumerate.

No organisms completely fulfil criteria so assumptions have to be made:

*Coliforms* are the most commonly used. Total coliforms (TC) are gram negative, rod-shaped bacteria, ferment lactose with gas formation within 48 h at 35°C, wide variety of bacteria, mainly enteric but also some natural soil and water. Faecal coliforms (FC) (*E. Coli*) is a sub-group identified by incubation at elevated temperature. All are enteric but are not distinguished between warm blooded animals.

*Fecal streptococci* — rod-shaped gram-positive 10<sup>6</sup>/g feces, ratio of numbers of fecal streptococci to fecal coliforms is different between animals and higher in humans than domestic live stock. Therefore can distinguish between humans and animals. However, pollution must be local/fresh (< 24 h) and replication to overcome natural variation in microbial counts, e.g.

	FS:FC
Humans	1:4.3
Cow	1:0.18
Dog	1:0.024
Pigeon	1:0.01
Elk	1:0.007

Therefore ratios greater than 1:2 often suggest human contamination.

*Cl. perfringens* — anaerobic spore forming rod-shaped bacteria, 10<sup>4</sup>/g feces, they can form spores which live for a long time, can indicate remote or sporadic pollution when other indicators are absent.

Techniques for identifying *E. coli* for 100 years are based upon selective media and incubation to select for organisms (the method of membrane filtration and the enzymatic method). The first method is based on aseptic filtration of 100 ml through 0.45 µm pore filter, retains bacteria on surface. The filter is placed in petri dish with sterile membrane lauryl sulphate broth (media) nutrients. It is incubated for 4 h at 30°C and 14 h at 37°C for TC or 14 h at 44°C. If sample is very polluted it is serially diluted or can be enumerated directly in media to avoid filter blocking. At the end of incubation, yellow colonies are counted (pH change via acid production) and reported as presumptive counts. For sensitive and legal results this requires confirmation by further biochemical tests (IMViC or API).

Conditions of media and temperature may not let to grow for all of the indicator organisms, suggested that up to 90% of environmental organisms are “unculturable”. Also it was reported they reproduce in some natural waters at temperatures over 30°C, so less appropriate in tropical climates.

Enteric pathogens are in unfavourable environmental conditions once outside intestine, but all can survive for a time in natural waters especially in

cold/anaerobic conditions. The main removal mechanisms are:

- Sedimentation (50–75% of fecal coliforms with particles  $sv > 0.05\text{cms}^{-1}$ )
- Sunlight (UV)
- Predation

The indirect bacterial indices are widely used on determining water quality.

*Microbes number* is one of the evidence of water contamination. It is a number of colonies, which grow up in a nutrient medium at the temperature of 37°C and 20°C from 1 ml of water. It is a total bacterial culture of water. Microbes number of the artesian wells doesn't exceed 10–30 in 1 ml. In mine wells the index forms 200–400 per 1 ml, in clean reservoirs — 1,000, in water from water-pipe — 100 per 1 ml in case of epidemiological cleaning. The single determination of microbes number is insufficient. We must determine it in dynamics.

The determination of *E. coli* and its group is important, as they are discharged out by the human and animal feces and are evidence of fecal contamination. It's a relative indicator of the risk of intestinal water-borne infections.

The degree of water contamination by *E. coli* is determined by coli-titre and coli-index. Coli-titre is the least volume of investigated water where we can find out one *E. coli*. The less titre — the larger fecal contamination. Coli-index — is the number of *E. coli* in 1 l of water.

Coli-titre in artesian water doesn't exceed 500 ml (coli-index no more than 2); in sanitary wells — 100 ml (coli-index — no more than 10).

By GOST-2874-82<sup>1</sup> and SSanR&N (State Sanitary Rules and Norms) N 383 the indices of epidemiological safety of water are: coli-index 3 (coli-titre — no less than 300), microbes number — 100 per 1 ml.

Table 11. Hygienic Standards of Drinking Water Quality (Physiological Adequacy)

Index	Recommended values
Total mineralization, mg/dm <sup>3</sup>	> 100.0 < 1,000.0
Total hardness, mg-eq/dm <sup>3</sup>	> 1.5 < 7.0
Total alkaliness, mg-eq/dm <sup>3</sup>	> 0.5 < 6.5
Magnium, mg/dm <sup>3</sup>	> 10.0 < 80.0
Fluorine, mg/dm <sup>3</sup>	> 0.7 < 1.5

<sup>1</sup> GOST — State Standard of USSR using in NIS currently.

In Ukraine new sanitary rules include indices of physiological adequacy (Table 11). These indices determine adequacy of salt content of drinking water to biological needs of human organism. They based on the interval between the minimum and maximum admissible levels in drinking water.

## HYGIENIC CHARACTERISTICS OF WATER SUPPLY SOURCES

At the absence of other sources of drinkable water in the arid zone of tropics and subtropical zone there can be used rain-water for the water supply of some families or even large groups of people. Atmosphere water is often used for drinking and cooking; water of opened reservoirs or unfavorable wells — for other purposes.

Structure of water consumption is shown at Fig. 23.

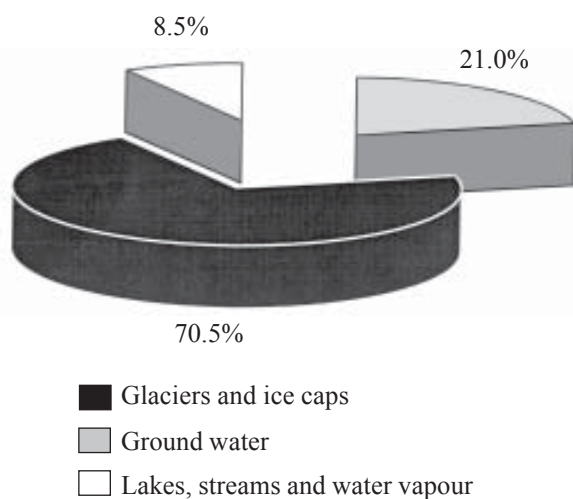


Fig. 23. Sources of Fresh Water

## ATMOSPHERIC WATER

*Atmospheric water* is lightly mineralized (no more than 30–50 mg/L), very soft, without color, not very pleasant in taste. Contents of microorganisms and suspended parts depend on the method of gathering and storage of water. For the family purposes rain-water is gathering from the roof. The best method is gathering water from the galvanized iron roofs. The first portion of water washes out dust from the roof. That's why it is not gathered. Uneven roofs from another materials promote accumulation of dust and leaves, color the water and give it a definite taste. For the gathering of big amounts of water in the mountain regions special water-gathering platforms are used. They are enclosed for the preventing of contamination soil by people and animals.

The best method of storage of atmosphere water is keeping it in the underground concrete tanks. In the regions where rains are often, people have special barrels with the volume up to 200 litres for the gathering of rain-water.

Atmospheric water is not quite safe from the epidemiological point of view. That is why it is recommended to make disinfection of water before usage.

## UNDERGROUND WATERS

*Ground waters* gather on the first from the surface impermeable for water layer (clay, granite, lime-stones). On that level water forms the first water-bearing horizon of soil water. Depending on the local conditions the bottom depth of this waters is within the limits from 1–2 meters to several tens of meters (Fig. 24).

Ground waters are used for the water supply of rural population. There shaft or pipe wells are usually used. Usually shaft wells which are supplied by soil waters produce from 1 to 10 m<sup>3</sup> of water per day. In several cases soil waters can be used for the organizing of small water-pipes in the countryside.

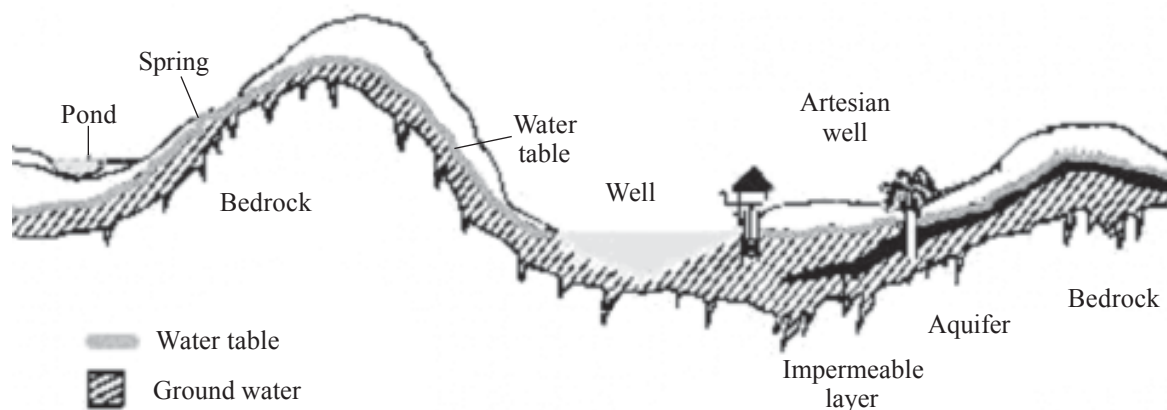


Fig. 24. Underground Waters

*Core waters.* When ground waters move along impermeable layer they can achieve the place between two layers impermeable for water. In that case they become interbed because they are located between two layers: bed and roof. Depending on the local geological conditions interbed waters can form the second, the third and more water-bearing horizons. As a rule interbed water fills all the space between two waterproof layers. If pipe well is made there, water can ascend in pipes or even run out like a fountain. Such interbed water is called artesian. The depth of interbed (core) waters is from tens to thousands of meters. Such waters are often met in arid zones of tropic countries.

Interlayer waters differ from soil ones by low temperature (5–12°C), constant level and structure. Usually it is transparent, without any colour, taste and smell. Concentration of mineral salts in such water is more than in soil ones and depends on the surroundings (rocks) where they accumulate. Interlayer waters may be such mineralized (very hard water, salt, many salts of fluorine, iron or sulfuric hydrogen) that they can't be used for the water supply without preliminary treatment.

As a result of long filtration and presence of impermeable roof which protects core waters from the pollution they are characterized by the almost complete absence of microorganisms and can be used for drinking without any treatment. Interlayer waters are exploited by the way of organizing pipe or, rarely, shaft wells. Constant and big outflow (from 1 to 200 m<sup>3</sup>/hour) and good quality of water allow to use core waters as the best source of water supply of small and average settlements where water is used in natural form, without preliminary treatment.

But there were cases when epidemic diseases of intestinal infections occur in using of interbed waters. Their contamination is a result of getting of infected water into them from the upper water-bearing horizon through the crack in the waterproof roof, not through the wells, quarries, unhermetic mouths of chinks, etc.

Lately there have been cases of contamination of underground waters by the chemical substances as a result of flooding of shafts and deep quarries by industrial sewage or as a result of soil infiltrating by this waters through the cracks in the storages of such fluids.

Sanitary workers of tropical countries point out the fact that pollution of interbed waters by toxic substances can be more dangerous than pollution of opened reservoirs. It is because underground waters couldn't be seen and tested, their flow is slow, often without any direction; such facts make the prognosis difficult. Water can stay polluted during a long period especially when it is polluted by stable chemical substances. Chemical pollution of underground waters stays unnoticed for longer period than pollution of opened reservoirs. In such cases artesian

wells can't be used because of worsening of organoleptic qualities of water (smell of the oil, aromatic smell, salt taste, etc.) or due to result high concentrations of toxic substances.

*Springs.* Underground waters can independently go out to the surface. In such cases they are called the "springs". The springs can be formed by soil and interbed waters as a result of cutting of water-bearing horizon on the slope of the hill or in the deep ravines (descending spring). If the first water-bearing layer breaks off in the ravine or river valley then ascending spring is formed. Quality of the spring water depends on the water-bearing horizon, organisation of captage (construction for water consumption). Constant and sufficient output springs are used for the organizing of water-pipes in small settlements.

Studying of spring contamination cases shows that it occurs at the site of outcome of the spring to the land surface.

That's why for the preventing of spring pollution the following rules must be kept:

1. The place of the well organisation must be as higher on the relief as possible and far from objects that contaminate the soil. On exploiting the spring the place must be kept clean.

2. The walls of the well must be waterproof. Clay lock is usually organized near the upper part of the walls. This lock prevents the getting of water from the surface along walls. The well must be covered for the prevention of pollution from the environment.

*Shaft wells.* Such wells are usually organized in the villages. They are of round or square form (up to 1 m<sup>2</sup>). Distance from the well to the residence of consumer must not exceed 50–150 m. The place for the well must be at the height and no closer than 30 m to the possible sources of pollution, for example lavatory, stables, etc. If a lavatory is located higher on the relief than the well, the distance between them must be no less than 80–100 m, and sometimes 120–150 m. While organizing the well it should be good to reach the second water-bearing horizon if it is not deeper than 30 m. The bottom of the well must be opened and walls are worked up with water-impermeable material. The walls of the well must be higher than the soil level by 80 cm. A pit of 1–1.5 m of depth is dug up around. It's width must be 1 m. It is filled in with clay ("clay lock"). Ground part around the well in the radius of 2 m should be covered with sand and concrete, stones or bricks.

The best method of drawing water is with the help of hand or mechanic pump. If the water is taken by the bucket, it should be public bucket.

*Pipe wells.* If soil waters are located not deeper than 7–8 m, a pipe well is used. They are sunk by hand and equipped with hand pump with productivity 0.5–1 m<sup>3</sup>/h.

In many countries of the Near East, Africa and Latin America shallow-pipe wells are organized by



driving in pipes into the soil. They are called Abyssinian wells.

For the organisation of deep-pipe well a special borehole is bored. A vertical cylindrical borehole has a diameter of 50–600 mm and depth from 10–15 m to 1,500 m. To prevent crumbling of walls metallic pipes which are called supporting are driven in into the borehole. Water is drawn from the well with the help of mechanic pumps productivity of which is about 100 m<sup>3</sup>/hour and more.

In case of correct organisation deep-pipe wells provide preservation of artesian water from pollution. But sometimes this water can be contaminated through the polluted soil waters which are connected with the deeper water-bearing horizon. Soil waters penetrate through rusty supporting pipes. That's why the upper part of the borehole must be closed up with two columns of supporting pipes. The space between these pipes is filled in with cement. Different agents can get into the well through the mouth of the bore-hole. For the prevention of such pollution the upper column of supporting pipes at the place of entrance of absorbing pipe must be completely hermetically sealed. The space between the supporting pipes and walls of bore-hole (retro-pipe space) must be filled in with cement. Such bore-holes are used for the water supply of big towns.

Underground waters which feed many oases in the Sahara, Eastern Africa, Iraq and other arid regions often begin to collect tens or even hundreds kilometres from sites of exploitation on the heights in the period of monsoon rains. Population in those regions gets underground water with the help of deep (up to 50–100 m) dug wells. Such underground irrigating constructions are made by karyzes (hazars, filages). Lifting of the water on the surface is made with the help of a special system — garb, which is moved by camels. Basic elements of the garb: laces, double pulleys, water-skins.

It is the fact that in many arid zones there are large amounts of salt and fresh waters at the depth of 500–1000 m which can be used for different purposes. Modern boring and water-drawing machines allow to organize deep bore-holes quickly.

## OPENED RESERVOIRS

Opened reservoirs are fed not only by atmospheric waters but also by underground ones. They are usually contaminated from the environment. That's why they can be dangerous from the epidemic point of view. In tropical regions reservoirs can play a significant role in the spreading of infections and helminthism by using this water for drinking and cooking (amebiasis, alimentary infections, drakynkylosis, leptospirosis, etc.), while swimming (shistosomosis, leptospirosis and others), and eating fish, crustacean, mollusks and water plants (dysentery,

clonorchosis, opistorchosis, angiostrongilosis, viral hepatitis and others).

The water is greatly polluted in reservoirs near settlements and at the places of outflow of industrial and cattle-breeding sewage.

In tropic countries blossoming and development of plankton and green water-plants are observed in reservoirs with stagnant water or with small flow. Due to their mass dying off the water is colored in green or brown and gets unpleasant scent and taste. During this process some substances form which can be dangerous for the man. A slight taste or scent is always present in almost every opened reservoir. They appear because of decay of organic substances in the water and at the bottom, and due to washing out of actinomycetas and products of their activity from the soil.

Superficial waters are slightly mineralized, soft. But in the lakes and reservoirs without any flow concentration of salts increases due to evaporation of water especially in the conditions of hot climate. Opened reservoirs are characterized by instability of water qualities which can change depending on the season and even the weather (for example, after rains). Rains wash out toxic chemical substances (pesticides), agrochemical agents, industrial sewers and others, pathogenic microorganisms especially in the regions where lavatories don't meet sanitary requirements. That's why the quality of water becomes worse after rains: turbidity increases up to 3–10 mg/l, coli-index — to 1 million, concentration of pesticides and other toxic substances also increases significantly.

## RESERVOIRS SELF-CLEARING

In spite of constant flow of different pollutants into the opened reservoirs in most cases there is no observed progressive worsening of qualities of the water. It can be explained by multitude physical-chemical and biological processes which provide “self-clearing” (removal) of reservoirs from suspended particles, organic substances, microorganisms and other pollutions.

At getting of sewage into reservoirs they are mixed with the water which provide the decreasing of concentration. Suspended mineral and organic substances, eggs of helminths and microorganism sediment so water becomes more transparent. Dissolved organic substances get mineralized due to the activity of microorganisms. Biochemical oxidation is completed by nitrification with the formation of nitrates, carbonates, sulfates and others. The presence of dissolved oxygen is obligatory for the biochemical oxidation of organic substances. In clean reservoirs oxygen saturation is more than 50%.

In the process of self-clearing constant dying off of saprophytes and pathogenic microorganisms occurs. They die due to decreasing of nourishing sub-

stances in the water, influence of sun rays, bacteriophages and antibiotic substances which are discharged by fungi and other saprophytes. Besides, in the countries with hot climate special conditions develop in the reservoirs which promote the reproduction of pathogenic microorganisms.

Special attention should be drawn to existence of viruses. Due to high resistance of enteroviruses they can spread in rivers at considerable distances, far from the source of pollution. At the coastal part of seas they are found at a distance of up to 7 km from the place of pollution. It is important to notice that viruses can infect mollusks for a long period. Infected mollusks live in the coastal waters of tropical countries and population uses them widely in food. It is known that even those mollusks which fished out in the waters with normal coli-titre became the cause of infectious hepatitis A.

Due to self-clearing of reservoirs the water becomes transparent, unpleasant odor disappears, organic substances are mineralized, part of pathogenic microorganisms dies and water acquire those qualities which it had before pollution. The speed of self-clearing depends on the power capacity of reservoir and degree of pollution.

One of the essential indices of contamination degree by organic substances is Biochemical Oxygen Demand (BOD). BOD<sub>20</sub> it is quantity of oxygen which is needed for complete biological oxidation of substances in the volume of 1 litre at the temperature of 20°C during 20 days. In sanitary practice BOD<sub>5</sub> is often used. It is quantity of oxygen which is needed for biological oxidation of 1 litre of water during 5 days. For natural waters BOD<sub>5</sub> is approximately 70% from BOD<sub>20</sub>. In clean reservoirs BOD<sub>5</sub> is less than 2 mg, and in relatively clean 2–4 mg (BOD<sub>20</sub> — 3–6 mg of O<sub>2</sub>).

Self-clearing ability of reservoirs is limited.

While using opened reservoir it is necessary to follow the rules:

— the using of bigger reservoir with constant flow of water;

— protection of reservoirs from the pollution by sewage and industrial waters and pesticides;

— disinfection of the water. Often, besides disinfection, it is necessary to purify the water from suspended particles and coloring and, in some cases, from toxic substances.

Lately opened reservoirs are used for water supply with the usage of water-pipe. It is explained by the development and modernization of techniques of clearing and disinfection of water and by increase of water consuming by big modern cities.

To summarize the said above, first of all artesian waters is the source of water supply. In case of impossibility to use artesian waters, other sources should be found.

## SANITARY PROTECTION OF RESERVOIRS

In many countries protection of reservoirs from contamination by pathogenic microorganisms remains a primary problem. Due to industrialization and progressive chemicalization of agriculture (pesticides, nitrogen and other fertilizers) protection of reservoirs from chemical substances is of great importance.

Chemical substances may worsen organoleptic properties of water such as unpleasant smell, color and taste. They can influence the microorganisms and other organisms of water; provoke death of fish and decrease activity of microorganisms which take part in the self-clearing of reservoirs. Some concentrations of toxic substances are dangerous for humans. Consumption of polluted water can bring about acute and chronic intoxications.

It is very dangerous when the reservoirs get sewage which contain radioactive substances especially with a long half-life period. They can accumulate in tissues of water organisms which can be the agents of secondary contamination of water and increased concentration of radioactive substances in tissues of fish and birds.

Sewage which contain an acid or alkaline compound, colored substances, oil or products of its processing worsen the water quality and self-clearing processes.

Located in settlements industrial enterprises often throw out their sewage into city sewerage without any previous purification. As a result of this action chemical composition of household-fecal waters becomes worse primarily by increased concentration of heavy metals, arsenic and other toxic substances.

The escape of non-purified sewage into reservoirs concerns the interests of population, agriculture and industry. That's why the task of sanitary protection of reservoirs has a state significance and for its effective solution legislative acts must be made.

Water resources of the country are national property and must be protected from pollution and exhaustion. In Ukraine the base of water legislation is The Law about Water (2002), GOST 2874-82 "Drinking Water" and 2761-84 "Sources of Centralized Household-Drinking Water Supply", which provide the necessity of primary satisfaction of drinking and household demands of people. That's why they have great demands to the hygienic conditions of reservoirs and quality of water in them. There are also exist "Rules of Protection of Superficial Waters from the Pollution by Sewage" (1988) and Sanitary Rules and Norms "Drinking Water. Hygienic Requirements to Water Quality in Centralized Water Supply" (1996).

These rules demand the carrying out of measures which must exclude the necessity of throwing out of sewage into reservoirs. It can be achieved by rationalization of technologic processes, recurring usage of sewage by industrial enterprises after their refining (working cycle), throwing out of sewage on the fields for irrigation and fertilization.

Rules allow to throw out sewage into reservoirs only in those cases when it can't be avoided. Sewage before throwing out into reservoirs which are used for the water supply of people or food enterprises must be completely purified. After mixing such waters with the water of reservoir in the worst conditions the following demands must be met: (1) don't worsen organoleptic qualities of water and outward appearance of reservoirs; (2) don't worsen processes of self-clearing and existence of organisms; (3) don't pollute the reservoir with pathogenic microorganisms or chemical substances in toxic concentrations.

Realization of these rules demands theoretically substantiated Maximum Admissible Concentrations (MAC) of toxic substances in water. Hygienists determine those concentrations for more than 700 different chemical agents which can pollute the reservoir. Each chemical substance must be examined in 3 directions: sanitary-toxicological, organoleptic and common sanitary. There are MACs for several chemical agents: arsenic — 0.05 (sanitary-toxicological), nickel — 0.1 (sanitary-toxicological), copper — 1.0 (organoleptic), zinc — 1.0 (common sanitary), sodium trichloroacetate — 5.0 (common sanitary), titanium — 0.1 (common sanitary) and others (See Annex 1).

## **THE METHODS OF WATER CONDITIONING. THE HYGIENIC CHARACTERISTICS OF WATER SUPPLY AND ITS SANITARY CONTROL**

There are many methods of water improvement. They make it possible to purify water from dangerous microorganisms, suspended matters, gumines, surplus salts, stinking gases, toxic and radioactive matters.

The use of different methods of water improvement let us use water resources of the country more completely and provide the population with qualitative water.

The traditional methods of water conditioning are: lightening, decolorizing and disinfecting.

### **PURIFICATION (LIGHTENING AND DECOLORIZING)**

The lightening and partial decolorizing are achieved by the long settling. It is realized in the sources

of water supply and storage ponds. It is a long process. The effectiveness of decolorizing is low. That's why, they often use coagulators, which accelerate the sedimentation of suspended matters.

As a rule the process of lightening and decolorizing is completed by filtration through the layers of granular material (sand, activated coal). There are two methods of filtration: slow and fast.

Natural settling is realized in the horizontal settling tanks, the reservoirs with the depth about some meters. Water moves very slowly there, its speed doesn't exceed 0.15 m/s. Water stays there for 4–8 h, and previously coarse suspended particles are sedimented. The settling within 3–7 days is used in hot countries. During that time little particles, the significant part of absorbed matters and microorganisms are sedimented. If schistosomiasis is widespread in that region, water must be in the settling tanks for about 3–4 days. This pathological agent dies in 48 h, if it doesn't get into the human or animal organism. So, the preservation of water for 2 days in the settling tank, free of mollusks, is a reliable method to prevent the spread of schistosomiasis. The tank should contain the walls higher than the ground, and a screen made of galvanized net with the cells no more than 3 mm to detain mollusks. These conditions are very important, as cercaria are stable for the disinfection by chlorine. After the settling water passes through the slow filter to be lightened completely. It is a brick or concrete reservoir. There are drainages from concrete slabs or drainage tubes with the openings. The suspending layer of detritus and gravel of 0.7 m in the thickness is placed above the drainage. Above it there is one meter layer of sand, the diameter of its granules is 0.25–0.5 mm.

Then, they pass water through it with the speed no more than 0.1 m/h.

*Slow filters* clear water well only after their "ripening": the diameter of pores in the sand decreases, owing to the keeping of suspended matters in the highest layer (Fig. 25). So, small particles, worm eggs and larvae and to 99.9% of bacteria can be detained. Viruses are not absorbed by the clean sand. But after the "ripening", about 50–99% viruses are kept in the slow filters. If such filters are used correctly, they free water from cercaria. At the same time a series of biological processes proceed in the ripped highest layer — biological film: the mineralization of organic matters and the death of bacteria. The contaminated highest layer of the sand is changed in 30–60 days. Slow filters are used when water turbidity doesn't exceed 200 mg/L in the small country water-pipes. They are always used after the preceding aeration to remove surplus iron and manganese (Fig. 25).

The *coagulation* is used to accelerate the sedimentation of suspended matters, filtration and lightening of water. They add the following coagulators

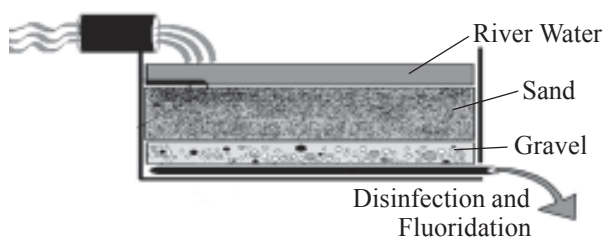
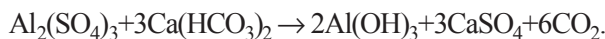


Fig. 25. Slow Sand Filtration

to water:  $\text{Al}_2(\text{SO}_4)_3$ ,  $\text{FeCl}_3$ ,  $\text{FeSO}_4$  and so on. They form insoluble compounds with the dissolved electrolytes, which are quickly sedimented as flocks. These flocks have a large active surface and positive electric charge. That's why they absorb even the smallest negative microbe particles and colloidal gumines, taking them to the bottom of the settling tank. The transparent and uncolored filtrate is formed after the sedimentation of flocks and the next filtration of water. The use of coagulants allows to decolorize water, to shorten the time of settling to 2–3 h and to use fast filters. 95% of worm eggs, 90% and more bacteria and viruses leave water after the coagulation and settling. Coagulation belongs to the most effective methods of water clearing from viruses. The best cleaning is realized by the combined coagulator ( $\text{Al}_2(\text{SO}_4)_3$  and iron salts).

Aluminium sulphate  $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$  is often used as a coagulator. It reacts with the calcium bicarbonate and forms  $\text{Al}(\text{OH})_3$ , which is bad-dissoluble and sediments as flocks.



The dose of coagulants is 30–200 mg/l, it depends on the color, turbidity, pH of water and many other conditions. It is determined by the experiment for the certain water. Lately they have been used large-molecular matters — flocculators (activated silicic acid), which are active in very small doses (0.2–2.0 mg/L), to accelerate coagulation and economize the coagulator. 5% solution of coagulator is given to the mixer with the help of special dosator, where it is quickly mixed with water. Then, the water enters the reaction chamber, where the formation of flocks completes in 10–20 min. Such water passes to the settling tank, where the flocks are sedimented. The size of settling tank corresponds to the settling for 2–3 h.

Then the water is given to the fast filters, where the layer of sand is 0.8–1.2 m and the granules — from 0.5–1 mm. The speed of filtration is 5–8 m/h (it is automatically regulated). Soon after the beginning of the work, the filtrating film, consisting of the flocks of coagulator and unsedimented particles, is formed in the highest layer. It improves the detain of microorganisms and admixtures. In 8–12 h the film becomes denser and the speed of filtration decreases. That's why the work is stopped and the filter is cleaned for 10–15 min by the stream of clean water, directed upwards, to remove the film.

The water becomes transparent, uncolored, free of worms' eggs and 70–98% microorganisms after the coagulation, settling and filtration. However, water, passed through the fast filters, must be subjected to disinfection.

## DISINFECTION

Disinfection is one of the most usable methods of water improvement. Usually it is a concluding and very important stage. The better lightening and decolorizing the better disinfection. The most spread methods of disinfection in hot countries are different methods of chlorination. Sometimes ozonization and UV-irradiation are used also:

- for water-pipes, boiling and filtration through the fast filters;
- for the local (decentralized) water supply.

### Chlorination

Chlorination of water is one of the most spread methods and it is of great importance for the prophylaxis of water epidemics. It is explained by the reliable disinfection, accessibility and cheapness.

The principle of chlorination is based on the treatment by chlorine or the chemical compounds, containing active chlorine and able to oxidize and provoke bactericidal action. Chlorine is subjected to hydrolysis in water:  $\text{Cl}_2 + \text{HOH} \rightarrow \text{HOCl} + \text{HCl}$ , so hydrochloric and chloric acids are formed. Chloric acid takes the central place in the mechanisms of bactericidal action. It was thought earlier that the latter was destroyed in water and discharged out atomic oxygen ( $\text{HOCl} \rightarrow \text{HCl} + \text{O}^-$ ), which was the main bactericidal agent. Now, such explanation is considered insufficient. Chlorine in the structure of chloric acid and hypochlorite-ion ( $\text{HOCl} \rightarrow \text{H} + \text{OCl}^-$ ) free active chlorine, which determines bactericidal action in water. Not large molecules and electric neutrality let chloric acid penetrate quickly through the bacterial membrane and affect the cellular enzymes, important for the metabolism and reproduction. It is assumed, that it reacts with SH-groups of enzymes, which become oxidized.

The reliable bactericidal effect of chlorine is achieved if about 0.3–0.5 mg/L of free chlorine or 0.8–1.2 mg/L of connected chlorine are left in water after 30–60 min of exposure.

There are 2 stages of chlorine action upon viruses: the first one, when chloric acid and hypochlorite-ion are absorbed in the viral membrane and penetrate through it, the second stage is an inactivation of viral RNA. Virucidal effect is the most expressed by the low pH.

Sanitary control of water-pipes includes the determination of the remaining chlorine in water every hour, and the bacteriological investigation — not rarer than once a day.

Long-term experience of using such a method in almost all countries of the world is evidence of chlorinated water safety for use. However, lately, the safety of such water has been disputed owing to the following facts. There was found a trustworthy connection between the concentration of chloroform (carcinogenous matter) in the tap water and the level of mortality from cancer of people, who had used such water. Further studies showed, that different chlororganic compounds (chloroform, tetrachlorethylene, etc.) and polychlorinated biphenyls had often been met in the water of open reservoirs very polluted by sewerage.

Nevertheless, chloroform and other chloroorganic compounds can be formed in small quantities during the chlorination of water. All these facts necessitate improvement of water treatment by the following methods: better purification of water before chlorination, the use of necessary doses in minimum quantities, the use of chlorination with the preceding preammonization, filtration of chlorinated water through the filters with the activated coal, which absorbs chloroorganic compounds. It is admissible to aerate water in the small water-pipes. As a result 90% of chloroform and other volatile compounds are removed.

Gaseous chlorine, preserved in the steel containers, is used to chlorinate water in the large water-pipes. A special apparatus chlorator, which measures chlorine input to water, is added to the container.

Chloric lime ( $3\text{Ca}(\text{ClO})_2 \cdot \text{CaO} \cdot \text{H}_2\text{O}$ ) is used for the small water-pipes and other reservoirs. Its bactericidal effect is determined by  $\text{OCl}^-$  group, which forms chloric acid in water. Chloride of lime contains up to 33% of active chlorine.

Chlorine dioxide ( $\text{ClO}_2$ ), calcium hypochlorite —  $\text{Ca}(\text{OCl})_2$ , containing 60–70% of active chlorine, and different chloramins (organic and inorganic) are also used for the disinfection. Calcium hypochlorite is more stable than chloride of lime and that's why it is recommended for hot countries. However, during the storage in the tropical sun, there were some explosions of containers. Oxidizing and bactericidal features of chloramins are inferior to that of chlorine and chloric lime.

**Simple Chlorination** (by chlorine request). Right choice of the dose is of great importance for the reliable disinfection. Only about 1–2% of active chlorine are spent on the bactericidal action during the disinfection. The rest part is spent on oxidation of organic and inorganic matters in water. All these connected forms of chlorine form such a notion as “chlorine-absorbability of water”. Different natural waters have different chlorine-absorbability. To disinfect water by such a method, they introduce such amount of chlorine, that the remaining free chlorine should be 0.3–0.5 mg/L and the remaining chlorammoniac chlorine — 0.8–1.0 mg/L. In such a case the organoleptic features of water do not become worse.

The number of active chlorine (mg), necessary for the disinfection of 1 liter of water, is called chlorine-request. It is determined by the experimental chlorination of certain volume of water, subjected to disinfection.

Besides the correct dose, good mixture and sufficient contact of chlorine with water are necessary for the effective disinfection.

The presence of suspended matters, gumines and other organic compounds in water lowers the action of chlorine. That's why it is necessary to light and decolourize turbid and colored waters before disinfection.

The chlorination of water by chlorine-request reliably disinfects water from the intestinal infections (typhoid fever, dysentery, cholera, pathogenous strains of *E.coli*, salmonellas), brucellosis, tularemia, leptospirosis. There are some disputes about the poliovirus. Many scientists consider, that this virus is inactivated by the chlorination for an hour. Water, containing Berket's rikketsia, amoebic cysts, worm eggs and the spores of some types of anthrax, cannot be disinfected by this method.

**Chlorination by the Post-Break Doses.** According to the results of some investigations the water can be disinfected by 2 doses of chlorine: 1 mg/L (before-break dose) and 5.2 mg/L (post-break doses), as the concentration of the rest chlorine makes 0.5 mg/L in both cases.

However, by before-break dose the remaining chlorine is determined as chloramin, and by post-break doses — as free chlorine. The bactericidal action of such method is very effective. At the same time we improve water organoleptic features at the expense of oxidation of organic substances with the bad smell. It is necessary to use this method in hot countries widely.

**Chlorination with the Preammonization (Chloramination).** First, they introduce ammoniac solution and than, in 0.5–1 min, chlorine to the water. As a result chloramins are formed in water:  $\text{NH}_2\text{Cl}$  — monochloramin and  $\text{NHCl}_2$  — dichloramin. The last one has the most expressed bactericidal action. The effectiveness of such method depends on the ratio  $\text{NH}_3:\text{Cl}$ . That's why they use the doses of reagents in the following ratios: 1:3, 1:4, 1:6, 1:8. The ratio should be chosen for certain reservoirs individually. This method prevents bad smells, which can appear by the chlorination of water, containing phenol and the matters from its group (as chlorphenols are formed). Chlorphenols impart medicinal smell and smack to the water even in the small quantities.

The speed of disinfection by this method is lower than that by chlorine. The exposure time should be no less than 2 h.

If the water of reservoirs contains ammonium salts, chloramines are also formed. This fact decelerates disinfection. So, it is necessary to define free and connected chlorine separately to determine the

reliability of disinfection. Obviously, the presence of only free chlorine is evidence of reliable disinfection.

**Double Chlorination.** In many river water-pipes chlorine is given before the settling and then after the filtration as usual. The introduction of chlorine before the settling improves the coagulation and decolorization of water, inhibits the development of microorganisms in the settling tanks, increases the reliability of disinfection. However, the possibility of chlororganic compounds formation increases too.

**Overchlorination.** By this method large doses of chlorine are used in to the water, for example 10–20 mg/L and more. As a result the reliable bactericidal effect is achieved even after the exposure for 15 min. By the 30–60 min of exposure even the turbid waters are disinfected reliably. Such agents, stable for the chlorine, as Berket's rikketsia, amoebic cysts, Koch's bacillus, viruses become dead. But even such doses of chlorine cannot destroy spores of *anthrax* and *helminthes* eggs. A lot of residual chlorine remains after the overchlorination. Water is dechlorinated by the filtration through the layers of activated coal or by the addition of sodium hyposulphite ( $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ ) in the concentration of 3.5 mg per 1mg of chlorine. Hyperchlorination is mainly used in expeditionary and military conditions.

### Ozonization of Water

It is widespread in the industrial countries. Ozone is destroyed in water, forming atomic oxygen:  $\text{O}_3 \rightarrow \text{O}_2 \rightarrow \text{O}$ . Now, it is proved, that this mechanism is more complicated: there are many intermediate reactions with the formation of free radicals (e.g.  $\text{HO}_2$ ), which also have oxidizing features. Ozone oxidizing potential (+1.9) is higher than that one of chlorine (+1.36). From the hygienic point of view, ozonization is one of the best methods of disinfection: water is well disinfected, organic admixtures become destroyed, organoleptic features are improved. Water becomes blue and it is equated with spring water.

Ozone dose is 0.5–6 mg/L. Sometimes, higher doses are necessary for the lighting of water and improving other organoleptic features. The time of disinfection is 3–5 min. The remaining ozone should make up 0.1–0.3 mg/L. The concentration of the remaining ozone 0.4 mg/L provides the reliable inactivation of 99% viruses for 5 min.

### UV-irradiation

The maximal bactericidal effect is achieved by the waves 250–260 nm, which pass even through the 25 cm layer of transparent and decolorized water.

The disinfection proceeds very quickly: vegetative forms of microorganisms die in 1–2 min. The

turbidity, colour and iron salts decelerate the disinfection, decreasing the transparence of water. Consequently, it is necessary to light and decolorize water before disinfection.

There are some advantages of UV-irradiation over the chlorination: bactericidal rays don't denaturate the water and don't change its organoleptic features, they have a wider biological action. Their bactericidal action is spread over the spores, viruses and helminth eggs, resistant to chlorine. Many investigators consider this method the best for the disinfection.

### Boiling

It is the simplest method of disinfection. Vegetative forms of pathogenous microorganisms die in 20–40 sec at the temperature of 80°C. The water is almost disinfected until it begins to boil. 5 min of boiling provides reliable safety even in the very strong pollution by suspended matters, viruses and other pathological agents. During 30 min of boiling most of spores die too. The spores of anthrax, worm eggs and larvae are inactivated. Protozoa die too. This method is often used in the everyday life, in hospitals, child welfare institutions, in the manufactures, railway stations. It is necessary to clean tanks before filling them with the boiled water and change water every day, as the microorganisms multiply very quickly there. Water contaminated by *Ent. hystolitica*, must be subjected to boiling.

When there is much water and the use of boiling is unreal, the following methods are used:

- coagulation by aluminium sulphate (100–150 mg/L);
- settling for an hour;
- filtration through the sand filter;
- chlorination for 30 min to the concentration of the remaining chlorine (1 mg/L).

### Bacterial Filters

Earlier it was said, that worm eggs and amoebic cysts didn't die during the chlorination. That's why portable bacterial filters are widely used in many tropic countries. Here, the water is filtered through the special filters — candles (Backfield's, Chamberlain's models) under pressure. The candle is an empty cylinder, made of porous ceramic material (for example, porcelain). Water is filtrated through the external surface of the candle to the inside part. It is liberated from the suspended particles, worm eggs, bacteria and even viruses, depending on the size of pores. The candles are cleaned and boiled for 5–10 min once a week. The series of firms make the candles of 3 models. Model "V" — the filters intended to the removing of suspended matters. They can be used at the first stage of cleaning. Model "N" — middle-porous, intended to clean water from worm eggs, cysts and cercaria. Model "W" — small-porous filters, they keep even viruses.

### Chemical Tablet Methods

The use of tablets and solutions are widely used for the disinfection in the expeditions and hikes. Tablets "Halazone" contain chloramin, stable during the storage. The tablet is introduced to a certain volume of water (usually it is 1 liter), and stirred every 3–5 min. It can be used in 30 min. But this tablet cannot be enough for the very contaminated water.

In this case we can use tablets "Chlor-dechlor", which contain more chlorine and dechlorinated agent in the middle of the tablet (sodium hyposulphite). They introduce one tablet to the water and stir it every 2–3 min thoroughly. After dissolving of the external part of the tablet its central part inactivates the surplus chlorine. If the water is very shady introduce 2–3 tablets at once. In Ukraine, we use tablets "Aq-uasept" and "Aquacide", which contain steady chlorine-containing preparations. One tablet (3.5 mg of active chlorine) is introduced to the 1 liter of water. Water becomes disinfected in 30 min.

Iodine-containing preparations are widespread in tropical countries. They disinfect water from bacteria, many viruses and cysts. The simplest method is the disinfection by 10% solution of iodine: 2 drops of such solution are introduced in 1 liter of very contaminated water. The water is usable in 20–30 min. Tablets "Globaline", "Potable", containing sodium tetraglycerate triiodate, disinfect water from bacteria, amoebic cysts, many viruses. They are the best disinfectant matters for the torrid zone. They are safe for humans. Large tanks for the preservation of water must have sturdy cover and a tap.

### Cleaning and Disinfection of Wells

It is necessary to clean and chlorinate the wells periodically. Water is removed from the wells, as well as the upper layer of silt and the layer of coarse sand or small gravel is put on the bottom. The walls of the well are treated by 3–5% solution of chloride of lime. When the well is filled with water introduce one bucket of 3–5% solution of chloric lime for every 1 m<sup>3</sup> of water. Then the water is stirred and left for 10–12 h. The water is ladled out until the chlorine smell disappears. Some samples of water are kept for the analysis. The chlorination of the well is carried on after its repair, if the data of analysis are unfavourable for the presence of infectious agents.

The chlorination is ineffective if there is a contamination of subsoil waters. It is necessary to remove the source of pollution. In this case notify people about the necessity to boil the water or carry out the chlorination of water in wells for general use. The chlorination in the wells is inferior to chlorination of reservoirs. But it still lowers the epidemic danger.

Preservation of water with keeping its organoleptic features and epidemiological safety is very important for the hot regions with water deficit. For this reason, large doses of chlorine are used: up to 20 mg/l, if water is preserved for 15 days and to 30 mg/l, if it is preserved during 30 days. Before use, water must be dechlorinated. It is achieved by the filtration through the activated coal and introducing sodium hyposulphate. It is better to use metal or concrete tanks for the preservation of water.

## Chapter 4

# FOOD AND NUTRITION

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To maintain the organism functions, we must replenish energy we burn in the course of our activities and ingest protein, vitamins, minerals and other substances that are essential for many enzyme systems as well as for growth, tissue repair and regeneration. The range of dietary requirements is broad, and it broadens further when there are demands, such as periods of rapid growth in childhood and adolescence, pregnancy and when metabolic requirement is enhanced by infection.

Adequacy of nutrition is determined with social-economic and hygienic methods. The former includes the balance method and the budget method. Hygienic methods define a real nutrition. There are the weighing method, the questionnaire method and the method using a menu.

*There are the following laws of nutritional adequacy:*

- the law of energetic adequacy;
- the law of plastic adequacy;
- the law of enzymatic adequacy;
- the law of biotic adequacy;
- the law of biorhythmic adequacy.

*The following diseases cause inadequate nutrition:*

- 1) nutritional deficiency diseases:
  - protein-calorie malnutrition;
  - kwashiorkor;
  - alimentary marasmus;
  - hypovitaminoses;
  - others;
- 2) overnutrition;
- 3) imbalanced nutrition.

The methods of balance and budget surveys of nutrition are used to estimate the consumption of basic foodstuffs or expenditures for nutrition of community or individuals. These methods give only restricted evidence for nutrition assessment thus there are used widely more exact methods, e.g. the use of questionnaires or weighting method. The disadvantages of the last two methods are presented by the impossibility to assess the composition of daily diet.

The laboratory methods of the assessment of energy value and nutrient composition have the highest accuracy but they require complicate and continuous investigations as well as significant financial contribution. Thus the screening methods based on the calculations are the most popular for hygienic assessment of community nutrition. The requirements for such screening methods include availability of the standard recommended daily allowances (RDA) for specific groups of population; daily or weekly diet content, tables of chemical composition of the foodstuffs (see Annex 6)

The duties of physician providing diet counseling include following elements:

1. Assessing the meal by its energy value and nutrient composition.
2. Providing a wide variety of different food products.
3. Control on replacing foodstuffs with alternative ones.
4. Correct distribution of foodstuffs by the meal-time (i.e. breakfast, lunch, dinner, supper, etc.). Normally, the distribution of daily calories intake should be about 30% for breakfast, 40–45% — for lunch, 20–25% — for dinner. The alternative distribution for 4-time meals is 25% for breakfast, 10% — for tiffin, 40% — for lunch and 25% — for dinner.

The findings of the research of diet include the following items:

- correspondence of energy value to the energy expenditures;
- correspondence of nutrient composition of meal to RDAs;
- correspondence of the ratio between animal and vegetable proteins (norm for protein of animal origin is 55% or more of total protein intake), animal and vegetable fat (norm for vegetable oil is 30% or more of total fat intake), starch and simple sugars (the latter should not exceed 20%);
- adequacy of vitamin intake;
- adequacy of mineral salt intake and ratio between calcium and phosphorus (the optimum is 1:1.5);



— diversity of food during the week recommendations for diet improving.

The alimentary status is the physiological state of human organism determined by the dietary pattern. The alimentary status could be estimated by the *correspondence of body weight to age and gender, somatic constitution, biochemical indices of metabolism, presence of the signs of alimentary deficiency*. The assessment of alimentary status is a very informative method for medical control on the nutrition of individuals and community. There are following classification of alimentary status:

1. Optimum (when physiological indices and body weight correspond to height, age, gender and intensity of labour).

2. Superfluous (may be determined by congenital predisposition, overeating, poor physical loading) that is characterized with increased body weight (obesity). There are four grades of the obesity: I — adipopexis exceeds normal weight by 15–20%; II — by 30–49%; III — by 50–99%; IV — by 100% and more).

3. Insufficient, or hypotrophy when weight is lower than standard — this state could be determined by malnutrition, vigorous physical work, psycho-emotional stress, etc.

Some experts (P. Kalmikov) determined following categories of alimentary status: (1) pre-morbid — determined by the physiological disruptions or dietary irrelevance; (2) morbid — weight reducing determined by the disease or starvation.

For assessing alimentary status of individuals or specific groups there are used both subjective (questionnaires, interviewing) and objective indices. The most popular is body mass index (BMI) or Quetelet's index. It's ration between individual's weight (kg) by the square of his/her height (m<sup>2</sup>) (Table 12).

Man needs a wide range of nutrients to perform various functions in the body and to lead a healthy life. The nutrients include proteins, fats, carbohydrates, vitamins and minerals. These nutrients are chemical substances which are present in the food we eat daily. Man needs all these nutrients, i.e. energy, proteins, vitamins, minerals in different amounts to grow, live and thrive. Since a man de-

rives all the nutrients he needs through the diet, it should be well balanced to provide all the nutrients in proper proportions. While planning a diet for the community, food-stuffs have to be chosen in proper amounts to provide all the required nutrients and considering the dietary habits and availability of food-stuffs.

## NUTRIENTS

### PROTEINS

Proteins (strands of amino acids) are compounds containing carbon, hydrogen, oxygen and nitrogen. The nitrogen component of proteins is what differs its structure from carbohydrates and fats. The word protein is derived from Greek "*proteios*" — principal or prime. Proteins are, in fact, principal components of biochemical systems.

The primary function of proteins is to support growth, and repair tissues (*plastic function*). They also act as antibodies, hormones, and enzymes. Proteins also help regulate the amount of fluids in the body, for fluid and electrolyte balance.

All proteins are made up of building units called amino acids. Once eaten, food protein is broken down by the digestion process into amino acids which are then reassembled in the body cells into a specific format to form specific tissue proteins. For example, proteins in a diet build the proteins of new tissues, such as an embryo, and a growing baby. Proteins also rebuild tissues that are lost through hemorrhage, burns, and surgery or other worn out cells. Proteins are also necessary for neurotransmitters synthesis.

It is important to know the differences between plant protein sources versus animal protein sources. Plant proteins do not contain all the essential amino acids needed by the body. For example, an essential amino acid from the animal protein source called tryptophan produces a vitamin called niacin. Methionine is necessary for synthesis of cholin, the lipotropic substance preventing fatty infiltration of the liver.

To meet the organism's needs in irreplaceable aminoacids and to maintain a necessary level of synthetic processes the major importance has equation of irreplaceable aminoacids, counterbalanced in a certain quantitative ratio. Presently it is considered, that in estimation of aminoacid value of meal, it is enough to be guided by three irreplaceable aminoacids — tryptophane, lysine, and sulfur-containing aminoacids (methionine + cystine + cysteine), ratio should be 1:3:3.

After protein is broken down for its main function, some residues should be placed or sent somewhere else. For example, the nitrogen residue is con-

Table 12. **BMI interpretation**

BMI, kg/m <sup>2</sup>		Alimentary status
Females	Males	
< 16	< 16	Hypotrophy III degree
16–17.99	16–16.99	Hypotrophy II degree
18–20	17–18.49	Hypotrophy I degree
20.1–24.99	18.5–23.8	Admissible deviations
22.0	20.8	Optimum
25–29.99	23.9–28.5	Obesity I
30–39.99	28.6–38.99	Obesity II
> 40	> 39	Obesity III

verted by the liver from ammonia to urea and sent to the kidneys to be excreted in the urine. A very little amount of residue comes out as sloughed off skin, nails and hair. The remaining residue is converted into glucose and used for energy.

Proteins provide amino acids for body to build, maintain, and repair cells and muscle tissue, heal wounds, and support the immune system. It is very easy to get protein in our diet, in fact, most people in developed countries consume 2–3 times more protein than necessary. Excessive protein is stored as fat.

High protein diets including intakes of protein more than 15% of total calories cannot be justified on a scientific basis. For an individual consuming 4,000 calories per day, 15% of calories represent 150 g of protein or 2 g/kg of the body weight for a 70 kg male (the required daily amount (RDA) is 0.8 g/kg of the body weight/day). This almost exceeds the requirement by 270%. High protein diets including intakes above 15% or 2 g/kg of the body weight are either burned for energy to support activity or are converted to fat. In addition, these processes result in residual nitrogen, which must be excreted through the urine as urea and ketones. This step requires the loss of water, which increases dehydration risk. High protein diets with excessive protein intake (5 times as much than RDA) can also cause a loss of bone calcium and can also put strain on the liver and kidneys.

Protein can be supplied from animal food sources, such as lean meat, poultry, fish, eggs, milk, and cheese, or vegetable food sources such as dried beans and peas, peanut butter, nuts, seeds, and tofu. Bread, cereals and vegetables contribute small amounts of protein to the diet. Plant protein from vegetable sources is usually low in one or more of the nine essential amino acids. Vegetable protein sources, in combination, can complement one another to provide a high-quality protein.

When protein is consumed, the body breaks it down into amino acids, the building blocks of all proteins. Some of the amino acids are nonessential. This does not mean that they are unnecessary, but rather that they do not have to come from the diet because they can be synthesized by the body from other amino acids. Other amino acids are considered essential, meaning that the body cannot synthesize them, and therefore must obtain them from the diet (Table 13).

Whenever the body makes a protein when it builds muscle, for instance it needs a variety of amino acids for the protein-making process. These amino acids may come from dietary protein or from the body's own pool of amino acids. If a shortage of amino acids becomes chronic, which can occur if the diet is deficient in essential amino acids, the building of protein in the body stops.

Because of the importance of consuming proteins that provide all of the necessary amino acids, die-

Table 13. **Essential and Nonessential Aminoacids**

Essential aminoacids	Non-essential aminoacids
<i>histidine</i> * (His)	asparginic acid
<i>arginine</i> (Arg)	oxyproline
valine (Val)	proline
treonine (Tre)	alanine
methionine (Met)	cysteine
phenilalanine (Phe)	tyrosine
thryptophane (Thr)	serine
lysine (Lys)	glutamic acid
isoleucine (Ile)	glycocol
leucine (Leu)	
valine (Val)	

\* — Aminoacids in italic are essential only for children.

tary proteins are considered to belong to two different groups, depending on the amino acids they provide. Complete (high-grade) proteins, which constitute the first group, contain ample amounts of all the essential amino acids. These proteins are found in meat, fish, poultry, cheese, eggs, and milk. Incomplete proteins, which constitute the second group, contain only some of the essential amino acids. These proteins are found in a variety of food-stuffs, including grains, legumes, and leafy green vegetables.

Although it is important to consume the full range of amino acids, both essential and nonessential, it is not necessary to get them from meat, fish, poultry, and other complete-protein food-stuffs. In fact, because of their high fat content as well as the use of antibiotics and other chemicals in the raising of poultry and cattle most of those food-stuffs should be eaten moderately. Fortunately, the dietary strategy called mutual supplementation enables you to combine partial-protein food-stuffs to make *complementary protein* — proteins that supply adequate amounts of all the essential amino acids. For instance, although beans and brown rice are both quite rich in protein, each lacks one or more of the necessary amino acids. However, when you combine beans and brown rice with each other, or when you combine either one with any of a number of protein-rich food-stuffs, you form a complete protein that is a high-quality substitute for meat. To make a complete protein, they combine *beans* with any one of the following: brown rice, seeds, corn, wheat, nuts.

All soybean products, such as tofu and soymilk, are complete proteins. They contain the essential amino acids plus several other nutrients. Available in health food stores, tofu, soy oil, soy flour, soy-based meat substitutes, soy cheese, and many other soy products are healthful ways to complement the meatless diet.

There are many groups which feel that recommended protein intakes are overdone. This situation

likely stems from several independent factors that all serve to come down in favor of low protein intakes. We can discuss some of these issues first and then discuss the actual data on protein requirements. Protein appears to be receiving a bad rap for several reasons. First, animal products are an excellent source of good balanced protein. Since plant based food-stuffs have lower protein and since the mix of amino acids in many plants is not balanced according to dietary needs of humans, many vegetarians have tried to argue that protein requirements are not as high as indicated by the RDA. Second, given the emphasis in nutrition over the last 15 years has been at lowering fat intakes and saturated fat intakes, sources of these items have been targeted for reduction in diets. Since, many of the “bad” fatty food-stuffs are also excellent sources of balanced protein, part of the public health message has been to convince people that they don’t need as much protein as they have been led to believe. Third, individuals with certain forms of renal disease can slow progression with a low protein diet. Fourth, high protein intakes have been associated with a greater degree of calcium excretion and reduced bone formation in young women suggesting that low protein diets may prevent osteoporosis. And fifth, low protein diets appear to extend lifespan.

The vegetarian argument can be dealt with easily. The assumption is made that the current RDA actually doubles the measured protein requirement in order to provide enough leeway for variability in diets. This is simply erroneous. Where this doubling notion arises from is the fact that someone fed a diet devoid of protein will result in a loss of protein from the body of around 30 g per day. However, this is a gross simplification and makes many assumptions that consuming 30 g ignoring the body’s compensatory adaptations that permit protein to be conserved when in short supply. This is not to say that people cannot survive on lower protein intake, but rather that over time the body will adapt by slowly lowering lean body mass.

The second point is equally fallacious, since it ignores the use of low fat and/or low saturated fat sources of animal protein. There are clearly other ways to reduce saturated fat intake without resorting to restricting protein intake, but for this and some other reasons discussed here, public health officials tend to adopt a narrow viewpoint. The renal disease issue first surfaced in animal studies and does apply to humans (in the setting of particular disorders); however, it is quite another leap to conclude that excessive protein actually initiates or contributes to creation of renal disease, rather than merely exacerbating it. There is little evidence in humans that high protein intakes are associated with the promotion of renal disease.

The data on osteoporosis are also rather clear even if misinterpreted. While there is a slight nega-

tive correlation of bone density formation with protein intake, and a weak positive correlation with calcium intake, there is a strong correlation with a high calcium to protein ratio. Thus, for a given level of protein intake, a minimum level of calcium intake is required. More protein means more calcium. Finally, the calorie restriction, low protein diets extending lifespan have only been demonstrated in small animals with short lifespans living under well controlled laboratory conditions. What is not clear is how applicable these results are to humans free living in a normal environment.

A final point to be noted is that many criticisms are based on the erroneous assumption that 30% of calories from protein is too much protein. This is clearly misguided thinking. Protein needs of the body are determined by absolute amounts, not percentage. The only way to determine if 30% is too much or too little is to know the total caloric intake. For example, a diet consisting of only 25 g of protein per day is 100% protein, but is clearly deficient in terms of protein needs; while a diet of 5,000 calories with 10% protein is still consuming 125 g of protein per day which is about double the current RDA recommendations. The percentage of protein is meaningless in terms of protein needs.

To evaluate a biologic value of protein chemical and biological methods are used.

**The chemical (calculating) method:**

$$BV = 38.6 + 0.634X \text{ (the Mitchell's formula)}$$

where X — content of limiting aminoacid (%)

$$X = \frac{A}{A_1} \cdot 100\%$$

where A — quantity of aminoacid in tested products (mg)

A<sub>1</sub> — quantity of aminoacid in ideal protein of FAO.

**The biologic method (Bender&Miller, 1952):**

$$NUP = \frac{1 - (U - U_0) - (F - F_0) \cdot 100}{I}$$

where NUP — net utilization of protein

I — nitrogen of food

U — nitrogen of urine during a diet containing tested protein

U<sub>0</sub> — nitrogen of urine during a non-protein diet (endogenic nitrogen)

F — nitrogen of feces during a diet containing tested protein

F<sub>0</sub> — nitrogen of feces during a non-protein diet

Needs in protein for various groups of population are presented in Table 14.

**FATS**

Fats are needed in the diet to supply essential fatty acids, to carry the fat-soluble vitamins A, D,

Table 14. Protein RDA, g/day

Target groups		Protein of animal origin	The whole protein
Children			
Age	Gender		
4–6	both	33	65
7–10	both	39	78
11–13	boys	46	91
	girls	42	83
14–17	boys	52	104
	girls	43	86
Adults			
<i>I group of labour intensity</i>			
18–29	men	37	67
	women	30	55
30–39	men	35	63
	women	29	52
40–59	men	32	58
	women	28	50
<i>II group of labour intensity</i>			
18–29	men	42	77
	women	34	61
30–39	men	40	73
	women	32	59
40–59	men	38	69
	women	32	58
<i>III group of labour intensity</i>			
18–29	men	50	91
	women	40	72
30–39	men	48	87
	women	39	70
40–59	men	45	81
	women	38	69
<i>IV group of labour intensity</i>			
18–29	men	59	107
	women	46	84
30–39	men	56	102
	women	45	81
40–59	men	53	96
	women	43	78
<i>Pregnant women</i>			
Pregnancy time			
first trimester		66	110
second trimester		69	115
third trimester		72	120

E, and K and to aid in their absorption from the intestine.

Fats are a group of chemical compounds that contain fatty acids. There are three main types of fatty acids: saturated, monounsaturated and polyunsaturated. Polyunsaturated fatty acids are of two kinds,  $\omega$ -3 or  $\omega$ -6.  $\omega$ -3 fatty acids which are present in fish oils have the potential for improving the health of cardiovascular system. Medical reports show that as their amount in the diet increases, the risk of coro-

nary heart disease decreases. Diets of Eskimo and coastal Japanese are rich in the  $\omega$ -3 fatty acids. Their death rate from heart attacks is much lower when compared to the Western man. It is a major component of the brain and retina, and has a possible role in nerve transmission. Research has shown that many migraine sufferers have experienced some relief from consuming fatty acids.

Recently a new term has been added to the fat lexicon: trans fatty acids. Since 1990, several studies in women and men have shown trans fatty acids to increase total blood cholesterol and LDL (low density lipoprotein) while decreasing HDL (high density lipoprotein) cholesterol, the protective form of blood cholesterol. The Nurses' Health Study, a prospective trial involving more than 85,000 women, showed a positive association of trans fatty acids with coronary heart disease. By analyzing individual food-stuffs, this study suggested that trans fatty acids formed during the partial hydrogenation of vegetable oils used in margarine, cookies, cakes, and white bread accounted for all of the increased risk of coronary heart disease (CHD).

There are naturally occurring trans fatty acids in animal fat, but these food-stuffs did not have the same association to risk of CHD in this study. An increased risk of heart attack was evident only among women consuming more than 0.5 parts of margarine per day. The risk remained significant after adjusting for other risk factors for CHD, including cigarette smoking, body mass index, hypertension, alcohol intake, dietary fat intake, and family history of early heart attack. However, the study did not address the apparent inverse relationship between trans fatty acid intake and the intake of carotene, dietary fiber, saturated fat, monounsaturated fat, vitamin/mineral supplementation and the amount of daily exercise.

The findings are thought provoking, but conclusions cannot be drawn based on this study alone; dietary patterns and lifestyles are what may be related to increased risk of CHD. Most margarine is made from vegetable fat and provides no dietary cholesterol. The more liquid the margarine the less hydrogenated it is and the less trans fatty acid it contains. Therefore soft margarines are better than hard ones.

The American Dietetic Association and the American Heart Association are not recommending that everyone substitute butter for margarine. The total amount of fat in the diet is still more important than the contribution of trans fatty acids makes to heart disease risk.

Phosphatides — biologic active substances, contained in the brain, heart, liver tissues (the nerve tissue contains them in greatest quantity. From phosphatides in products of a meal is most widely submitted lecithin (it's contained in vegetable oils, eggs, butter, etc.).

Sterines are contained in vegetative and animal fats. Cholesterol supports metabolism processes in craters, connects poisonous substances and neutralizes them, takes part in synthesis of bilious acids, vitamin D, hormones of suprarenal glands cortex, sexual hormones, playing thus important physiological role in the organism, but alongside with it looks narrowly and as the factor, which takes part and in atherosclerosis genesis. Cholesterol metabolism is determined by character of a meal and life-style. It stabilizes physiological balance between biosynthesis of cholesterol and using it in tissues, consumption of folic acid and vitamins C, B<sub>12</sub>, B<sub>6</sub>. The lack of fat results in exhaustion and reduction of weight, high fat diet results in metabolic disorders, e.g. acidosis.

## CARBOHYDRATES

Carbohydrates are very important factors of nutrition, biological role of which is defined, basically, by their energetic properties. They are dynamic sources of energy, used in the process of muscular and mental activity. Energy capacity of 1 g of carbohydrates composes 4 kcal (16.7 kJ). Significance of carbohydrates as a source of energy is also defined (unlike fats) by their capability to be oxidized in the organism by aerobic as well as by anaerobic mechanism. They not only satisfy the organism requirements in energy, but also promote decreasing of acidic changes. Carbohydrates enter the composition of cells and tissues, and consequently, participate in plastic processes. Brain functions, osmotic work of kidneys, many metabolic processes in the liver and other organs depend on them.

Many carbohydrates possess expressed biological activity, executing specialized functions in the organism. To them we refer ascorbic acid with its vitamin properties, heparin preventing coagulation of blood, hyaluronic acid, increasing barrier function of cellular membranes of bacteria, oligosaccharides of womanize milk, detaining growth of some bacteria in the intestine and promoting normalization of intestinal microflora, heteropolysaccharides of RBC membranes, which determine specificity of blood groups, and others.

Carbohydrates and their metabolites participate in the synthesis of nucleic acids, amino acids, glycoproteins, mucopolysaccharides, co-ferments and other life important substances. They render protein saving action in the organism, promoting in the maintenance of nitrogen balance on a lower level, prevent dehydration and loss of electrolytes by the tissues.

Reserves of carbohydrates in the organism, basically, in the liver and muscles, and are comparatively not large, in relation what they should enter along with food continuously. Metabolism of car-

bohydrate is closely related with the metabolism of fats. During heavy physical exertions, when expended energy is compensated by carbohydrates of food and their reserves in the organism, formation of glucose from lipids of sufficiently capacious fat depots takes place. However, often a reverse phenomenon is noted: formation of new quantities of fat due to excess entrance of carbohydrates with food.

About 50–70% of the organism requirement in energy is fulfilled by carbohydrates, mainly, of products of vegetable origin (grains cereals, etc.). This requirement is satisfied by sugars which are pure carbohydrates.

Absorption of carbohydrates is comparatively high and depends on the character of food products, the carbohydrates itself and the quality of culinary processing. Average absorbing rate of carbohydrates of bread and cereal products composes 94–96%, of vegetables — 85%, of potatoes — 95%, of fruit and pulps — 90%, of pastries and cakes — 95%, of sugar — 99%, of milk and milk products — 98%.

It follows to note that animal products, as a rule are not essential sources of carbohydrates. Basic carbohydrates of such origin are glycogen and lactose. Glycogen, possessing the properties of starch is present in small quantities in animal tissues, mainly, in the liver and muscles and does not possess any perceptible significance in nutrition.

Lactose (milk sugar) is present in human milk and in milk of different animals in a quantity of 5 g and more per 100 g of product. Its energetic role becomes real during systematic consumption of milk, particularly in child and elderly age.

Overall all the carbohydrates depending on the complication of their structure, solubility, speed of absorption and use in glycogen formation may be classified as follows:

1) simple carbohydrates — sugars, divided into monosaccharides — glucose, fructose, galactose, and disaccharides — sucrose, lactose and maltose;

2) complex carbohydrates, including starch glycogen, pectin substances and cellulose.

Simple carbohydrates differ by uncomplicated chemical structure, due to which they are easily soluble in water, easily split up (disaccharides) and ghastrly absorbed. They possess expressed sweet taste and therefore belong to sugars. However sweetness of sugars fluctuate in sufficiently wide limits and, when determined by the Bister Wood's method, further are the values: sucrose — 100, fructose — 173, invert sugar — 130, glucose — 74, xilose — 40, maltose — 32.5, ramnose — 32.5, galactose — 32.1, rafinose — 22.6, lactose — 1. Amongst the enumerated ones, fructose possesses the most weak properties, lactose the most strong. It follows to note, that this sign possesses undoubtful hygienic significance like coefficient of absorption of glucose (0.178) is more than two times than that one of fructose (0.077).

Monosaccharides are the most simple forms of carbohydrates, used by the organism. By their chemical structure they represent themselves hexes, possessing 6 atoms of carbon, 12 atoms of hydrogen, and 6 atoms of oxygen in their structures.

Most spread monosaccharides are glucose (grape sugar) which is present in many fruit and pulps as well as formed in the organism as a result of hydrolysis of disaccharides and starch of food. Particularly bee honey contains large quantity of glucose (up to 36%). This is most easily absorbable carbohydrate, entering the metabolic processes without any intermediate changes. It is ghastrly and easily used for nutrition of brain, maintaining of physiological level of sugar in the blood and creation of reserves of glycogen in the liver.

Consumption of glucose during intensive physical exertions increases endurance of the organism by 8–10% and promotes restoration of power during rest. It is widely used in medical practice as an effective measure of parental nutrition of postoperative and other weakened patients.

By its properties fructose is similar to glucose and it is also valuable and easily absorbable sugar. But some peculiarities are habitual to it, which are highly attractive in hygienic respect. It is slowly absorbed from the intestine, soon leaves the vascular bed, and detained by the liver (up to 70–80%) and other organs and systems, where it is intensely used in metabolic necessities, and easily transformed into glycogen. All that promotes prevention of hyperglycemia, lipidemia, and cholesterinemia, tells upon on insulin formation function of pancreas. Besides, fructose is better than glucose in maintaining physiological level of sugar in the blood during heavy physical exertions, it follows to note, that considerably high sweetness of fructose in comparison with other simple carbohydrates enables us to use it in essentially small quantities for achieving necessary taste sense, which possesses important significance during forming of food rations of low calories.

In the force of the indicated properties of fructose it is recommended to have in form of an independent food product, particularly for diabetic patients. In this plan it is perspective to use glucose-fructose syrup or maize sugar, widely used in USA, Germany, Japan, England, France and other countries. They are substituted by usual sugar during production (manufacturing) of ice-cream, sweet cheeses, bakery products, non-alcoholic drinks. Natural sources of fructose (as well as of glucose) are many fruit and pulps (grape, persimmon, cherry and other). In water-melons and melons its quantity is sufficiently high (up to 8% and more). Particularly bee honey is rich in fructose (up to 37.1%).

Galactose is contained in milk sugar, lactose and some polysaccharides — galactones, which are met in composition of many vegetable slimes. Galactose

is considerably less sweet, than glucose, and especially fructose, but its nutritive values are no less.

In human nutrition basic importance is given to sucrose (sugar cane or beet root sugar), which during hydrolysis in the intestine splits up into two molecules of monosaccharides — glucose and fructose. Sugar is met in many fruit and vegetables, but particularly in considerable quantities it is present in the roots of sweet potato (12–24%) and in the stems of sugar cane (9–19%), which is the basic raw material for its industrial manufacturing. In XX century in comparison with XIX century consumption of sucrose has increased more than 7 times, which is explained by the accessibility of its obtaining by high taste and nutritive properties and comparatively cheap price. Content of saccharose in usual sand sugar composes 99.75% and in refined sugar — 99.9%.

It has been established, that even single intake of big quantities of sugar or products rich in it leads to although to temporary but sharp rise of fat concentration in blood, and in some people — even cholesterol. Systematic excessive consumption of such products may cause a stable disorder of fat and cholesterol metabolism, development of obesity, lipidemia, hypercholesterinaemia, with the deposition of cholesterol in vascular walls, tendency towards thromboses of coronary vessels (which is also promoted by exhaustion of blood platelets). On the background of indicated nutrition often hyperplasia and gallbladder stones, nephrosis, caries of teeth, exhaustion of insular apparatus of pancreas (diabetes mellitus), disorders of composition and function of intestinal microflora develop. It is known, that excessive consumption of sugar intensifies transformation of all present food substances possessing energetic values into fat in the body: starch, food fat and partially protein. Consequently, control after the quantity of sugar in diet may prove to be a factor, regulating metabolism overall and fat — in particular.

Lactose is made up of galactose and glucose, present in milk of all animals and human milk. In cow's milk its content on an average composes 4.8%, in breast milk — 7.5%. Lactobacilli fermentate lactose into acetic acid and CO<sub>2</sub>. On this property the production of all sour milk products is based. As already noted, lactose is the least sweet amongst all simple carbohydrates and is not used in refined form in the nutrition, however it possesses undoubtful significance in composition of milk and in the children nutrition. Particularly its role during breast feeding is great. It slowly splits up under the action of glucose, which limits the processes of fermentation, promotes normalization of intestinal microflora, providing preferential growth of lactobacilli, oppressing growth of putrefactive microorganisms. It is also important to know, that lactose is the least used in the organism for fat formation.

Maltose (malt sugar) consists of glucose, and not found in free form in natural products. It is formed during hydrolysis of starch and glycogen in the intestines and as an intermediate product in the process of fermentation during preparation of beverages (beer, kvass) and during obtaining spirit.

Complicated carbohydrates differ by complexity of structure of own molecules and poor solubility in water.

Starch belongs to the most important food carbohydrates, composing nearly 75.8% of their daily consumption. High content of starch defines energetic value of many products, including bread, cereals, pasta and other flour products, rice, potato, beans.

In the human organism under the influence of amylase of saliva and pancreas, starch, through amylo-, erythro-, archo- and maltodextrines is transformed into glucose. Especially as this process is completed sufficiently slowly, which provides gradualness of glucose release and its use in energetic and other needs. This explains the absence of lipogenic and lipemic action of starch.

Glycogen — “animal starch”, present in liver and muscles in a quantity of 300–400 g, composing practically the whole reserve of carbohydrates, which without filling are spent by the organism in a period of 12–13 h. As a composite part of food products, as a result of small content it does not possess essential significance. However, it promotes preservation of meat, by transforming it in its process of maturing into acetic acid, which leads to increase in concentration of hydrogen ions and to the formation of acidic reaction of the medium, preventing development (growth) of microorganisms. Restoration of glycogen in the organism takes place by its resynthesis from blood glucose.

Dietary fibre is a broad term; it includes the following chemicals, which form the structural components of plants, including many of the plant food-stuffs we eat: (1) cellulose; (2) hemicellulose; (3) lignin; (4) pectin; (5) mucilage; (6) gums.

The first three are insoluble fibers which can absorb and hold water in the digestive system. The others are soluble fibers, which are partially broken down in digestion to a gel-like substance, which also retains water.

Fiber's ability to hold water and to bind minerals and cholesterol-like materials results in a number of physiological effects which vary depending on the type of fiber and/or where it is in the digestive tract.

1. In the mouth, fiber stimulates the flow of saliva.
2. It is a natural laxative.
3. It absorbs H<sub>2</sub>O, helps feeling full after eating.
4. It stimulates peristalsis.
5. It helps to prevent digestive disorders.
6. It bulks up stools and makes it softer, reducing risk of developing hemorrhoids and lessening the discomfort you have already had.

7. In the stomach and small intestine, fiber dilutes the contents and delays the emptying and the absorption of nutrients; this promotes a feeling of fullness.

8. In the large intestine, fiber dilutes the contents and provides a place for bacterial growth and digestion. The water-holding capacity of insoluble fiber in the lower intestine softens the stool and increases stool size, so that the process of elimination is easier and faster.

9. In the large intestine, fibre also acts to bind certain chemicals. Different kinds of fiber have different binding capacities: when fiber binds cholesterol-like compounds, it lowers cholesterol, a healthy result; when fiber binds minerals, it decreases their absorption, a less desirable result.

Because of these physiological effects, fiber is considered beneficial in preventing, alleviating or curing a number of diseases and conditions, including:

- arteriosclerosis;
- excessive food intake;
- diverticular disease;
- irritable bowel syndrome;
- the Crohn's disease;
- gallstone formation;
- constipation.

Recent recommendations suggest that we should be getting fiber from a variety of food-stuffs high in different types of fibers, rather than from dietary supplements. A healthy diet should provide a mixture of both soluble and insoluble fibers. About 8 g of daily fiber intake should be in the form of soluble fibers (pectins), such as: fruit, especially apples and citrus, vegetables, especially leafy green varieties and oat.

Major sources of insoluble fibers (cellulose and hemicellulose) include: wheat bran, whole grains, legumes, most fruit and vegetables.

A good source of fiber should have at least 3 g of fiber. High-fiber food-stuffs provide 5 g or more. The accompanying chart lists a variety of food-stuffs and their fiber content (Table 15).

A healthy adult should get 20–25 g of fiber a day, based on the assumption that we need 10–13 g of fiber a day for every 1,000 calories consumed. Unfortunately, most Americans consume only about 10 g.

Children aged 3–18 need less fiber than adults, and they need different amounts at different ages. To calculate a child's daily fiber requirements, add the child's age to the number five (for 5 g). For example, a four-year-old child needs 9 g of fiber a day.

To get the appropriate amount of fiber, adults should include the following in their diets:

- 1) two to three servings of whole grains (as part of the 6–11 recommended daily servings);
- 2) five servings of fruit and vegetables a day;
- 3) one or two servings of legumes every week.

Table 15. Sources of Fibre

Food	Amount of fibre, g%
bagel	2.1
bran bread	8.5
white bread	1.9
cornflakes	2.0
oatmeal	10.6
wheat flakes	9.0
barley, pearled (minus its outer covering)	15.6
cornmeal, whole grain	11.0
rice, raw (brown)	3.5
rice, raw (white)	1.0–2.8
apple (with skin)	2.8
apricots (dried)	7.8
figs (dried)	9.3
kiwifruit	3.4
pears (raw)	2.6
prunes (dried)	7.2
raisins	5.3
broccoli, raw	7.7
brussels sprouts (cooked)	2.6
cabbage (white) raw	2.4
cauliflower, raw	2.4
potatoes, white, baked, w/skin	5.5
sweet potato, cooked	3.0
tomatoes, raw	1.3
corn chips, toasted	4.4
nuts:	
almonds, oil-roasted	11.2
coconut, raw	9.0
peanuts, dry-roasted	8.0
pistachios	10.8
tahini	9.3
tofu	1.2

Increasing fiber intake to recommended levels may cause some unpleasant effects unless a person does it gradually and drinks much water. This can help man avoid:

— gas distention and/or diarrhea resulting from increases of fiber intake;

— colon obstruction caused by very large intake of fiber;

— interference with the absorption of some minerals.

Depending upon the quantity of food fibers in the products, carbohydrates are classified into refined and protected. To the former we refer vegetable sources of carbohydrates, containing less than 0.4% of cellulose, as well as sugar food products with overall quantity of carbohydrates (or carbohydrates together with fats) more than 70%. In the list of such products there are sugar, honey, sweets, chocolate, khalva, biscuits, pastry cakes, jam, products of high carts of flour, etc. These products are

easily digested in the intestine and their carbohydrates soon enter the blood, create excess of ready for utilization energetic substances, which due to the impossibility of use are deposited in a form of fat reserves. Consequently, indicated products possess lipogenic, lipemic and cholesterologenic action with all consequences following from this for the health of person. In the form of indicated they should be limited in nourishment of elderly persons, as well in young ones, subjected to hypodynamia and with tendency to obesity. Products-sources of protected carbohydrates contain sufficient quantity of cellulose (more than 0.4%).

Carbohydrates in relation with the possibility of their substitution by other nutrients do not belong to strongly standardized components of nutrition. Nevertheless their minimal requirements are known. According to M. Logatkin minimal quantity of carbohydrates, preventing appearance of ketone bodies, composes about 1 g per every gram of daily ration. From here minimal quantity of carbohydrates, preventing proteins from destruction is equal to 100–120 g a day and warranted — 200–250 g. At the end of XIX century Foit determined the norms of carbohydrates for the adult person on the level of 500 g a day. In Ukraine 60–70% of daily diet calories are covered owing to carbohydrates, which nearly corresponds this standard. In European diets content of carbohydrates fluctuates in a diapason 45–65%.

K. S. Petrovsky (1982) defined the requirement of adult people in carbohydrates, not occupied by hard physical work on the level of 400–500 g; 350 g — at the expense of starch and 50–100 g — due to mono- and disaccharides. This author recommended adults to have in their diet on an average 15% of sugars from overall quantity of carbohydrates, in diet of individuals, spending large quantities of energy in a comparatively small period of time (sportsmen, porters and others) — up to 30–35%. We should underline, that requirement of people in carbohydrates is defined accordingly to their energetic expenditures, as well as by age and sex (Table 16).

It is also important, that consumption of carbohydrates is balanced with consumption of proteins and fats. For individuals, occupied by easy or mechanized labour ratio of proteins, fats and carbohydrates should be 1:1:4, for those occupied by partly mechanized labour — 1:1:5, during long period physical exertions — 1:0.8:6, for aged people — 1:0.8:3.

Standardization of carbohydrates may also be conducted in accordance to energetic value of daily ration, when in every 1,000 kcal 137 g of these are recommended.



Table 16. Recommended Normatives of Carbohydrates Consumption for Adults, g/day

Group of labour intensity	Age					
	18–29		30–39		40–59	
	men	women	men	women	men	women
I	378	324	365	310	344	287
II	412	351	399	337	378	327
III	440	371	426	358	406	344
IV	518	441	504	427	486	406
V	607	–	574	–	546	–

## VITAMINS

Vitamins are essential for normal functioning of specific enzyme systems, e.g. those involved in metabolism or other bodily activities. If diets are deficient in specific vitamins, characteristic and readily recognizable diseases occur; more often, multiple deficiencies and mixed clinical pictures are seen. Vitamins could be classified into two groups: fat-soluble (A, D, E and K) and water-soluble (vitamins C and group B).

**Vitamin A.** Some food-stuffs contain both vitamin A itself, and other substances that can be converted to vitamin A, known as provitamin A, vitamin A precursors or carotenoids. Although it is possible to have a toxic amount of preformed vitamin A, this appears not to be the case with provitamin A, so that it is clearly safer to have more of the latter.

Vitamin A is a fat-soluble vitamin like vitamins D, E and K. It is therefore necessary to have some fat in the diet for these vitamins to be adequately absorbed.

One of the most important consequences of vitamin A deficiency is dryness of the eyes eventually leading to blindness. It remains one of the main causes of blindness in the world (Fig. 26). Night blindness is also an eye complication of early vitamin A deficiency.

The units for expressing the amount of vitamin A changed from time to time because of the need to consider both preformed vitamin A (called retinol) and provitamin A (a group of components called carotenoids, of which beta-carotene is the most active and important). The present custom is to express the total amount of vitamin A activity as equivalent to so many micrograms of retinol. But some vitamin preparations may express the amount of vitamin A in different ways, so to help you compare. A list of conversion factors is given below:

1 retinol equivalent = 1 µg of retinol  
 = 6 µg of β-carotene  
 = 12 µg of other provitamin A carotenoids

The original system using international units (IU) was different, so:

1 retinol equivalent = 3.33 IU vitamin of A activity from of retinol  
 = 10 IU of vitamin A activity from beta-carotene

RDA of vitamin A is 1.0 mg of retinol equivalents per day (in Australia, India and some other countries — 750 µg).

For the majority of people, most vitamin A activity is derived from carotenoids and this is the safest way to have it to avoid vitamin A toxicity. Vitamin A supplements are more likely to contain preformed vitamin A, which is toxic in large amounts. The only adverse effect of excessive intake of carotenoids appears to be a possible yellow-orange appearance of the skin.

Of great interest is the growing evidence that a high intake of carotenoid-containing food-stuffs may be protective against certain cancers such as lung and prostate cancer. In general, green leafy vegetables are good sources of provitamin A.

There is no recommended intake specifically for provitamin A. Provitamin A has about one-sixth of the biological activity of retinol so we would need six times more of provitamin A than of retinol if the provitamin was our only source of vitamin A supply.

**Vitamin D** originates from animal food (cod liver, butter, etc). This vitamin is important for the metabolism of calcium. Substantial amounts of vitamin D<sub>3</sub> (cholecalciferol) are produced in the skin by sunlight. From the diet or the skin it is converted into a biologically active form in the liver and kidneys. Calciferoles promote absorption of calcium and phosphate from food which is metabolized for mineralisation of the bones and cause release of calcium from the bones. Uniquely for a vitamin it has hormone-like functions. RDA of vitamin D is 400 IU per day.

**Vitamin E** originates from plants. It is found in vegetable oils such as corn, olive, palm, peanut and cotton-seed oils. Animals acquire their vitamin E from plants directly, or by eating other animals that have derived their vitamin E from plants and stored it in their liver, muscles and fat. Vitamin E has an important function as an antioxidant. As such, it prevents the degradation of polyunsaturated fat and oth-

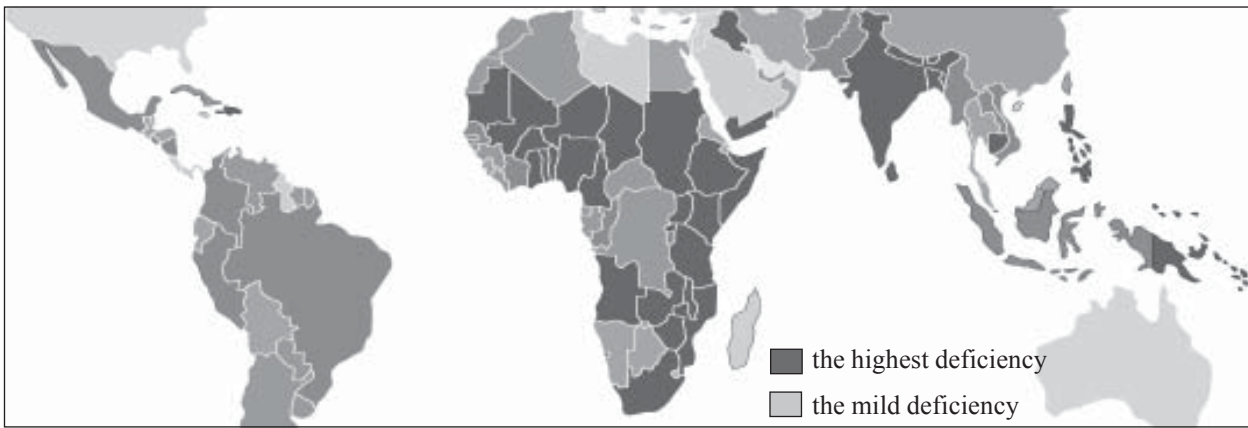


Fig. 26. Vitamin A Deficiency in the World

er compounds by oxygen. It may have some additional functions in the membranes of body cells. Although an attractive idea, there is really no good evidence that vitamin E retards the aging process or reduces coronary heart disease.

It has been recommended that enough vitamin E should be present in food containing polyunsaturated fat in order to prevent oxidation (degradation) of the fat. Up to 10% of dietary energy comes from polyunsaturated fat, 10 to 20 mg of vitamin E per day adequately protects the fat and provides enough of the vitamin for an adult. An alternative recommendation is that the diet should contain 0.4 mg vitamin E for each 1 g of polyunsaturated fatty acid consumed. Vitamin E can be found in different forms known as tocopherols or tocotrienols. Although there is some variation in their biological activity, about 1 mg of vitamin of E is equivalent to 1 IU (Table 17).

**Vitamin K** cannot be made by our bodies, but not all vitamin K needs to be obtained from food, because bacteria in our gut can make it. Probably, about half of vitamin K needs can be made by gut bacteria. Vitamin K is involved in the formation of special liver proteins, known as coagulation factors, which, when circulating in our blood, reduce the risk of haemorrhage or bleeding. Newborns can sometimes suffer from vitamin K deficiency, like people who do not absorb fats, since vitamin K is fat-solu-

ble. Those with liver disease may require more vitamin K.

Some proteins in bone and kidney are vitamin K dependent, so that vitamin K may have functions in these tissues as well (Table 18).

Another way of expressing vitamin K requirement is to say that about 2 µg/kg of the body weight per day are needed, but half of these could come from gut bacteria (Table 19).

**Vitamin B<sub>1</sub> (thiamin)**. Whether there is a thiamin deficiency or not can depend not only on the amount of thiamin ingested, but on the presence of thiamin antagonists in food.

For example, an enzyme (a natural substance that speeds up a chemical reaction), called thiaminase, occurring in raw fish can break down thiamin, and cause beri-beri in some people. One of the most significant losses of thiamin from food occurs in the milling of cereals. But thiamin is also water soluble and can be lost in cooking water. It can also be destroyed on heating and is sensitive to air or oxygen and also to alkaline conditions. In addition, alcohol can reduce the availability of thiamin to the body. For these various reasons, in both developing and developed countries, thiamin deficiency can be a problem. Thiamin is involved in the action of certain enzymes in the body, especially for decarboxylases enable carbohydrate to be used as energy. Thus, thiamin deficiency results in Wernicke — Korsakoff' psychosis, dry beri-beri and wet beri-beri, respectively.

The requirement for thiamin relates to the amount of energy, especially carbohydrate consumed (Table 20).

Table 17. Recommended Daily Dietary Intake of Vitamin E Expressed as Alpha-Tocopherol Equivalents

Target group	Vitamin E, mg
Infants	2.5–4
Children	5–11
Adult men	7
Adult women	7
Pregnancy	10
Lactation	9.5

Table 18. Safe and Adequate Daily Intake of Vitamin K

Target group	RDA, µg
Infants	10–20
Children and adolescents	15–100
Adults	70–140

Table 19. **Vitamin K Content in Some Food-stuffs**

Product	Content, µg%
Apples	less than 5
Asparagus	21
Beans, green	22
Beef, mince	7
Beef, liver	100
Broccoli	100
Cabbage	100
Carrots	15
Cauliflower	150
Lettuce	200
Milk (cow's)	5
Milk (cow's, skim)	4
Oranges	less than 5
Peas	19
Potatoes	20
Soya beans	190
Spinach	240
Strawberries	13
Wheat bran	80
Wheat germ	37

**Vitamin B<sub>2</sub> (riboflavin).** Riboflavin, like other water-soluble vitamins, can be lost when cooking. Water containing the dissolved vitamin is discarded. Riboflavin can be destroyed by the action of ultraviolet radiation in sunlight. A particularly important loss of this vitamin can occur in milk packed in clear containers when they are exposed to sunlight during or after delivery. The products of this destruction can also cause a loss of vitamin C.

Riboflavin deficiency results in inflammation of the tongue and lips and also cracking and dryness of the lips and corner of the mouth (cheilosis) and other symptoms. Riboflavin deficiency in children causes growth retardation. Inadequate intakes of riboflavin would normally be associated with a deficiency of other B-group vitamins, which would result in multiple problems.

**Niacin (vitamin PP)** can be obtained from food or made in our bodies from amino acid, tryptophan.

Table 20. **Recommended Daily Dietary Intake of Thiamin**

Target groups and conditions	RDA, mg
Infants	0.2–0.4
Children	0.5–1.2
Adult men	1.6–2.5
Adult women	1.3–1.9
Pregnancy	2.0
Lactation	2.4

Tryptophan is a constituent of protein, although not all proteins are good sources of tryptophan. To obtain 1 mg of niacin, we need 60 mg of tryptophan. Thus, if both niacin and tryptophan in food are taken into account, the niacin equivalent (mg) in food can be worked out. However, not all niacin in food may be equally available to the body, because some are rather tightly bound to other food constituents and not easily released. Since niacin is water soluble, losses can occur by discarding water containing the dissolved vitamin.

Those at particular risk of niacin deficiency are the socio-economically deprived, those with a high consumption of corn, which is low in both tryptophan and niacin, and alcohol abusers. Pellagra is a condition resulting from niacin deficiency, in which there are symptoms of dermatitis in skin exposed to the sun, diarrhoea and dementia. In lesser degree of deficiency, general weakness, loss of appetite and indigestion can occur, but these symptoms can also occur in many other circumstances (Table 21).

The forms of **vitamin B<sub>6</sub>** found in food are pyridoxine, mainly in vegetables, and pyridoxal and pyridoxamine, mainly in food-stuffs from animal sources. Vitamin B<sub>6</sub> is water soluble and can be lost by discarding water in which it is dissolved. It is also sensitive to light, air or oxygen and to alkaline conditions. Vitamin B<sub>6</sub> is involved in the functioning of some enzymes (natural substances that speed up chemical reactions), especially those involved in protein metabolism, the formation of chemicals for transmission of impulses in brain and nerves, and in red blood cell formation.

With early deficiency of vitamin B<sub>6</sub>, nonspecific symptoms such as sleeplessness, irritability and weakness may occur, but, of course, their presence may be for other reasons. If you have been on high-dosage of vitamin B<sub>6</sub>, you may develop these symptoms during its withdrawal as your body readjusts to more normal intakes. A bigger vitamin B<sub>6</sub> deficiency may lead to depression, convulsions, abnormal nerve functions (especially in the limbs), dermatitis, cracking of the skin at the corner of the mouth and the lips, a smooth tongue, and anaemia.

Those at risk because of vitamin B<sub>6</sub> deficiency are alcohol abusers. Certain medications, such as the oral contraceptive pills and isoniazid, which are used

Table 21. **Recommended Daily Dietary Intake of Niacin**

Target groups and conditions	RDA, mg
Infants	4–7
Children	9–22
Adult men	14–20
Adult women	10–14
Pregnancy	14–16
Lactation	17–19

to treat tuberculosis, may increase vitamin B<sub>6</sub> requirement. In some metabolic diseases the requirement of vitamin B<sub>6</sub> is increased.

**Vitamin B<sub>12</sub> (cyanocobalamin).** Animals ultimately acquire vitamin B<sub>12</sub> from microorganisms, people eating animal products are unlikely to suffer any deficiency. People in traditional vegetarian cultures probably obtained most of their vitamin B<sub>12</sub> through microbial contamination of food. Small amounts may also be obtained from water through its association with soil microorganisms, and from bacteria normally living in the mouth. With newer, more hygienic practices, vitamin B<sub>12</sub> deficiency sometimes occurs in people on a vegetarian diet, especially the infants of vegetarian mothers. It has been suggested that a few plants, like comfrey, might be sources of vitamin B<sub>12</sub>.

One reason why vitamin B<sub>12</sub> deficiency is rare is that the liver stores in our bodies can last for as long as 5 years or more. Vitamin B<sub>12</sub> is water soluble and can be lost in cooking water. It is not sensitive to heat, light, air or oxygen, but can be destroyed by alkaline conditions. Vitamin B<sub>12</sub> and folacin are involved together in the formation of the genetic material in the nuclei of body cells (DNA), and in the formation of RNA, which is another important chemical involved in protein synthesis. The main features of vitamin B<sub>12</sub> deficiency are anaemia and disordered function of the central nervous system. The condition called pernicious anaemia results from an inability to absorb vitamin B<sub>12</sub> rather than through dietary deficiency. Hence, in this condition, vitamin B<sub>12</sub> injections are given. It is worth noting that vitamin B<sub>12</sub> contains cobalt and our bodies need for cobalt is a need for vitamin B<sub>12</sub>.

**Folacin (vitamin B<sub>9</sub> or B<sub>c</sub>)** is present in many forms in food. It is sometimes referred to as folic acid, or folate. The availability to the body of folacin in food depends not only on the form, but also on other food properties, such as acidity, the amount of dietary fibre and the amount of carbohydrates. Folacin is water soluble and easily lost in discarded cooking water. It is also sensitive to heat, to air or oxygen and to alkaline conditions. Folacin, like vitamin B<sub>12</sub>, is involved in the formation of the genetic material of newly forming cells and in protein formation. The consequences of deficiency include anaemia and defective lining of the gut, adversely affecting absorption of many nutrients. Since the number of blood platelets (which play a part in blood clotting) can be low with folacin deficiency, a tendency to prolonged bleeding can also occur.

Those at risk from folacin deficiency include users of certain medications, pregnant women, the elderly and alcohol abusers (Table 22).

**Pantothenic acid** is widely distributed in nature and is present in a wide variety of food-stuffs, efficiency is, therefore, very rare. It is water soluble, heat sensitive and can be degraded in both acid and alkaline conditions.

Table 22. **Recommended Daily Dietary Intake of Folacin**

Target groups and conditions	RDA, mg
Infants	50–75
Children	100–200
Adult men	200
Adult women	200
Pregnancy	400
Lactation	350

**Biotin** (vitamin H) deficiency was first recognized not because of inadequate amounts in the diet but because of the effects of a chemical called avidin, which is found in raw eggs. Avidin binds and inactivates biotin. Biotin can be made by gut bacteria and absorbed from the large bowel, so that not all biotin needs to be obtained from food. Theoretically, antibiotics that affect gut bacteria could reduce the amount of biotin available. Biotin is water soluble, sensitive to air and oxygen as well as to alkaline conditions. The vitamin acts as part of enzyme systems involved in building up chemicals containing carbon and oxygen, such as fats and glucose.

Infants may be at risk of biotin deficiency, which shows up as a “seborrheic dermatitis” (Swift’s dermatitis) that responds to biotin. Consumption of raw egg can cause biotin deficiency because protein of egg-white — avidin which is anti-biotin factor. Also, some infants have a metabolic disorder requiring extra biotin. There has been some suggestion that “cot deaths” or the sudden infant death syndrome may be due, in some cases, to an inadequate intake of biotin.

Biotin in human milk averages about 10 µg per 1,000 kcal (4,200 kJ) and in infant formulae is usually at least 15 µg per 1,000 kcal. However, a higher concentration of biotin may be preferable for infant formulae because nutrients can be more biologically available to the infant from human milk than from infant formulae.

**Vitamin C (ascorbic acid).** Probably the first disease to be recognized as being caused by a nutritional deficiency was scurvy, when it was found that certain food-stuffs could prevent the disease. Scurvy was described by the Egyptians and Greeks, but it was Bachstrom in Leiden in 1734 who maintained that it was due to a lack of fresh vegetables in the diet. In 1795, the British Admiralty adopted James Lind’s recommendations for citrus fruit to prevent seaboard scurvy and, thereafter, British sailors were nicknamed “limeys”.

In scurvy, the connective tissues of the body are defective; the tissues are fragile, and bleeding occurs into the skin, from the gums and into deeper tissues. Wound healing is also poor. Changes in the brain and nerve function occur, with mood and per-

sonality changes. Muscle weakness and proneness to infection may occur. Our bodies' ability to detoxify certain chemicals may also be reduced in scurvy. It seems likely that there may be lesser degrees of vitamin C deficiency than the extreme of scurvy.

Vitamin C can be lost from food-stuffs because of its water solubility, and sensitivity to heat, air or oxygen. The addition of alkalis, such as bicarbonate of soda, and the use of copper cookware can also destroy it.

People at risk from vitamin C deficiency include those who avoid fruit and vegetables, those with poor cooking, the elderly, alcohol abusers and cigarette smokers. Persons with chronic diseases have high risk of vitamin C deficiency.

Recommendations about vitamin C intake were first concerned with the prevention of scurvy. Recommended intakes of about 30 mg per day do not usually "saturate" the body tissues with vitamin C and, indeed, this may not be necessary. But to saturate body tissues, no more than 100 to 130 mg per day are required. With intakes above this, our bodies adapt by increasing breakdown of vitamin C or excreting it in the urine. From a mixed diet it would be difficult to have more than about 400 to 500 mg of vitamin C per day (Table 23).

It has been suggested that daily intakes of vitamin C in excess of 500 mg may be of benefit. There is some evidence that amounts of this kind may reduce the symptoms of the common cold (Polling, 1965). This raises the question of non-nutritional or drug-like properties of the vitamin. The possible adverse effects must also be considered. These include: "rebound scurvy", which may occur if you are coming off high-dosage of vitamin C; increased excretion of oxalic acid in the urine which may lead to "stones" in the urinary tract; an increased absorption of iron in those susceptible to iron overload; increased absorption of toxic metals, such as mercury; and interactions with certain medications, for example warfarin, aspirin, antidepressants and the contraceptive pill.

**Bioflavonoids** (hesperidine, rutin, quercetin, etc.) are vital in their ability to increase the strength of the capillaries (blood vessels) and to regulate their permeability. They assist vitamin C in keeping col-

lagen, the intercellular "cement" in healthy condition; are essential for the proper absorption and use of vitamin C; prevents vitamin C from being destroyed in the body by oxidation; beneficial in hypertension; helps hemorrhages and ruptures in the capillaries and connective tissues and builds a protective barrier against infections. Quercetin is a very highly concentrated form of bioflavonoids derived from citrus fruit. Deficiency may result in varicose veins, tendency to bruise and bleed easily, appearance of purplish spots on the skin.

## MINERAL SALTS

The mineral substances play an important role in plastic processes, serve a material necessary for construction of tissues of a growing organism. They are necessary for formation of a skeleton, muscular and other tissues, which define growth of the body, for normal development and function of endocrine glands, production of biologically active substances. In salts of calcium the dairy products, egg yolk, nuts, beans and vegetables are rich. The greatest quantity of phosphorus is in cottage cheese, egg yolk, meat, oatmeal, nuts and some fruit. Rye bread, peas are rich in salts of magnesium. The vegetables and fruit, meat, fish (also wheaten and rye bread, porridges) are rich in salts of potassium. For average norm of the cooking salt for children of school age accept 8–10 g per day. The subproducts (liver, kidney), fish, egg, caviar, seafood are richest in microelements.

**Sodium** occurs naturally in many food-stuffs and is also added in the form of salt or other sodium-containing substances. Common salt or dietary salt is a chemical compound of sodium and chlorine and is called sodium chloride. The sodium content of food has important implications for health. Salt contains about 40% of sodium, and a teaspoon of salt, which weighs about 5 g, contains about 2 g of sodium.

Rock salt and sea salt are almost entirely sodium chloride, with only traces of other elements (minerals). Iodized salt contains about 0.03 mg of iodine per 1 g of salt. It is intended as a supplement for people whose diet is iodine deficient. Common

Table 23. Recommended Dietary Intake of Vitamin C

Target groups and conditions	National RDA, mg/day		
	Australia	USA	Ukraine
Infants	30	35	35
Children	30–50	45	50
Adult men	30	60	70
Adult women	30	60	70
Pregnancy (2nd and 3rd trimester)	60	80	100
Lactation	60	100	150

food additives, such as house-hold soda, some preservatives, and monosodium glutamate (MSG), also contribute to the total amount of sodium we consume.

Probably one-fifth of the population, because of genetic predisposition, may be increasing their risk of high blood pressure (hypertension) by high sodium intake. Such people have a high incidence of hypertension and strokes. High blood pressure is rarely seen in those who consume less than 1.2 g (1,200 mg) of sodium per day. But sodium is an essential nutrient, and we need a certain amount for normal body function. A safe intake is considered to be between 0.9 and 2.3 g of sodium per day, although in special circumstances, such as excessive sweating and diarrhoea, higher levels may be needed.

There is usually no need to increase salt intake in hot climates to avoid cramps, fainting and other symptoms because the body's hormones will adjust over a few days and conserve body sodium. Excessive heat presents other risks and should, in any case, be avoided.

Some people find it hard to reduce their intake of sodium. We all have an ability to taste salt, but the extent to which we like our food salted can be modified by experience. The amount of salt we consume cannot be wholly controlled by the moderate use of the salt shaker at the dinner table. This use only accounts for about one-third of our daily intake. Up to half of our salt intake is from processed food, with the balance occurring naturally in food and water. The amount consumed in processed food is difficult to control, although with highly salted food-stuffs, taste is a reliable guide. Some items that do not taste highly salted can contribute significant quantities of sodium to our diet because of the amounts we consume. Examples include bread, tomato sauce, cakes and biscuits. Many "take-away" food-stuffs, such as fish and chips, hamburgers and Chinese food, are highly salted. Bottled mineral waters can contribute a significant amount of sodium. An indication of sodium content is usually given on the label.

An increase in **potassium** intake seems to offset the adverse effect that sodium has on blood pressure. Food-stuffs that contain significant amounts of potassium and also low levels of sodium are fresh and frozen fruit and vegetables. But there is no justification for the unrestricted use of potassium salts as substitutes for sodium, as this would present new problems. Potassium supplements and salt substitutes can be potentially hazardous to health and should only be used under medical supervision.

Potassium, like sodium, is essential for normal body function. Potassium is necessary for muscle function, the transmission of nerve impulses and for carbohydrate and protein metabolism. It is unlikely that we would have a dietary deficiency of potassi-

um as it is present in a large number of food-stuffs. Deficiency can occur when there are losses resulting from excessive urination or from prolonged vomiting and diarrhoea. Although sodium is an important dietary factor in high blood pressure for some people, variations in the ratio of sodium and potassium will also affect blood pressure under certain circumstances. An increase in potassium intake appears to partly offset the adverse effect of sodium on blood pressure. If you are prone to high blood pressure it would be beneficial to decrease sodium intake and increase your dietary intake of potassium, by eating more food-stuffs having low amounts of sodium and significant amounts of potassium, such as fruit and vegetables.

The use of potassium salts as substitutes for common salt (sodium chloride) is dangerous, and over-use can be fatal. Excessive potassium intake can cause heart irregularities and can cause the heart to stop beating (cardiac arrest). Potassium supplements and bulk substitutes should not be used without medical advice. High potassium intake can be particularly dangerous for children.

**Calcium**, in combination with phosphorus and other elements, is necessary to give strength to bones and teeth. When our dietary intake of calcium is greater than our bodies' requirements some excess of calcium is stored in our bones. When our day-to-day intake of calcium does not meet requirements, the calcium stored in bone becomes available to meet this shortfall.

Calcium has other important roles. It is essential for normal clotting of blood and is a vital link in transmission of nerve impulses. It is also an essential element in enzyme regulation, in the secretion of insulin in adults, and in regulation of muscle function.

During periods of growth the demand for calcium is greater than usual, although some calcium is incorporated into bone at certain other stages of life. Thus, children, adolescents and pregnant and lactating women need additional calcium. Adults continually need to replace calcium that is lost from the body in urine and faeces and to a lesser extent in sweat.

The bodies' utilization of the calcium in food can be adversely affected by the presence of two chemicals called phytic acid and oxalic acid. Phytic acid is found in the bran portion of cereals, and oxalic acid is present in significant quantities in spinach and rhubarb. The magnitude of the effect depends on the amount of these acids we consume and a higher intake of calcium may be necessary if large quantities of food-stuffs containing oxalic and/or phytic acids are eaten. Diets high in protein and salt also increase the requirement for calcium.

Osteoporosis, a decrease in the density of the bone, is a disease that becomes especially evident in women after the menopause, and is responsible

for many serious bone fractures that occur in this group. It is associated with a decrease of calcium in the bones and may be due to an imbalance between calcium and phosphorus earlier in life. Obtaining adequate calcium and avoiding factors that adversely affect calcium balance throughout life may be helpful in preventing the development of this disease. In old age it may be difficult to replace lost bone calcium.

Contrary to a popular belief, finger nail changes are not an indicator of inadequate calcium intake.

Many enzyme (natural substances required for chemical reactions in the body) systems that are needed for the transfer of energy within our bodies must have a supply of **magnesium**. Magnesium also plays a part in the normal functioning of muscles and nerves.

Magnesium occurs widely in food-stuffs, and cereals and vegetables are particularly good sources. An inadequate supply of magnesium in the diet is rare. However, deficiency can occur as a result of prolonged vomiting, diarrhoea and other gastrointestinal disorders. Chronic alcoholics frequently suffer from magnesium deficiency, which may be due to low intake and large losses in urine.

**Iron** is an essential element in the diet. It is a component of body systems that are involved in the utilization of oxygen. It forms haem, part of haemoglobin. Two thirds of iron in the body presents as haem. The remainder is stored in the liver, spleen, bone marrow and muscles where it is present as myoglobin (acting as an oxygen reservoir within the muscle fibres). Iron is involved in the production of red blood corpuscles, oxygen transport.

We cannot use all food sources of iron with equal efficiency. This means that not all of the iron consumed is available to our bodies. Animal sources of iron are more readily utilized than those from plant food-stuffs. The recommended dietary intake for iron takes into account the varying availability of the iron from food. The presence of vitamin C in the meal can enhance the availability of iron.

Iron deficiency is the most commonly occurring nutrient deficiency. In healthy people, iron deficiency can occur in infancy, during periods of rapid growth, because of menstruation, and during pregnancy. Additional amounts of iron are needed during these periods. Blood loss and disorders of the gastrointestinal tract can also lead to deficiency. Severe iron deficiency can result in anaemia.

Excessive body levels of iron can result in poisoning, although, for healthy individuals, daily intakes of 25 to 75 mg should not cause any effects. Poisoning has occurred in children who have eaten adults' iron supplements.

**Phosphorus** is an important element for many essential processes in the body. In combination with calcium it is necessary for the formation of bones and teeth. Phosphorus is also involved in the me-

tabolism of fats, carbohydrates and proteins, and in the effective utilization of many of the B-group vitamins, and in energy metabolism.

Phosphorus is very widely distributed in both plant and animal food-stuffs. Because of its widespread occurrence, it is unlikely that you will have any dietary deficiency. But you could become deficient if you used large amounts of antacids for a long time. Also, people with faulty kidneys could have a deficiency of phosphorus.

Pregnant and lactating women, and children during years of rapid growth (10 to 18 years) should have a higher phosphorus intake of 1,200–1,500 mg per day.

We obtain most of our **sulphur** from proteins in the diet. The essential amino acid methionine is one of several sulphur-containing components of protein. The proteins are broken down into their constituent amino acids, and the sulphur-containing amino acids are reused for the formation of body proteins needed for growth, tissue maintenance and enzyme production. New sulphur-containing compounds are also made by our bodies from the protein components. Some of these have metabolic function, and some are used to remove potentially toxic substances, including certain drugs, from the body.

**Chlorine** is present in food and our body almost entirely in the form of chloride. Chloride is important in maintaining water balance, and is an essential component of gastric juice. We get our supplies of chlorine from food mainly in the form of sodium chloride (salt). Dietary deficiency of chlorine is rare and is only likely to occur if you have excessive losses from your body. This can result from prolonged vomiting, diarrhoea or profuse sweating. If you are on a severe sodium-restricted diet it may be necessary to obtain chlorine from other sources.

There is no recommended dietary intake for chlorine in the most countries. For the average adult an estimated safe and adequate amount of chlorine is closely related to that for sodium and is in the range of 1,700 to 5,100 mg of chlorine per day. To keep to this level, most of us would need to reduce the amount of salt used in cooking or added at the table. Additionally, highly salted food-stuffs should be avoided.

Our bodies need **zinc** for many different functions, which include protein and carbohydrate metabolism, wound healing, growth and vision. Zinc is vital to 200 enzymes. Zinc metalloenzymes are found virtually in every metabolic pathway. Zinc is a component of insulin, involved in formation of bone tissue, healthy skin, vitamin A metabolism, phosphorus absorption, linoleic acid transformation. It reinforces the immune system. A too high intake may compromise the absorption of copper. It functions in the antioxidant enzyme superoxide dismutase (copper-zinc SOD). Greater assimilation achieved by supplementing a form of zinc with a

higher absorption rate such as zinc orotate, zinc amino acid chelate or zinc yeast. Several groups of people are at risk of developing dietary zinc deficiency. If they restrict their food to vegetables, and particularly wholegrain cereals, they could become deficient in zinc. Although zinc is present in these food-stuffs, it is not utilized by the body as efficiently as the zinc in other sources, such as meat, eggs and liver. Alcoholics also develop zinc deficiency, due to an inadequate diet and to large losses of zinc in their urine. Zinc deficiency also appears to be a problem in some disease states. Inadequate zinc intake can result in retarded growth, delayed wound healing, loss of taste sensation and dermatitis.

The dietary requirement for zinc must take into account the different degree of availability of zinc in different food-stuffs. Animal products are more efficient sources compared with cereals. The recommended dietary intake for zinc assumes that the zinc comes from mixed animal and plant sources. For vegetarians a higher intake may be necessary.

A human organism should have an adequate intake of **iodine** to form the hormones produced by the thyroid gland. If the dietary level of iodine is inadequate, the thyroid gland swells and produces goitre. Unless treated, this condition can cause mental retardation and stunted growth in children, hair loss, slowed reflexes, dry, coarse skin and other effects in adults. Food-stuffs produced in regions where soils are low in iodine, such as Tasmania in Australia, the Thames Valley in the U. K., the north-west region of the USA, northern India, Alpine countries are deficient in this element. Goitre caused by iodine deficiency can be prevented by supplementing the diet with added iodine. This is commonly done by adding sodium iodide to dietary salt to produce iodized salt. For some people, iodized salt can be an important source of iodine, and a change to a low-salt diet should make allowance for the decrease



Fig. 27. Endemic Goitre in Philippines

in iodine intake. Some food-stuffs, such as cabbage, sprouts and other brassicas contain natural anti-thyroid substances. In circumstances where both large quantities of these food-stuffs are eaten and the level of dietary iodine is marginal, goitre could develop (Fig. 27).

Excessive amounts of iodine can also lead to goitre. This has occurred where food-stuffs, such as seaweeds, which are rich in iodine, are commonly eaten. Although excessive iodine intake is not common, it should be noted that, in addition to food, many cough medicines and milk contaminated with an iodine containing sanitizing agent also contribute to iodine intake. But it is unlikely that any harmful effects would occur with habitual intakes up to 300 µg per day (Tables 24, 25).

The usual form of **fluorine** in our bodies is fluoride. Populations with a low intake of fluoride (about 1.2 mg per day for adults) have more dental decay (caries) than those with a higher intake (3.5 to 4.5 mg per day for adults). Main source of fluorine is drinking water (70–90% of total intake). The fluoridation of public water supplies in low fluoride areas has significantly reduced decay in these areas. The fluoride content of a water supply is often described by the term “parts per million” (ppm). 1 ppm = 0.1 mg/100 ml. About 1 ppm seems to be the optimal level of fluoride in the water supply; i.e. a litre of such water would provide 1 mg of fluoride. At 2 ppm, mottling of tooth enamel may occur. The condition of “fluorosis” or excessive deposition of fluoride in bones, with associated skeleton deformities, is only present after prolonged consumption of 20 to 80 mg of fluoride per day. The

Table 24. Recommended Daily Dietary Intake of Iodine

Target groups and conditions	RDA, µg/day
Infants	50–60
Children	70–150
Adult men	150
Adult women	120
Pregnancy	150
Lactation	200

Table 25. Iodine Content in Some Food Products

Food	Iodine content, µg%
Iodized salt	3,000
Seafood	66
Vegetables	26
Meat	26
Eggs	13
Dairy products	10
Bread and cereals	4



Table 26. **Fluoride Content of Some Food-stuffs and Beverages**

Food	Fluoride content, mg%
Crude sea salt	3.5–5.5
Fish and seafood	0.5–1.0
Tea	0.05–0.2

intake of fluoride, at the higher end of the safe range, has also been associated with reduced osteoporosis (“thinning of bones”), which is a fairly common condition in elderly people. Therefore, this also may be favourably affected by the fluoridation of water. Another cause of fluorosis can be consumption of tea (Tibet, China) (Table 26).

**Chromium** is considered to be an essential element for humans. Those without it in their diets, such as hospital patients on artificial meal, develop a diabetes-like condition, with high blood sugar (glucose) levels. The availability of chromium to the body may depend on the form in which it is present in food. For example, it is found in a form in association with other compounds in brewer’s yeast and known as “Glucose Tolerance Factor (GTF)”. Elderly people may be an at-risk group from chromium deficiency.

**Manganese** forms a part of substances essential for body metabolism, known as enzymes, no definite deficiency has been recognized in humans. In animals, deficiency can lead to abnormalities of the developing skeleton, of balance, and of carbohydrate and fat metabolism. Manganese poisoning from food is very unlikely.

**Selenium** is an element that forms part of an important body enzyme (substances essential for body metabolism), which has an antioxidant action in preventing, for example, breakdown of fats (lipids) to substances that can be damaging to the body. The enzyme probably takes care of what other antioxidants like vitamin E have failed to do because they were not present in sufficient amounts.

Selenium deficiency has been observed in patients receiving parenteral nutrition, but with selenium-poor solutions. Keshan’s disease, a disease of heart muscle affecting children, is a selenium-deficiency disease seen in a selenium poor area of North-Eastern China.

**Cobalt** is essential for humans because it is a part of vitamin B<sub>12</sub>. This form of cobalt is obtainable from microorganisms or from animal sources. Vegetable sources of cobalt are more important to animals that are ruminants (sheep and cattle). Cobalt deficiency in humans is like vitamin B<sub>12</sub> deficiency, with anaemia and nervous system problems. As little as 0.1 µg cobalt as vitamin B<sub>12</sub> per day is needed by adults. Total cobalt intake may be in a range

from 10 to 1,800 µg per day. Cobalt in a different chemical form (i.e. not as a part of vitamin B<sub>12</sub>) will stimulate blood formation, but this is probably not a normal action.

When cobalt was used to stabilize beer froth, it was found to have a toxic effect on the heart. Its toxicity, at cobalt intakes of about 8,000 µg per day, probably arose from its interaction with alcohol itself, and other nutritional problems created by alcohol.

No definite disease due to deficient **molybdenum** intake in humans has been recognized. However, it is an element that is part of enzymes that are involved in the production of waste products prior to excretion. The molybdenum content of food-stuffs depends on the soil where plant food-stuffs are grown.

**Tin** is an essential element for the growth of rats, but whether this applies to human growth is not known.

**Copper** is an essential part of several body enzymes (natural substances required for chemical reactions in the body). It is necessary for iron metabolism, for the formation of the brown pigment, melanin, in hair and skin, and in the functioning of the body’s central nervous system.

Copper deficiency due to inadequate dietary intake is rare. However, a deficiency may arise due to an inherited metabolic abnormality. Sources of copper include shellfish, liver, kidney and nuts. The amount of copper in household water supplies depends on the type of pipe and the hardness of the water. More copper is present in water from the hot tap than from the cold. For preparing hot drinks it is probably safer to heat cold water rather than use water from the hot tap, particularly for children. In the U. S. A. an intake of 2 to 3 mg per day for adults is considered to be safe and adequate. (It is assumed that up to an occasional 10 mg per day is safe for adults.)

**Nickel** is probably an essential element for humans, with several possible roles in maintenance and production of body cells. Adequate amounts are probably obtained from most diets, provided that the gut is functioning properly. There is some evidence that a few people may develop a skin sensitivity reaction to nickel. For these people, acid food cooked in stainless steel utensils and canned food may need to be avoided.

After oxygen, **silicon** is the most abundant element on earth. Its presence in our bodies might be thought of as that of an environmental contaminant. From the health point of view, most interest has centered on toxicity to the lungs from inhalation of silica dust. However, it has been shown in animals that silicon is essential for normal growth. Its action appears to be connected with bone mineraliza-

tion and formation of connective tissue. Good sources are wholegrain cereals and citrus fruit.

**Vanadium** is an essential element in the diets of people; deficiency affects bones and blood. Vanadium is considered to be an essential micro-trace element for mammalian systems. Influences enzyme systems — horse muscle appears to contain stable compound of vanadium — vanadyl ATP (adenos-

ine triphosphate). ATP plays a vital role in releasing energy for ion transport across membranes; and the pumping out of sodium from the cells and exchanging it for potassium. The most striking effect is that it mimics insulin effects — modifies tissue responsiveness to insulin. Toxicity has not been seen with intakes below 4,500 µg per day.

Other minerals are presented in Table 27.

Table 27. Trace Elements and their Role in Nutrition

Element	Usual food source	Function	Hazard caused by excess in food
Aluminium	From cooking vessels, aluminium-containing medications, some fruit and vegetables	Poorly absorbed; no known function	Decreased phosphate absorption leading to bone diseases, altered mental function
Antimony	Food-stuffs stored in enamel vessels and cans	No known function	Very low toxicity
Arsenic	Crustaceans and fish, contaminated water, fruit and vegetables grown in contaminated areas or with spray residues	Possibly essential for growth in rodents, pigs and poultry	Gut, skin, brain and nerves affected
Barium	Brazil nuts, cereals grown in barium-rich soil	No known function	Very low toxicity
Boron	Plant food-stuffs	Not essential for animals, although it is for some plants	Very low toxicity
Bromine	From fumigated grain and its products	Will replace chloride and so accumulate; will also be taken up by the thyroid gland instead of iodine	Adverse effects on brain and thyroid function
Gold	Information inadequate	No known function	Skin, gut and kidney damage
Lead	Variable content in food; more in produce grown near highways with vehicles using leaded petrol; more in food from metal cans than from glass or aluminium containers; some from reticulated water	Not essential	World Health Organisation suggests tolerable weekly intake of 50 µg/kg of the body weight for adults. Excess affects brain, blood, bone and kidneys.
Mercury	Mercurial fungicides contaminating food; organic mercury in fish from contaminated water, such as near paper mills; from shark, which is high up in the marine food chain with progressive concentration of mercury	Interacts with selenium	Brain damage, kidney damage
Rubidium	Soy beans, beef	Can act partly as a substitute for potassium	More toxic in low potassium diets, with effects on growth and reproduction
Silver	From food prepared in silver-plated vessels, contaminated by silver-lead solders or stored in silver foil	Not essential	Low toxicity
Strontium	Plant food-stuffs have more than animal food-stuffs. More in bran than the remainder of cereal grain	Found in bone, and can be replaced by radioactive strontium from fall-out; interacts with calcium	May affect growth

## NUTRITIONAL DEFICIENCY DISEASES

There are some nutritional components of meal which do not have a nutritive value (Fig. 28).

Up to one third of the world's population goes hungry for much or most of the time. Majority of people who do not get enough to eat live in the dry savannah country of Africa, in the overcrowded nations of Asia and in the urban slums of Latin America.

In the 1980s there were wide spread famines in Africa and in the 1990s largely associated with war and genocide further localized and regional famines have occurred again but in different regions, notable southern Sudan and in the refugee communities on the Rwanda-Burundi-Zaire borders. In the aftermath of the Gulf War and the imposition of sanctions, very severe food shortage approaching famine affected many of people of Iraq. Also in the early 1990s the economic and political disruption of parts of the former Soviet Union and the conflicts in the former Yugoslavia causes several very severe localized periods of food shortage. A series of natural disasters mainly floods probably aggravated by inefficient production distribution caused famine in North Korea in 1995–1996. At any time small numbers of undernourished or starving people can be found almost anywhere even in the richest cities in the affluent industrial nations. They may starve because of inadequacies in the social services. Victims of this situation are elderly people on inadequate pensions; children of low-income parents, especially single parents, etc.

Undernutrition can result from inadequate intake, malabsorption, abnormal systemic loss of nutrients due to diarrhea, hemorrhage, renal failure, or excessive sweating, infection, or addiction to drugs. Undernutrition is associated with poverty and social deprivation, occurring among the poor. The risk of undernutrition is also greater at certain times in a person's life, i.e. infancy, early childhood, adolescence, pregnancy and lactation, and old age.

Because of the high demand for energy and essential nutrients, infants and children are at particular risk of undernutrition. Protein-energy malnutrition in children consuming inadequate amounts of protein, calories, and other nutrients is a particularly severe form of undernutrition that retards growth and development (see below). Hemorrhagic disease of the newborn, a life-threatening disorder, is due to inadequate vitamin K intake. Deficiencies of iron, folic acid, vitamin C, copper, zinc, and vitamin A may occur in inadequately fed infants and children. In adolescence, nutritional requirements increase because the growth rate increases. Anorexia nervosa, a form of starvation, may affect adolescent girls.

Requirements for all nutrients are increased during pregnancy and lactation. Aberrations of diet, including pica (the consumption of non-nutritive substances, such as clay and charcoal), are common in pregnancy. Anemia due to folic acid deficiency is common in pregnant women, especially those who have taken oral contraceptives. Folic acid supplements are now recommended for pregnant women to prevent neural tube defects (spina bifida) in their children. An exclusively breastfed infant can develop vitamin B<sub>12</sub> deficiency if the mother is a vegetarian. An alcoholic mother may have a handicapped and stunted child with fetal alcohol syndrome, which is due to the effects of ethanol and malnutrition on fetal development.

A diminished sense of taste and smell, loneliness, physical and mental handicaps, immobility, and chronic illness can militate against adequate dietary intake in the elderly people. Absorption is reduced, possibly contributing to iron deficiency, osteoporosis (also related to calcium deficiency), and osteomalacia due to lack of vitamin D and absence of exposure to sunshine. Irrespective of the age, disease or dietary deficiency there is progressive loss of lean body mass, amounting to about 10 kg in men and 5 kg in women. It accounts for the decrease in BMR, total body weight, skeletal mass, and height and for the increase in mean body fat (as a percentage of

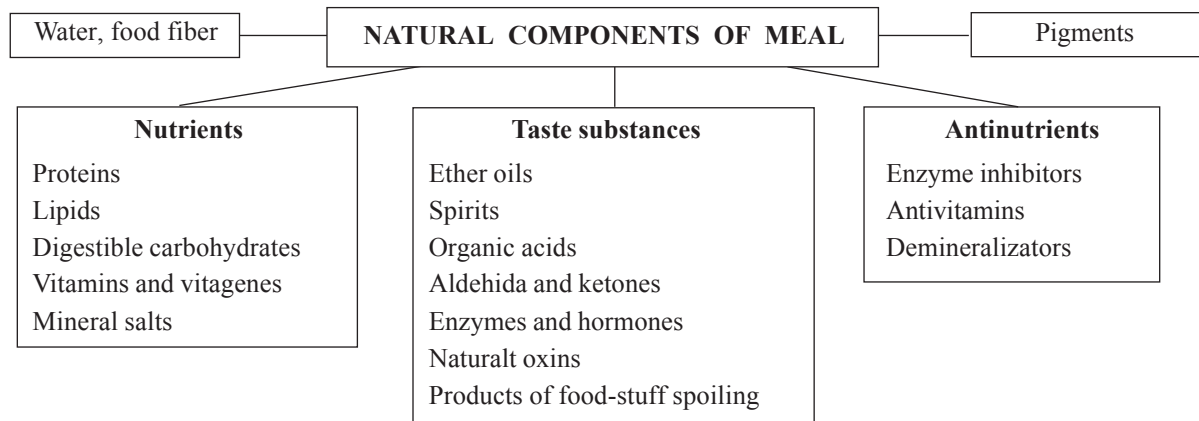


Fig. 28. Natural Components of Meal

body weight) from about 20 to 30% in men and from 27 to 40% in women. These changes and a reduction in physical activity result in lower energy and protein requirements compared with those of younger adults.

In patients with chronic disease, malabsorption states (including those resulting from surgery) tend to impair the absorption of fat-soluble vitamins, vitamin B<sub>12</sub>, calcium, and iron. Liver disease impairs the storage of vitamins A and B<sub>12</sub> and interferes in the metabolism of protein and energy sources. Patients with kidney disease, including those on dialysis, are prone to develop deficiencies of protein, iron, and vitamin D. Some patients with cancer and many with AIDS have anorexia, which complicates treatment. In patients receiving long-term home parenteral nutrition most commonly after total or near-total resection of the gut, vitamin and trace mineral deficiencies must be especially guarded against. A physician should be sure that biotin, vitamin K, selenium, molybdenum, manganese, and zinc are adequately supplied.

**Vegetarian Diets.** The most common form of vegetarianism is ovo-lacto-vegetarianism, in which meat and fish are eschewed but eggs and dairy products are eaten. Iron deficiency is the only risk. Ovo-lacto vegetarians tend to live longer and to develop fewer chronic disabling conditions than their meat-eating peers. Vegans consume no animal products and are susceptible to vitamin B<sub>12</sub> deficiency. Yeast extracts and oriental-style fermented food-stuffs provide this vitamin. Intake of calcium, iron, and zinc also tends to be low. A fruitarian diet, which consists solely of fruit, is deficient in protein, salt, and many micronutrients and is not recommended.

**“Fad” Diets.** Many commercial diets are claimed to enhance well-being or reduce weight. A physician should be alert to early evidence of nutrient deficiency or toxicity in patients adhering to them. Such diets have resulted in frank vitamin, mineral, and protein deficiency states and cardiac, renal, and metabolic disorders as well as some deaths. Very low calorie diets (more than 400 kcal/day) cannot sustain health for long. Some trace mineral supplements have induced toxicity.

**Alcohol or Drug Dependency.** Patients with alcohol or drug problems are notoriously unreliable when questioned about their eating habits, so making judicious inquiries of relatives or acquaintances may be necessary. Addiction leads to a disturbance of lifestyle in which adequate nourishment is neglected. Absorption and metabolism of nutrients are also impaired. High levels of alcohol are poisonous and can cause tissue injury, particularly of the GI tract, liver, pancreas, brain, and peripheral nervous system. Beer drinkers who continue to consume food may gain weight, but alcoholics who consume more than 300 ml of hard liquor per day lose weight and become undernourished. Drug addicts

are usually emaciated. Alcoholism is the most common cause of thiamine deficiency in the developed country and may lead to deficiencies of magnesium, zinc, and other vitamins.

**Protein-Energy Malnutrition (PEM).** Meeting energy requirements is basic to survival, and the way in which this is accomplished from protein or non-protein sources determines the type of severe PEM produced. A diet with excessive non-protein calories from starch or sugar, but deficient in total protein and essential amino acids, results eventually in kwashiorkor. Severe discrepancy of energy and nutrients causes total inanition, which in the young child is called marasmus. Intermediate forms are termed marasmic-kwashiorkor.

Marasmus is the predominant form of PEM throughout most developing countries. It is associated with the early abandonment or failure of breastfeeding and with consequent infections, most notably those causing infantile gastroenteritis. Kwashiorkor is less common and is usually manifested as the intermediate marasmic-kwashiorkor state. It tends to be confined to those parts of the world (rural Africa, the Caribbean and Pacific islands) where staple and weaning food-stuffs such as yam, cassava, sweet potato, or green banana are protein deficient and excessively starchy.

In marasmus, energy intake is insufficient to match requirements and the body draws on its own stores. In kwashiorkor, increased carbohydrate intake with decreased protein intake leads to decreased visceral protein synthesis. The resulting hypoalbuminemia causes dependent edema; and the impaired  $\beta$ -lipoprotein synthesis produces fatty liver.

Marasmic infants show hunger, gross weight loss, growth retardation and wasting of subcutaneous fat and muscle. Kwashiorkor is characterized by generalized edema, “flaky paint” dermatosis, thinning and discoloration of the hair, enlarged fatty liver, and petulant apathy in addition to retarded growth. In developing countries, severely malnourished children may also be HIV positive. Differential diagnosis includes secondary growth failure due to malabsorption, congenital defects, or deprivation. Skin changes in kwashiorkor differ from those of pellagra where they occur on parts exposed to light and are symmetrical. Edema in nephritis, nephrosis and cardiac failure is accompanied by features of these diseases. Hepatomegaly from disorders of glycogen metabolism and cystic fibrosis must be differentiated. Mortality varies between 15 and 40%. Death in the first days of treatment is usually due to electrolyte imbalance, infection, hypothermia, or heart failure. Long-term effects of malnutrition in childhood are not fully understood. In the adequately treated case the liver probably recovers fully without subsequent cirrhosis. Humoral immunity is usually unimpaired. Cell-mediated immunocompetence is markedly compromised in the acute phase but is

restored with recovery. Behavioral development may be markedly retarded in the severely malnourished child. The degree of mental impairment is related to the duration of malnutrition and age of onset. The infant with marasmus is affected most severely than the other child with kwashiorkor. Prospective studies suggest that a relatively mild degree of mental retardation persists into school age.

Starvation is the most severe form of malnutrition. It may result from fasting, famine, anorexia nervosa, catastrophic disease of the GI tract, stroke, or coma. The basic metabolic response to starvation is conservation of energy and body tissues. However, the body will mobilize its own tissues as a source of energy, which results in the destruction of visceral organs and muscle and in extreme shrinkage of adipose tissue. Total starvation is fatal in 8 to 12 weeks.

In adult volunteers who fasted for 30 to 40 days, weight loss was marked (25% of initial weight), metabolic rate decreased, and the rate and amount of tissue protein breakdown decreased by about 30%. In more prolonged starvation, weight loss may reach 50% in adults and possibly more in children. Loss of organ weight is greatest in the liver and intestine, moderate in the heart and kidneys, and least in the nervous system. Emaciation is most obvious in areas where prominent fat depots normally exist. Muscle mass shrinks and bones protrude. The skin becomes thin, dry, inelastic, pale, and cold. The hair is dry and sparse and falls out easily. Most body systems are affected. Achlorhydria and diarrhea are common. Heart size and cardiac output are reduced; the pulse slows and blood pressure falls. Respiratory rate and vital capacity decrease. The main endocrine disturbance is gonadal atrophy with loss of libido in men and women and amenorrhea in women. Intellect remains clear, but apathy and irritability are common. The patient feels weak. Work capacity is diminished because of muscle destruction and, eventually, is worsened by cardiorespiratory failure. The anemia is usually mild, normochromic, and normocytic. Reduction in body temperature frequently contributes to death. In famine edema, serum proteins are usually normal, but loss of fat and muscle results in increased extracellular water, low tissue tension, and inelastic skin. Cell-mediated immunity is compromised, and wound healing is impaired.

## HYGIENIC CHARACTERISTICS OF ANIMAL FOOD PRODUCTS

### MEAT AND FISH PRODUCTS

**Meat** is an important source of biologically valuable proteins in human nutrition. Chemical composition, organoleptic properties and food value of

meat moderately vary depending upon the type of animals, their age and character of their fodder, as well as on the part of carcass.

Quantity of proteins in meat is 13-18%, and quantity of fat fluctuates depending upon the feed of the animal, for example from 3 to 23% in beef and up to 37% in pork. Carbohydrates (glycogen) in meat are less than 1%. Phosphor, sulphur, potassium, sodium and iron (3 mg per 100 gm) are sufficiently more, as well as small quantity of vitamins of B group. Nitrogenous extract substances give meat especial aroma and taste, exciting secretion of digestive glands. Meat food increases excitation of the brain cortex, stimulates working capacity.

However meat products may be the cause of food intoxication, few infectious diseases and helminthoses. Protection of consumers health from these diseases is provided by veterinary and sanitary inspection at all steps of movement of meat from slaughter to realization by consumers.

Possibility of meat use of those animals, sick with brucellosis, foot and mouth disease, erysipelas, enteritis, septicemia, as well as of those animals which are subjected to slaughter is solved by veterinary-sanitary service, and such meat is considered as conditionally edible and is subjected to disinfection at the place of slaughter.

Goats most often fell sick with brucellosis. However in some regions of Argentina 75 to 100% of cows fell sick with brucellosis. Often cows and pigs, rarely sheep are sick with tuberculosis.

Meat and organs of the cattle sick with anthrax plaque are not permitted for consumption.

In anthrax cases the carcass is burned and subjected to burial into ground at the depth no less than 2 m. At the slaughter house, walls, floor and other objects are disinfected with 4% solution of formaldehyde or 5% solution of carbolic acids.

After wards slaughter veterinary inspection of carcass and investigation of internal organs is compulsorily conducted with the purpose of revealing diseases, difficult to diagnose while alive: tuberculosis, measles, trichinosis and others. On observation of single finna in the meat of pigs, it is considered to be conditionally edible and is subjected to realization only after disinfection at the slaughter house by boiling or freezing it up to -12°C with further keeping at this temperature for a period of 10 days. In high contamination with finna (more than 3 finna in the area of 40 cm<sup>2</sup>) meat is subjected for technical utilisation. In case of detection of at least one trichina meat is considered as non-edible.

The liver of the cattle or of sheep may be affected by *Fasciola hepatica*. In such cases the liver is rejected as defective, and meat is considered to be conditionally edible.

If the animal is thin and the tissues are edematous, the whole carcase is rejected as defective. Analogically organs affected with *Echinococci* should

be burned or buried. Conditionally edible meat is disinfected at the place of slaughter by boiling of small pieces (no more than 8 cm) for a period of 25 h.

In solution of mankind provision problem of mostly developing countries with biologically valuable proteins, the world ocean is among the first to be used. Already in 1980s nearly half of the indicated countries utilized hydrobiontes of the ocean.

Flesh of **fish** depending upon chemical composition and food value is similar to the meat of animals. There are 8–25% of protein and what's more they are biologically well-balanced, rich with essential amino acids. Content of fats fluctuates from 0.1 to 29% and more. Fat is of semiliquid consistency and contains large quantities of mono- and polyunsaturated fatty acids, which are easily oxidized by air oxygen, giving the product with unpleasant smell and taste during long preservation. Quantity of thiamin and riboflavin is 0.0005–0.001 g/kg and niacine — 0.001–0.05 g/kg. There are retinol and calcipherol present in fatty fish. Particularly the liver of sea fish is rich in them. Meat of the latter is richer than beef in mineral substances and microelements, particularly in iodine. In 100 gm of sea fish, shellfish, crayfish 30 to 300 mg of iodine is present, and in seaweed — up to 1,000 mg and more. Inclusion of sea food in the diet enriches nutrition in microelements up to physiological optimum.

Fish is rich in extractive substances, easily changing into broth. Therefore fish broth, more than meat, excites secretion of the digestive glands. Fish broth is useful in conditions of hot climate, and as an element of prophylactic nutrition.

In the flesh of fish connective tissue is up to 5 times less than in beef, due to this fish boils sooner and the nutrients contained in it are absorbed by 95–97% and more. Due to unique food properties of fish it is widely used in clinical dietology.

In nutrition shellfish (mussels, oysters, squid, octopuses, etc.) are used. In shellfish there are 10–17% of biologically valuable proteins, 0.6–1.6% of fats, 1.5–4% of glycogen. Mollusks are the sources of mineral substances, biomicroelements, vitamins of B group. Edible tissues of mussels and oysters are boiled, salted, dried, frizzed, processed into different tinned food.

Oysters are widely consumed in raw (unconditionally fresh). Mollusks are eaten in raw, boiled, salted, dried, marinated, baked and fried form.

High food properties are characteristic of crabs and shrimps. Many dishes, prepared from crayfish and shrimps, possess excellent delicacy properties.

In the last years great attention is given to the source of biologically valuable proteins — antarctic crayfish (krill) about 30–50 tons of it are fished every year. Edible tissues of this crayfish contains 15–19% of proteins and 2–10% of fats, rich in PUFA (polyunsaturated fatty acids) and fat soluble vitamins. They are exclusively rich in biomicroelements and vitamins of B group. They use krill to produce proteinous iso-

late using to enrich the sausages, bread and other products. Krill protein paste, minced meat, meat of krill and others are manufactured. Inclusion of shrimp paste or minced meat from krill in the diet stimulates hemopoiesis and increases adaptive possibilities and resistance of the organism to toxic, cancerogenic agents and ionising radiation. Products from krill are rich in fluorine and therefore their inclusion in ration stimulates osteogenesis and mineralization of the bones, which may be used in prophylaxis and treatment of senile osteoporosis, fractures and teeth decay.

Fish and other hydrobiontes belong to easily spoilable products. They spoil faster than meat. Therefore fish should be freezed soon after fishing.

Fish and other hydrobiontes may be the cause of food intoxication, as well as mechanism of transfer of infectious diseases (typhus, paratyphus, dysentery, cholera, infectious hepatitis and others) as well as of helminthoses (diphyllobotheuriosis), opisthorchiasis, clonorchiasis, paragonimiasis and others.

Diphyllobotheuriosis develops after consumption of insufficiently boiled, fried or raw fish, infected with larvae of broad tapeworm, — by plerocercoids with length of 10 mm and width of 2–3 mm. Tape worm mature in the human intestines, its length reaches several meters. Segments of the tapeworm filled with eggs burst out and are brought out into external environment by fecal matter. Further eggs may get into the organism of intermediate host (cyclope, fish) and they develop up to the invasive stage. Disease of human often leads to pernicious anemia as a result of disorder of endogenic synthesis of cyanocobalamine.

Taking into account, that larva dies at the temperature of 50–55°C within 5 min, consumption of well boiled or fried fish totally prevents development of this disease, as well as of other helminthoses.

Opisthorchis felineus — biohelminth, basic host of which is a human, a cat, a dog, a pig and other animals, the first intermediate host — fresh water mollusk and the second — carp fishes. In hydrodermic cellulose and spine muscles of infected fish they found metacercaria — insisted larva of oval form with the length up to 0.3 mm developed. The human is infected during consumption of poorly boiled or fried, as well as of less salted jerk or raw fish. Larvae of helminth enter the liver, pancreas, causing serious damage. For the prophylaxis fish should be fried in small pieces during no less than 15–20 min, boiled during 15–20 min from the moment of boiling, with salt using no less than 14% of the fish mass, after that the latter is kept at the temperature of 16–20°C for 2 weeks.

Measures of social prophylaxis of helminthosis transferred through fish and water is protection of reservoirs from contamination by fecal matters, prohibition of letting non-disinfected waters (Table 28).

**Eggs** are good food products containing biologically valuable proteins (12.5%), fats (12%), vitamins (thiamin, retinol, nicotinic acid, calcipherol, toco-

Table 28. Meat- and Fishborne Diseases

Disease	Pathogenic organism	Meat product
anthrax	<i>Bacillus anthracis</i>	mutton, horseflesh, beef, veal, goat's flesh, pork, etc.
brucellosis*	<i>Brucella abortus</i> , etc.	mutton, goat's flesh
Q fever*	<i>Rickettsia burneti</i>	beef, veal, etc.
tuberculosis	<i>Mycobacterium bovis</i>	liver, lungs, spleen and other sub-products from ill cows
trichinosis	<i>Trichinella spiralis</i>	pork, bear's flesh, walrus flesh
taeniosis	<i>Taenia solium</i>	pork
taeniarinchosis	<i>Taeniarinchus saginatus</i>	beef, veal
diphylbotriosis	<i>Diphylbotrium latum</i>	fish (perch, pike, ruff, burbot, salmon, smelt fish, etc.)
opisthorchosis	<i>Opisthorchis felineus</i>	fish (carp, tench, bream, red-finned fish, roach, etc.)
clonorchosis	<i>Clonorchis sinensis</i>	fish (Cyprinidae)
opicthorchosis viverrae	<i>Opicthorchis viverrae</i>	fish (Cyprinidae)
metagonimosis	<i>Metagonimus yokogawai</i>	fresh-water fish
heterophyosis	<i>Heterophyes heterophyes</i>	gray mullet and other fish
nanophyetosis	<i>Nanophyetes schikhobalowi</i>	fresh-water fish
paragonimosis	<i>Paragonimus westermani</i>	crabs, crayfish
echinostomoses	<i>Echinostoma Rudolphi</i>	shellfish
echinichamosis	<i>Echinichamus perfoliatus</i>	fresh-water fish
sparganosis	<i>Diphyllobothrium erinacei europeii</i>	snakes, frogs

\* — the abattoir workers are at risk of these diseases (cutting of raw meat is risky).

pherol, riboflavin) and are rich in phosphorus. Eggs spoil as a result of drying and growing mouldy and due to damage by putrefactive microorganisms, which enter through the shell.

Salmonella already in the womb may infect eggs of ducks and goose. Therefore their sale to the population in commercial network is prohibited; they may be used only in food industries for preparation bread products during conditions of good baking. With the purpose of prevention of food intoxication, consumption of such eggs defective in incubator is prohibited.

For disinfection of eggs which may be infected by salmonella they are immersed into 5% solution of lime chloride for 5–10 min.

## DAIRY PRODUCTS

**Milk** contain all necessary food substances for the growing organism, present in soluble or slightly dispersed state, as a result of which it is easily digested and well absorbed (95–98%). Milk and milk products are irreplaceable in child nutrition, in patient and elderly people nutrition.

The most widespread in the world is cow's milk. It contains about 3.2% of biologically valuable proteins (2.7% of casein and 0.5% of albumin), from 3 to 5% of fat and from 4 to 5% (on average 4.8%) of carbohydrates — lactose.

Lipids determine value of milk fat and soluble retinol and calciferol, contents of which is more in summer and autumn.

Milk contains all necessary mineral salts, but particularly rich in absorbable calcium (1.2 g/kg). Out of water-soluble vitamins riboflavin, pyridoxine and pantothenic acid are the most common.

Milk causes weak secretion of gastric glands and therefore it is recommended to patients with peptic ulcer and hyperacid gastritis. Lactose promotes formation of normal intestinal microflora with prevalence of bifidobacteria preventing putrefaction.

Sodium chloride is very less in milk and therefore it is recommended to patients, suffering from nephritis and edema. Considering absence of nucleonic compounds in it, milk is indicated to those with disorders of purine metabolism.

Many components of milk (methionine, choline, tocopherol, vitamins of B group) are decreasing quantity of cholesterol in blood.

Milk is an ideal medium for multiplication of microorganisms. Development of streptococci and lactobacilli, decomposing lactose with formation of lactic acid, leads to sowing of milk.

In spreading of pathogenic microflora milk may be a cause of infectious diseases: intestinal infections, polio, diphtheria, scarlet fever, viral hepatitis. Milk and milk products occupy an important place

among the causes of spreading of brucellosis, which not infrequently takes place in hot countries, particularly the countries, where sheep milk is widely consumed. Milk and milk products may be the source of tuberculous infection.

To provide the epidemiological safety of milk, decrease bacterial growth and increase its quantity it is necessary to conduct the following steps:

1. Strict veterinary control for sanitary conditions, health of animals.

2. Prevention of contamination of milk during milking, preservation, transportation, cooking etc (cleanliness of the udder and skin of animals, hands and clothes of personel, mechanised milking, filtration of milk through a cloth, observation of health and personal hygiene of milkers and other working people in contact with milk);

3. Cooling of milk up to the temperature less than 8°C and its fast delivery to consumers.

4. Consumption of disinfected milk in food.

Pesticides, antibiotics, aflatoxins and other toxicants may get into the organism of lactating animals through milk along with food, feed supplements, stimulators of growth as well as during condition of prophylactic and therapeutic measures.

Since milk is a basic product of child nutrition, it should not contain any toxic admixtures and this is a very important element of sanitary-hygienic control.

If milk is obtained from healthy cows with keeping all hygienic rules, it is safe from the epidemic point. But if there are any doubt, disinfection of milk should be conducted by 4 methods: boiling, pasteurisation, complete sterilization or drying.

During boiling pathogenic microorganisms and part of lactobacilli microflora die but at the same time milk properties become worse; part of albumin and potassium salts falls down into sediments, vitamins and ferments are destroyed, disperseness of fat decreases, taste worsens. So to minimize the indicated changes boiling of milk is substituted by pasteurisation.

Dry milk (or milk powder) — wide spread product of processing of milk. Food value of dry milk is less than of the whole milk, but it's widely used in nutrition. Food and biological properties of dry milk depend upon the method of its preparation — film or pulverization. During the film method of drying milk comes in contact with hot (90–120°C) metallic surface of shaft dryers for a short duration (less than a minute). Formed film of milk with thickness of 0.14–0.2 mm is extracted automatically by special knife. However, this method essentially changes a composite part of milk particularly proteins, worsens biological properties and solubility of obtained product. Undoubted fully milk has advantages, which is received by pulverization method. Drying is conducted by hot air (145–160°C) in special tanks by scattering of milk in fine particles. During

this composite parts of milk in chemical relation nearly doesn't change and solubility reaches 98%. Content of moisture in dry milk in hermetic package should not exceed 4%, in non-hermetic — 7%. The total content of microorganisms in dry milk of high quality should not exceed 50,000, in dry milk of the I sort — 70,000, in dry milk for children — 25,000–30,000 in 1g of milk. The period of preservation of dry milk is 8 months in a hermetic package and 3 months in a non-hermetic one.

Tinned condensed milk capable of being preserved for a long period. To them we refer condensed and sterilized milk, cocoa and coffee with condensed milk and others. Condensed milk with sugar contains water no more than 16.5%, sugar — no less than 43.5%, fat — 8.5%. Acidity is no more than 48°C (Fig. 29).

The best and most used method of making milk safe is pasteurization. They use also sterilization. Several pasteurization techniques are used with different combinations of time and temperature to kill pathogens without altering the flavor or consistency of the milk. The pasteurization temperature for homogenized, pasteurized milk is usually 72–75°C. In Ukraine the following regime is the most suitable for pasteurisation: heating of milk at the temperature of 63–65°C for a period of 30 minutes. Last years new method of complete sterilization of milk, called uperisation is used: through milk vapors are inflated until temperature does not rise up to 150°C. Such milk maintains natural properties, as after pasteurization and if it is powdered into sterile packets, may be preserved up to 30 days. The pasteurization process may vary from one country to another according to national regulations.

Pasteurization is often combined with other processes such as homogenization to improve the appearance and ostensibly the flavor of milk. Other ways to safe-guard milk products include freeze-drying and condensing. Sweetened condensed milk like other sweet preparations relies on the high sugar concentration to kill pathogens.

Dry milk (milk powder) is a valuable product, obtained by drying of spilt whole-pasteurized milk in vacuum chambers. Solution of dried milk in the corresponding quantity of boiled water is called reduced milk. The latter may replace natural milk even in nutrition of children. Dry milk is often used in many tropical countries, in particular for realization of programs of provision of children with milk and milk products.

### **Sour Milk Products**

Sour milk products contain large quantity of live bacteria of homogenous composition (lactobacilli), which are capable of suppressing growth of other types of microorganisms including pus forming. With the help of sour milk drinks one can limit or even fatally stop formation of harmful substances



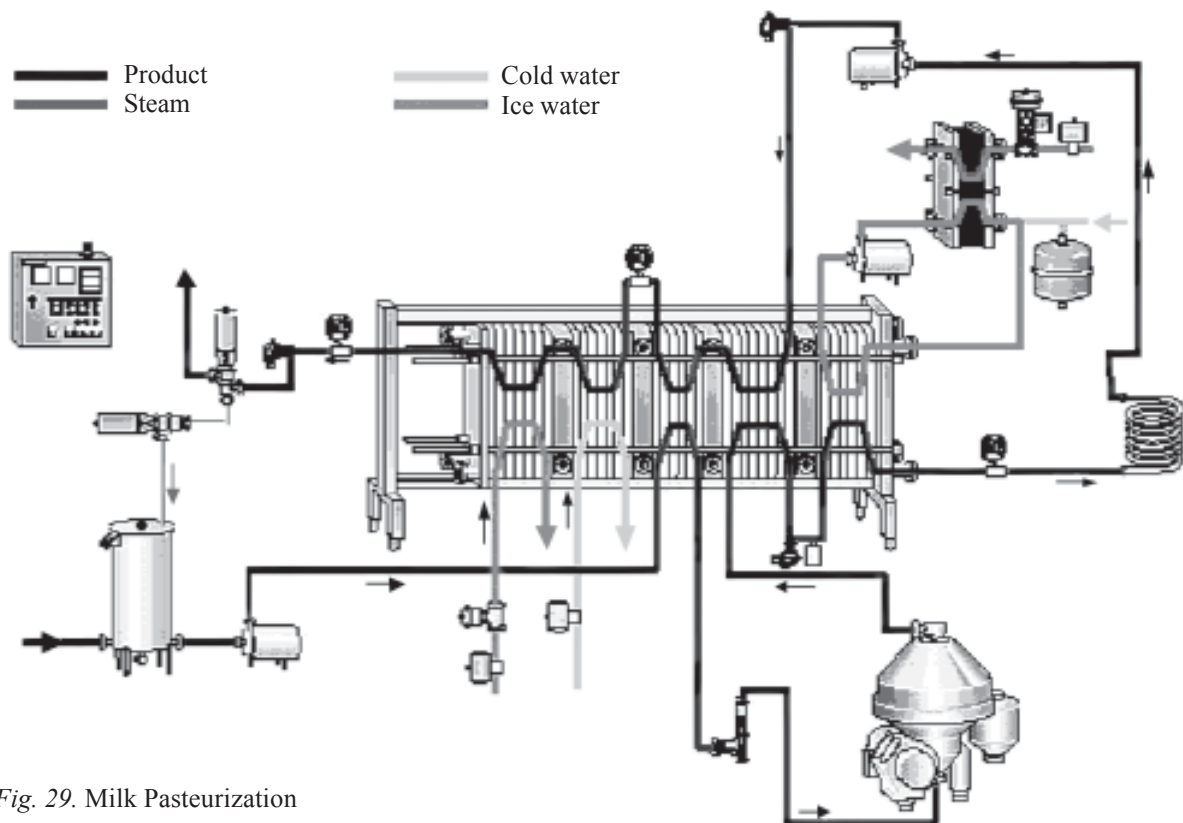


Fig. 29. Milk Pasteurization

in intestine formed by pus forming microbes, as this follows from works of I. I. Mechnikov, which may participate in forming atherosclerosis and shorten the life. Definite types of lactobacilli (acidophilic coli, lactic acid streptococcus and others) form antibiotic substances in sour milk drinks, which are of bacteriostatic and bactericide activity. For example acidophilic bacteria produce thermostable antibiotics: nysin, lactolin, lactomin, streptocin and others, displaying their activity primarily in acidic medium. Therefore use of sour milk acidophilic products in some diseases of the intestinal tract in moderate degree improves microflora of the intestine, which is mainly related with suppression of pus forming and pathogenic microorganism.

Lactobacilli are producers of vitamins of group B. By way of selection of highly active cultures one may obtain sour milk products with high content of vitamins. Sour milk products possess different biological and therapeutic properties. Therapeutic action of sour milk products (drinks) is widely used in many diseases of the digestive system. They improve gastric secretion, normalise peristalsis of the intestine, intestinal microflora, decrease gas formation.

Sour milk products are divided into products of lactic acid and mixed fermentation.

Products of lactic acid fermentation. The available sour milk products in Ukrainian market are usually prepared from pasteurized milk with the use of pure culture of lactic acid streptococci. The Mechnikov's milk products are prepared from pasteurized milk. Ryazhenka (Ukrainian sour milk) is a mixture

of baked milk and cream (8%) mixed with pure culture of lactic acid streptococci.

A special group of sour milk is formed by its mixture — iogurts and others, prepared from pasteurized milk by introducing combined ferment, including pure culture of lactic acid streptococci, lactobacilli with or without addition of yeast. The newest medical dietetic sour milk products at NIS markets are biokefir, bifidoc and others.

A transitive type of product between the indicated ones of lactic acid fermentation and acidophilic product is acidophilic sour milk, which represents itself pasteurized milk mixed with pure cultures of lactic acid of streptococci and acidophilic coli.

Qualitative index of sour milk: content of fat 3.2%, (in ryazhenka 6% and 8%), acidity no more than 100°T (for iogurts — no more than 140°T), titre of *Escherichia coli* not below 0.3 ml.

Acidophilic products are prepared from pasteurized milk with the use of pure cultures of acidophilic coli. To therapeutic products of this group we refer acidophilic milk, acidophilic paste and acidophilic-fermented milk. On these yeast there are prepared therapeutic sour milk used for treatment of the intestine and few other diseases.

Acidophilic milk possesses remarkable antibiotic properties. It is prepared on pure culture of acidophilic coli. Two varieties of culture of acidophilic coli are used: mucous, causing mucous consistency and not high acidity of a product (140°C) and non-mucous, put causing high acidity (300°C). One can obtain product of sour cream consistency by using

yeast, made up of 80% of non-mucous and 20% of mucous culture.

Acidophilic milk is indicated for treatment of child diarrhea and colitis in adults, dysentery and other diseases.

**Acidophilic Paste.** It is prepared of acidophilic milk by pressing and extracting serum. It's acidity is located between 180–220°C. Antibiotic activity of paste enables to decrease intensity of decaying processes in the intestine during constipation and meteorism. Besides, paste is indicated in treatment of achilic gastritis, ulcerative colitis, rectosigmoiditis and others.

High antibiotic (therapeutic) properties differentiate acidophilic-fermented products. Concentration of antibiotic substances in them is moderately high due to biosynthesis not only by acidophilic coli, but also by yeast. Acidophilic-fermented milk proposed by A. M. Skorodymova is used during treatment of tuberculosis, intestinal diseases and furunculosis.

**Sour Cream.** It's prepared of pasteurized cream by addition of special ferments from mixed culture of lactobacilli. Content of fat of high quality is 36%, acidity — 65–90°T, in sour cream of the I sort — 30% and 65–110°T, in sour cream of the II sort — 25% and 65–125°T.

**Curds (cottage cheese).** It is prepared of pasteurized milk by mixing it with pure culture of lactic acid streptococci with further processing of clot for extraction of serum. Curds of 20% and 9% of fatness, and fatless with acidity of 200–225°T, 210–240°T and 220–270°T correspondingly are available at the market.

In curd basic components of milk — protein and calcium — are represented in moderately high quantities. Fatty curds and hard cheeses are peculiar concentrates of milk. They are prepared by curdling of preliminary pasteurized milk. Fatty curds contain up to 14% of casein and 18% of milk fats. Fatty curds are prepared of fattiest milk. Low fat curd contains up to 18% of casein and only 0.5% of fat. Large quantity of methionine is present in casein of curds out of which choline is synthesized, which prevents adipose infiltration of the liver. Curd is rich in calcium (up to 150 mg per 100 g). Therefore it is very important to include these products in the diet of patients with liver pathology, elderly patients, pregnant women, lactating mothers and children.

Therefore curds are considered as natural milk concentrate, possessing high biological value. It is enough of 200–300 g of this product so as to provide daily need of the organism in irreplaceable amino acids and calcium. Particularly curds, rich with labile methyl groups, which are easily used in the organism for synthesis of choline are of great importance. They avoid adipose infiltration of bile.

Curd promotes excretion of cholesterol from the organism, hence it may be considered as therapeutic remedy in atherosclerosis. It also possesses di-

uretic action and is recommended in diets during disturbed nitrogen excretory function of kidneys, decompensated diseases of heart, hypertonic disease otic desiasse.

**Kefir** is prepared of pasteurized whole milk or fatless natural or reduced cow's milk with the use of yeast, prepared on kefir fungi or on pure cultures of specially selected microorganisms, causing lactic acid and alcoholic fermentation.

Fatty kefir from whole milk and fatless kefir are differentiated, and depend upon the period of maturation — weak (one day), medium (two days) and strong (three days). In fatty kefir content of fat should not exceed 90°T, and content of alcohol — 0.2%, in medium kefir — 105°T and 0.4%, in strong — 120°T and 0.6% accordingly.

Kefir is widely used in daily and therapeutical nourishment. It renders favorable influence on digestion, stimulates motor function of the intestine (light kefir), decreases intensity of decaying processes in the intestine, increases diuresis.

**Koumiss** is widely used in Bashkiria, Buryatia, Yakytia and Tataria (Russia), as well as in Kyrgystan and Kazakhstan. Koumiss is prepared of primarily pasteurized milk of mare or cow by way of mixing it with pure culture of lactobacilli (Bulgarian coli and others) and lactic yeast. Koumiss from mare's milk is considered to be better, chemical content of which favors in moderate degree those processes necessary for obtaining this excellent product.

Depending upon degree of maturation (ripening) koumiss, like kefir is divided into light, medium and strong. Content of fat in all categories of product composes no less than 0.8%. In weak koumiss alcohol is no more than 1%, acidity — 60–80°T, in medium — accordingly 1.75% and 81–105°T, in strong 2.5 and 106–120°T. As for content of carbon dioxide koumiss is very good aerated drink.

Koumiss renders general (overall) strengthening action, improves process of digestion and absorption of food substances, stimulates oxidative-reduction processes in the organism. It is successfully used since many years during treatment of pulmonary tuberculosis, indicated during chronic bronchitis, enterocolitis, anacidic gastritis and other diseases.

**Cheeses.** Basic substances of milk, highly valued proteins, fats, calcium and phosphor are represented in a higher degree in cheeses rather than in curds. Therefore these products can be considered as highly valuable milk concentrates.

Depending upon the method of preparation they are divided into chimosinic and lactic acidic. Original raw product for them is pasteurized milk.

Rennet cheeses are prepared by method of coagulation of milk with digestive ferment (chimosine or pepsin) with further processing of clot. Processing consists in splitting of proteins under influence of chimosine (or pepsin) into albumoses and peptones which further are splitted by ferments, excret-

ed by specific microorganisms (lactobacilli and others) up to aminoacids, which in its turn are subjected to splitting. Characteristic peculiarity of such splitting in cheeses is absence of formation of any harmful combinations during this (indole, scatole and others), which is characteristic of splitting of proteins during their decaying. Indicated splitting of proteins positively acts on their absorption by the organism and their use for tissue synthesis. The major role during preparation of cheeses belongs to biochemical transformation of lactose in lactic acid.

Cheeses differ by high content of protein (20–25%), fat (25–30%) and what is also important — calcium and phosphor. Looking upon contents and on level of balance of irreplaceable aminoacids cheeses are considered to be excellent products of nourishment. Methionine is 2 times, triptofan 3–4 times more in cheeses than in meat. Cheeses differ by exclusively high content of absorbtive calcium (up to 100 mg in 100 g of product, which 100 times more than in meat and 8 times more than in curds). Content of phosphorus in cheeses 500 mg or 100 g of product. Moreover calcium and phosphor in cheeses are present in condition of optimal balance (1:0.5), which provides high absorption of both macroelements. Therefore cheeses provide reliable possibility to fulfill demands of the organism in calcium and phosphor in any age groups of population. For this daily intake of 80–100 g of this product is enough. Although the value of lactic acid bacteria (LAB) in food fermentations has been recognised for centuries, development of the probiotic idea is attributed to I. I. Mechnikov, who observed that the consumption of fermented milk could reverse putrefactive effects of the gut microflora (Mechnikov, 1907). From these beginnings the probiotic concept has progressed considerably and now is the focus of great research attention worldwide. Significant advances have been made in the selection and characterisation of specific cultures and substantiation of health claims relating to their consumption. Consequently, the area of probiotics has advanced from anecdotal reports, with scientific evidence now accumulating to back up nutritional and therapeutic properties of certain strains.

Probiotics are microbial cell preparations or components of microbial cells that have a beneficial effect on health and well being of the host. The health effects attributed to probiotic consumption which have been best substantiated with scientific evidence include alleviation of lactose maldigestion, cancer prevention, prevention/treatment of infections, serum cholesterol reduction and modulation of the immune system. While the exact mechanism by which probiotics exert specific health effects is not completely understood, given the range of health benefits attributed to probiotic consumption, it is unlikely that each strain will act in the same way. In general, health effects are related to intestinal

microflora modification and strengthening of the gut mucosal barrier.

Food-stuffs containing probiotic bacteria fall within the functional food-stuffs category and increased commercial interest in exploiting the proposed health attributes of probiotics has contributed in a significant way to the rapid growth and expansion of this sector of the market. In addition to probiotics some dairy yogurts now also contain prebiotics which are non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improve host health. Many dairy products containing pro- and prebiotics with associated health claims have been launched onto the market and in some countries these are an established market segment. The trend is towards exploitation of the synergistic effect of combining probiotics with prebiotics, while some of the earlier products contained probiotic cultures alone.

Recently it was shown that milk protein and milk fat also contain bioactive components that can exert specific physiological effects. These effects include aiding calcium absorption (caseinophosphopeptides), prevention of hypertension (ACE-inhibitory peptides) and anticarcinogenicity (CLA, Butyric acid, Vitamin A, D,  $\beta$ -carotene).

#### **Milk of Other Animals**

Besides cow's milk, milk of other animals is also used in different countries.

Goat's milk according to its composition is nearly the same as cow's milk, but its biological value is even higher, as it contains more high-dispersed protein and during condensation in the stomach more soft clots are formed. It is held in the stomach of a child of breast age for a period which is 2 times less than that one for cow's milk. Goat's milk contains albumins and methionine more than in cow's milk and by this index surpasses even breast milk. Size of fat drops in goat's milk is moderately less than in cow's milk, that's why lipids in the intestine are easily emulgated and absorbed better.

The amount of mineral salts and vitamins in goat's milk is also a little higher. All these facts explain why during some diseases (hypotrophy, anemia, tuberculosis, infections, hepatitis) pediatricians observe better effect in treatment of children who receive goat's milk.

Sheep's milk contains nearly 1.5 times more proteins, fats, many vitamins and mineral substances, than the cow's milk, its food value is higher. It should be noted that sheep more often, than other animals get sick with brucellosis, but rarely with tuberculosis. Therefore this milk should be compulsorily boiled, and curds and brynza (sheep's milk cheese) — should be held for no less than 2 months after their preparation.

In countries of the Middle East and many other hot countries population often consumes goat's and

sheep's milk. In some regions with hot and dry climate where cows are poorly acclimatized, basic milk animal is buffalo (Indonesia, Egypt, India and others). Milk of buffalo is richer in fats, proteins, calcium and water-soluble vitamins than the cow's milk. High fatness of milk defines its high energy value. Consumption of the whole milk buffalo may cause diarrhea. Therefore in some countries (for example, in India) its mixing with fatty or whole cow's milk is practiced.

Milk of camels by its composition and energetic value is similar to cow's milk, but it is richer in ascorbic acid (up to 25 mg per 100 g). In deserts and semideserts camels are not infrequently the single source of milk. It is consumed in free form or in a form of refreshing sour milk drink — shubat. From shubat a peculiar milk cheese — kurt is made, which can be preserved for a long time in desert conditions, which is a good source of proteins, fats, carbohydrates and other nutrients.

### The Role of Milk in Infants Feeding

The best food for infants is breast milk, which is evolutionary adapted towards particularities of digestion and metabolism at this age. This concerns composition of nutrients and the form, in which they are in the milk, as well as presence of substances promoting digestion (ferments, phospholipids and others) in the breast milk. Besides, breast milk is not subjected to thermal treatment and consequently to denaturation. Breast milk contains many components of defensive importance: lactoferin, antibodies, phagocytes, and macrophages. Observations conducted in India, China and other countries have shown that in children fed with breast milk in comparison with those fed with formula, disorders of growth, obesity, respiratory infections, otitis, diarrhea, septicemia occur rarely.

Infant formulas initially were based on cow's milk composition, but have evolved somewhat to reflect human milk composition. This is still an area of concern. Infant formulas generally are made from cow's milk or soybean ingredients. The casein protein ratio for cow's milk is 80:20 compared to human milk with 40:60 ratio. Human milk does not form a hard clot in the stomach of the infant as cow's milk does. The presence of  $\beta$ -lactoglobulin (not present in human milk) or soy proteins in formulas can lead to a dietary protein allergy (Table 29).

Human milk has a very high lactose content, 7 g per deciliter or about 200 mM and lactose provides about 40% of the calories available to the infant. The adaptive significance of this high lactose content (the highest of any species currently known) is probably two-fold:

1) The infant brain is large and requires glucose as a metabolic substrate; lactose is broken down into glucose and galactose prior to intestinal absorption.

Table 29. **Macronutrient Composition of Human Milk and Cow's Milk**

Component	Human Milk	Cow's Milk
Carbohydrates, g/dl		
Lactose	7.3	4.0
Oligosaccharides	1.2	0.1
Proteins, g/dl		
Caseins	0.2	2.7
Lactalbumin	0.2	0.1
Lactoferrin	0.2	Trace
Secretory IgA	0.2	0.003
$\beta$ -Lactoglobulin	None	0.36
Milk Lipids, %		
Triglycerides	4.0	3.2
Phospholipids	0.04	0.04
Minerals, mM		
Sodium	5.0	15
Potassium	15.0	45
Chloride	15.0	35
Calcium	8.0	30
Magnesium	1.4	4.0

2) From an osmotic standpoint, the secretion of lactose obligates the concomitant secretion of a large amount of water. This water is sufficient to meet the infant's needs for sweating and evaporational water loss, high in a warm climate, as well as for urine formation.

Because lactose can be synthesized only from glucose, maternal glucose utilization is increased by about 30% in the fully lactating woman. More than 50 oligosaccharides of different structure also have been identified in human milk, these compounds comprise up to 1.2% of mature human milk (compared to about 0.1% of cow's milk). The components of these complex sugars include glucose, galactose, fucose, N-acetylglucosamine, and sialic acid and represent a significant proportion of the non-protein nitrogen found in human milk. Some of these may act as growth factors for lactobacillus which populates the gastrointestinal tract of the breast-fed infants, or as protective factors against certain bacterial toxins. However, their real function is not understood.

Human milk has a relatively low casein content as compared to other mammals, approximately 0.2 g/dl in mature milk, probably reflecting the relatively slow growth rate of the human infant. Most of the casein in human milk is bound in micellar form. The casein micelle also contains most of the calcium and phosphate. The other major milk proteins that are synthesized in the mammary gland are  $\alpha$ -lactalbumin and lactoferrin, both are present at a concentration of about 0.2 g/dl in mature human milk.  $\alpha$ -Lactalbumin

functions in the synthesis of lactose, the major carbohydrate in milk. Lactoferrin is an iron-binding protein found in high concentration in human colostrum and milk. It is considered to be a protective factor in milk because of its antibacterial properties. Only about 5–10% of its iron-binding capacity is occupied so that one mechanism of bacteriostasis is thought to be binding of iron needed by bacteria to multiply. Lactoferrin concentration in the mammary secretion is increased in colostrum, during mastitis, and following involution. The fourth major milk protein is secretory immunoglobulin A (sIgA), also present in mature milk at a concentration of about 0.2 g/dl. This protein is synthesized by cells of the immune system and transported into milk by a specific mechanism described below. It is also thought to act as a protective factor; its concentration is much higher in colostrum (up to 10 g/dl) and in post-involutional secretion than in mature milk. Other proteins in human milk include lysozyme (which has a particularly high activity in human milk), lipases, growth factors and many others.

Although the fat content is highly variable, on the average milk lipids comprise about 4% of human milk. The majority of these lipids are triglycerides. About 20% of the triglycerides are synthesized from medium chain fatty acids made in the mammary gland itself, the remaining 80% are derived from plasma. The medium chain fatty acids are unique to mammary secretions. Milk also contains phospholipids and cholesterol in much smaller, but apparently regulated quantities.

Compared to the mineral content of most kinds of milk, human milk contains very small amounts of macrominerals such as sodium (8 mM), potassium (15 mM), chloride (14 mM), calcium (7 mM) and magnesium (about 1 mM). The low concentrations of these substances reflect both the high concentration of lactose (leaving little residual osmotic activity for monovalent ions) and the low concentration of casein providing little binding activity for calcium.

Several amino acid differences exist between human and cow's milk that can present problems in feeding cow's milk-based formulas to certain infants. Human milk has a high cysteine:methionine ratio and some taurine. Cow's milk has a lower cysteine:methionine ratio and essentially no taurine. The human infant's liver and brain have only low levels of cystathionase, the enzyme that converts methionine to cysteine (the fetus and pre-term infant are completely lacking this enzyme). Cysteine is important for central nervous system development. Taurine is made from cysteine (the enzyme is cysteinesulfonic acid decarboxylase), and taurine is needed in the infant for brain development and function, retinal development and function, and conjugation of bile salts. Cow's milk-based formulas may not contain optimal levels of cysteine or taurine.

Another amino acid problem in human milk vs. cow's milk-based formulas is the concentration of phenylalanine and tyrosine. Human milk is low in Phe and Tyr (particularly milk from mothers of pre-term infants). Infants have limited ability to metabolize these amino acids, which can build up and cause Phenylalanine Ketone Urea (PKU babies).

Cow's milk has *lower lactose* than human milk. Lactose may be particularly important as a glucose (energy) source for the rapidly developing brain of the human infant. Generally, cholesterol is very low in formulas (1–3 mg/dl) compared to human milk (7–47 mg/dl) or cow's milk (10–35 mg/dl). Cholesterol is needed by the infant in challenging the development of cholesterol metabolizing enzymes and it contributes to synthesis of nerve tissue and bile salts.

The **Ca:P ratio** is 2.29 for human milk vs. 1.26 for cow's milk. Formulas low in cow's milk can cause hypocalcemia and tetany. High P in formulas may lead to hyperphosphatemia and low serum Ca. Iron is low in human and cow's milk, and most formulas are fortified with iron. Both iron and zinc are more efficiently absorbed from human milk than from cow's milk.

Most lipophilic and many hydrophilic compounds will pass into the milk of the mother. Many antibiotics, anticoagulants, antithyroid drugs, alcohol, nicotine, and caffeine will be transferred to the milk. Many lipophilic environmental contaminants which are stored in the body adipose tissue of the mother are mobilized during lactation and end up in the milk (such as pesticides, industrial contaminants like PCBs, and many known carcinogens).

All types of animal milk according to their composition differ from the breast milk. Goat's milk is the nearest to the breast milk by its composition of nutrients and biological properties.

At present formulas are widely used (in form of powder). The composition of nutrients of these mixtures is close to the composition of breast milk even in amino acidic composition of proteins. Nutrients are present in them in such forms, which can be easily absorbed. It was shown that growth of children, feeded by formula is moderately better than those, who received animal milk.

In few people diarrhea is observed after drinking milk. Their percentage raises with age. The reaction could be caused by:

- 1) low activeness of intestinal lactase ( $\beta$ -galactosidase) congenital or acquired in ontogenesis;
- 2) intolerance of lactose or the whole milk.

In literature data there is information about low activeness of intestinal lactase within big groups of population of many developing countries. In relation to this it is necessary to introduce correctives in program of provision of child population with milk and milk products, partly by substituting it for other products, containing proteins of animal origin.

## HYGIENIC CHARACTERISTICS OF VEGETABLE FOOD PRODUCTS

### GRAIN, BEAN AND OIL CULTURES

**Rice.** This plant is mainly grown in subtropical zone and other zones. Its production is 400 mln of tons per year. In many countries (Japan, India and others) rice is the main cultivating plant. Because of lack of gluten rice is used for production of cereal. For this purpose the grain is separated from external coating and embryonic membranes. In such condition food substances are well preserved. It contains up to 75% of starch, 12% of proteins, 2.5% of fats and only 0.65–0.9% of gluten. Proteins of rice are mostly biological valuable vegetable fats. It contains sufficient amount of vitamins and mineral substances. While producing of polished rice all the membranes, embryonic layer and germ are removed from the rice. That's why polished rice is by 2–4% of starch richer but there is low contents of proteins, fats, gluten, mineral substances and vitamins. Earlier such rice was the cause of development of B<sub>1</sub> avitaminosis (beri-beri disease) and B<sub>1</sub> hypovitaminosis in South-Eastern Asian and other countries in which rice was the main grain plant.

**Maize.** It is one of the ancient grain plants. It was grown in Mexico in the VI century B. C. It is one of the widely spread grain plant, annual production of which is 450 mln of tons. Maize grain is consumed cooked. The following products are made from maize: maize flour, cereal or the so called bursted grains. The germ of maize grain contains 30% of fat which is used for preparing maize oil. Endosperm contains up to 78% of starch, 7% of proteins, 1.5% of fats; it is used for preparation of flour. Flour is used for cooking jelly-like products (such as hominy), polents, bread. But bread is slightly porous and has small quantity of cellulose. Maize grains have small amount of triptofan and nicotinamide. That's why these proteins are not biologically valuable as wheat and rice proteins. Low niacin coefficient was the cause of pellagra in many countries among poor people who eat mostly maize. At present in the world there have been conducted the selection program to optimize amino acid structure of maize by the way of increasing triptofan and lysin content.

**Barley, oats** are widely spread in the world; millet and sorghum cultures — in tropic countries. Barley, oats and millet are consumed in the form of flour and cereal. Peculiarities of oats products are high amount of fat — 6% in cereal and 7% in flour. Proteins amount is 12–15%, carbohydrates — 56–65%, cellulose — 1% (flour) and 2.5% (oatmeal).

**Sorghum** and sorghum cultures (gaolan, durra, cafire, siallu, pearl millet, rag) attract a special attention. Sorghum cultures are stable against drought, their motherland is Africa. They have 10–13% of proteins, 71–72% of carbohydrates, 3–45% — of fats. Suger content in the stem of some sorts is high. In spite of the fact that sorghum does not contain large amount of cellulose (2%), it is a more rough food for a man than other grain cultures. They are used for nutrition of poor people of countries of Africa and Asia. It is being substituted by wheat and rice; sorghum is used as forage for poultry cattle.

After rice and wheat, **millet** is the third most used grain. Two varieties are widely cultivated — pearl millet (Bajra) and finger millet (Ragi). Pearl millet seeds are very small and yellowish-grey in colour. It is used primarily in the Northern and Western parts of India for its flour which is used to make different kinds of bread, depending on the region. Gujarathis make Bajra Potla (Bhakri), Batlou, Dhevra, Talipeeth — different kinds of flatbreads made with millet flour. Finger millet or Ragi, which is considered superior to pearl millet, is used to make dosas and roti in Southern India. Millet grains are also used to make pulaos. Millet is rich in protein, B group vitamins, phosphorus and iron. Different sorts of millet are also stable against drought and cultivated in some countries of Africa. One kind of millet cultures — fenyó (*Digitaria exilis*) is used in South Africa as cereal for cooking of pilaf and in pulverized form is added to different flours.

In the latest years in many countries there was cultivated triticale — the first artificially made grain culture; it was made by the way of amalgamation of chromosomes of wheat and rye. The most attractive features are crop capacity, resistance against unfavourable soil, climate conditions and diseases, and also good food qualities. Amount of proteins is approx. 11.7–22.5%, starch — 73.8%, fats — 2.24%, mineral substances — 0.43%. Proteins are rich in lysin (more than wheat ones), their common biological value is higher than that of other grain cultures. But bread qualities of the flour from triticale is worse than that of wheat flour.

**Bean seeds** which are rich in proteins are considerable part of the food ration of people in a number of agrarian countries. Bean cultures contain from 15 to 37% of proteins, 26–63% of starch-containing substances, from 1 to 6% of fats. The only exception is soy-bean which contains 18–20% of fats. Bean cultures are rich in cellulose — 3–7%. But because of big content of cellulose they are digested worse than grain cultures. Biological value of proteins is lower than that of grain-cultures. Soy-bean is only exception.

Bean cultures can contain antialimentary factors (e.g. substances which blockade tripsin and chemo-tripsin) and sometimes — small amount of toxic substances, e.g. white haricot bean contains thermic-

ly unstable agent with haemagglutination ability — fasin. After prolonged thermal treatment which decompose cellulose food biological value of beans increases.

The most spread leguminous are soy-bean (world production is approx. 90 mln of tons), haricot bean, pea, horse bean, noot, china, mash and others. In many developing countries where there is a deficit of animal proteins beans proteins are valuable addition to grain cultures in the diet.

**Soy-beans.** By the chemical composition they take a unique place among grain and bean cultures. Soy-beans contain 37% of proteins. It is more than in any other food product. Their proteins are characterized by high content of essential amino acids and that's why they have the greatest biological value in comparison with other vegetable proteins. As compared to wheat flour content of lysin in soy-bean flour is 1.5 times more, triptofan and methionine — 3 times. Soy-beans are the source of oil, flour, soy-bean milk and cheese. Isolated and concentrated soy-bean protein obtained from the flour is used as a nutritional addition, for example, to sausage-meat. In addition to high biological value and comparatively low price proteins have high functional qualities. That's why soy-bean is used for preparing different artificial products including those which imitate meat products.

From ancient time people use vegetable products with high content of fats. These products are different sorts of nuts, seeds of oil cultures. Vegetable oils are obtained from seeds of cotton, sunflowers, crucifers (mustard, winter-cress and others), cacao, oil palm, sesame, hazel-nuts, coconuts, olives and others. As for containing of PUFA (Poly-Unsaturated Fatty Acids) and tocopherols the most valuable are oils gotten from germs of maize, seeds of sunflowers and cotton.

Refined cotton oil contains 33–50% of linole and 29–44% of oleinic acid.

**Peanut** is an important oil culture. It contains 60% of fats, 15–20% of nitrogen-free substances, 2–4% of cellulose. Peanut is rich in vitamins of B group, tocopherols, cholin. Peanut oil has palatable taste and contains 7–26% of linole, 51–80% of olein fat acids. Oilcake is the product which remains after the extraction of oil. It is rich in proteins and vitamins and it is used for production flour which is primary used as forage.

In tropical climate conditions peanut and peanut flour are often damaged by mouldy fungi including aspergills which produce aflatoxin — toxic and cancerogenous substance. Taking into consideration the fact that peanut is widely cultivated in tropic countries prophylaxis of aflatoxicosis in such countries is to be an urgent problem.

**Coconut** palm growths in tropic regions. Coconut is the source of coconut milk and nucleus crumb which is dried out (copra). Coconut milk contains

0.13% of proteins, 0.4% of glucose, 0.13% of fats. It is used as fresh drink. Coconut oil is produced from copra which is after refining is used in food. In contrast to other vegetable oils it contains up to 85% of saturated fatty acids and poor in tocopherols. Coconut oil is important part in producing of margarine.

**Oil palm** grows in tropics of Africa and Asia. Oil which is obtained from stones of the palm is directly consumed in food and also is used in production of margarine. It is close to coconut one by its qualities: it contains 80–85% of saturated fatty acids, 1–2% of linole and 16–19% of olein acids.

The first place among all **root-plants** is taken by **potato** (more than 300 mln of tons per year). It contains up to 14% of starch, 15% of proteins, 1–2% of sugar, 20–30 mg% of vitamin C, and vitamins of B group. Potato is mostly spread in tropics of Central and North America.

**Manioc** takes important place in this group (production more than 100 mln of tons per year). It is cultivated in the whole tropic zone. The mass of root is 0.8–2 kg. It contains 24% of carbohydrates (including 1.2% of sugar), 1% of proteins, 0.5% of fats, 3% of cellulose. Amount of mineral substances and vitamins in manioc is less than in batata and potato.

It is important to emphasize that some sorts of manioc contain toxic cyanogenous glycoside (approx. 30–67 mg/kg). Concentration of glycoside is more in the peel (15–20 times) than in pulp. If concentration of glycoside is above 80 mg/kg, such roots are considered to be poisonous. It is recommended to eat only root-plant which contain no more than 50 mg/kg of glycoside. It is a thermically stable substance; so, it can not be completely destructed during cooking. In the process of drying out 75% of glycoside are destructed. Starch washed out of the pulp is free from this glycoside.

The root-plants free from the peel are boiled as potato. Boiled manioc contains 80–85% of starch, 0.4–4.2% of sugars, 1–2.5% of proteins, 0.5–1.2% of fats. Besides, population of tropical zone prepare the product which is called hari from manioc. For that purpose roots are peeled out, pulverized and squeezed out the juice of this mass. Then this mass must be boiled and dried out. Prepared hari (1/4 of roots mass) contains 10–15% of water, 80–85% of carbohydrates, 0.5–1.4% of proteins and 1% of fats. There are almost no glycosides in hari.

Manioc flour can be sifted on the hot stove. This granulated product is called tapioca which is widely used in pastry-cook production. Tapioca contains 12.6% of water, 80% of carbohydrates, 0.7% of proteins and 0.2% of fats. Tapioca is poor in mineral substances and vitamins. Energy value of 100 g of tapioca is 345 kcal.

Important starch-containing root-plant culture is **batata (sweet potato)**. Its annual production is more than 75 mln of tons. The mass of root-plant is 4–

5 kg. It contains 24% of carbohydrates, 2% of proteins, 1.5% of fats, 3% of cellulose. Besides of starch, there are other carbohydrates which add sweet taste to batata. Mineral and vitamin composition is close to that of potato but batata has more carotin (0.36–1.0 mg/100 g).

**Yams and taro** are also related to this group of cultures which are gradually substituted by manioc. Yams contains to 29% of carbohydrates, 2% of proteins, 0.03% of fats and 1% of cellulose. Root-plant of yams and taro are eaten uncooked.

## FRUIT AND VEGETABLES

The most spread vegetables in the world are cabbage, carrot, beet, onion, garlic, dill, parsley, turnip, radish, cucumber, aubergine, pepper, spinach and others. In the regions with hot climate watermelon cultures are cultivated.

An important part of food ration of a modern man is fruit. Energy value is not high (it is approx. 60 kcal per 100 g) but they have good taste. They are rich in different sugars, organic acids and vitamins.

**Citrus plants** widely spread in tropical countries include several tens of sorts of fruit which have good taste and dietetic qualities. Every year production of citrus fruit is more than 40 mln tons. They are such fruit as oranges, tangerines, grape-fruit, lemons, limes, citrons and others.

Citrus fruit has a great significance in dietary of sick people. There are 5% of inverted sugar, 3% of sacharose, 1% of citric acid in the pulp of sweet orange. Because of thick peel and acidity of its juice different vitamins (including vitamin C) are well preserved in orange. Citrus fruit are rich in substances which have properties of vitamin P. Orange, tangerines, grape-fruits, pampelmus are eaten in raw. They are also used in pastry-cook production.

Other citrus fruit (lemon, lime) contain great amount of citric acid in the pulp. The amount of organic acids in the lemon is 6–8%, inverted sugars — 2–3%, sacharose — 0.5%. Juice of this citrus fruit are used for preparing fresh drinks, culinary products and confectionery. People often prefer tea with lemon from all the hot drinks. Lemon peel contains vitamin C 2–3 times more than the pulp. Lemon juice stimulates immunity of the organism, has antiscorbutic, antianaemia and other curable qualities.

**Banana** — is an important vegetable culture. It is considered that banana is one of the first food products and one of the first plant which is started to be cultivated. It grows primary in tropical zone with increased humidity. Harvests of bananas from one hectare is approximately 100 times more than wheat and 40 times — than potato. Bananas must be unripe because only in artificial conditions (in rooms with temperature 16–17°C, humidity 85–90% during 7–8 days) they get good gustatory and food

qualities. During this process of ripening starch turns into sugar (changing of the taste), protopectin — into water soluble pectin (changing of consistence, formation of aromatic substances) and other chemical processes.

All sorts of bananas are divided into two groups according to the character of their possible use. The largest part of them are bananas of the group of plentins which contains a large amount of starch. They are used in boiled state or dried and pulverized into flour. They contain about 64% of water, 12% of starch, 19% of sugars, 1.2% of proteins, 0.8% of fats, 0.8% of cellulose. Bananas are not rich in vitamin C (approx. 0.7 mg per 100 g) but contain a number of  $\alpha$ -carotins (0.7 mg per 100 g) and vitamins of B group, especially riboflavin (0.6 mg per 100 g). Those sorts of bananas are consumed by local population. In some regions of India, Indonesia, Malaysia and especially tropical Africa importance of bananas in the nourishment of population can be compared with importance of bread in conditions of moderate climate.

The second group consists of sweet bananas which are usually exported. Content of water is 72–76%, carbohydrates — 22–27% (16% of sacharose, 11% of reduced sugars), proteins — 1.3–1.5%, fats — 0.1–0.6%, other substances — 0.8–0.9%. Besides, they are used for preparation of jams, candied bananas, banana flour, dried bananas, etc.

In South-West Asia, North America and Sahara there are regions where the **date-palm** is cultivated. Dates are a good food product (“bread of deserts”). They contain about 72% of carbohydrates (including 60% of sugars among which sacharose prevails), 7.5% of proteins, 2.5% of fats, 3–6% of cellulose. They contain vitamins of B group especially niacin and pantothenic acid (0.8 mg of each per 100 g). They can be kept for a long period. In ancient times dates were the most popular food for sailors and travelers in deserts.

**Bread-fruit tree** is spread in Indonesia, Polynesia and nearly located regions. Fruit of this tree is round or oval of 10–12 cm in diameter. Their pulp has many fibers and yellow colour, the signs of a ripe fruit. Fruit are eaten raw, boiled, baked and they are used for bread baking. Fruit contain 65% of water, 19% of starch, 12% of sugars, 1.5% of proteins, 0.2–0.5% of fats and 1% of cellulose.

**Mango** is one of the best Indian fruit-delicacy. Average mass of fruit is 300–400 g (sometimes up to 2–4 kg). The pulp is of yellow colour and has palatable sweet taste, strong aroma which reminds smell of apricot, melon or lemon. The pulp contains 75–85% of water, 11–20% of sugars (mostly sacharose), 0.2–0.6% of organic acids, 0.5–1% of proteins, small amount of mineral substances but a lot of ascorbic acid (approx. 25 mg per 100 g),  $\alpha$ -carotins, vitamins of B group. They are often used in juices, jams and other products. In India the fruit



are used for preparation of marinades, Indian dishes: cari and chashni. Mango juice is used in popular medicine as a remedy against a lot of diseases including cholera and plague.

**Avocado** is a fruit tree which grows in American tropics. The fruit's size is from 7 to 20 cm. The pulp is of a yellow-green colour, butter consistence and the same taste but with smack of walnut and smell of bay leaf. Seeds of avocado are uneatable. Composition: 60–70% of water, 1.2–1.8% of proteins, 10–29% of fats, 5–10% of carbohydrates; energy value is 218 kcal per 100 g. Oil contains 77% of olein and 10% of linole acids. Pulp of the fruit contains many water soluble fat-soluble vitamins. Avocado is used for preparing of canned products.

**Papaya (melon tree).** Fruit are from 0.4 to 20 kg of weight. Taste depends on the sort of papaya. Some sorts have sweet taste, the others are without taste, the others have bitter smack. Pulp is of dark-yellow or orange colour. It contains 85–88% of water, 0.4–0.7% of proteins, 0.25% of fats, 8–12% of sugars (mostly monosacharides), sufficient amount of vitamins (ascorbic acid — up to 46 mg/100 g, carotin — up to 2 mg/100 g). The pulp of papaya (specially unripe fruit) contains enzyme papain which is similar to pepsin. This fact allows to use papaya in curative diet.

Tropical zone is rich in different plants. So, any country depending on its climate conditions and food needs can choose optimum from hygienic positions, plants to be cultivated. It's important to emphasize that the role of fruit of tropic and moderate zones as the source of vitamins is almost similar.

## FOOD POISONINGS AND THEIR PREVENTION

Food poisoning is toxic foodborne disease. The modern classification of food poisonings divides them into three groups: microbial, non-microbial and unconfirmed ethiology (Fig. 30).

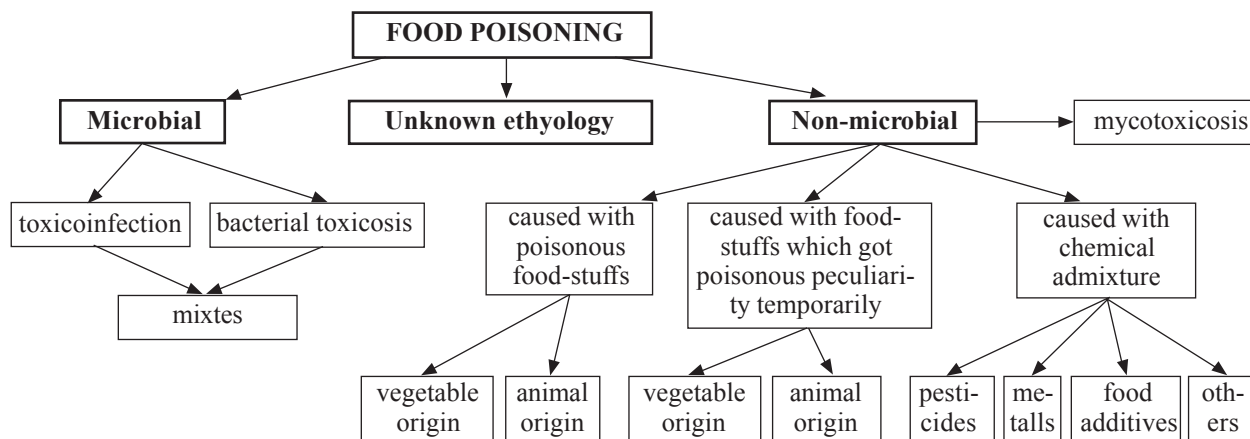


Fig. 30. Classification of Food Poisonings

## Microbial Food Poisonings

**Food bacterial toxicoses** are acute food-borne diseases caused by microbic toxins. There are botulism and staphylococcal toxicoses.

**Botulism** is a rare but serious foodborne disease. It is caused by contamination of certain food-stuffs by the botulism bacterium commonly found in the soil. *Cl. botulinum* are gram-positive, spore producing bacilli. They are obligate anaerobic. Due to plasmid contained in some *Cl. botulinum* organisms they can product 7 neurotoxic types of botulinum toxin: A, B, C1, D, E, F, G under anaerobic conditions. There are released by autolysis as a prototoxin. Bound to hemagglutinins and inhibits degradation by digestive enzymes is doubtful.

Risk associated food-stuffs: home canned vegetables and mushrooms, smoked fish and preserved sea food, sausages. Recent epidemics in USA were caused with Peyote cactus tea, Mascarpone cream cheese.

There are two different illnesses: adult botulism and infant botulism. An adult may become ill by eating spoiled food containing the botulism toxin. This toxin is produced when the bacteria grows in improperly canned food and occasionally in contaminated fish. Infant botulism is caused by eating the spores of the botulinum bacterium. For infants one source of these spores is honey. When contaminated food is eaten by adults, toxin is absorbed from the intestines and attaches to the nerves causing the signs and symptoms of botulism. Early symptoms include blurred vision, dry mouth, difficulty in swallowing or speaking, general weakness, and shortness of breath. The illness may progress to complete paralysis, respiratory failure, and death. When infants eat contaminated food, the spores grow in the intestines and release toxin. Diagnosis is made by the presence of appropriate neurologic symptoms and by laboratory tests that detect toxin or by culture of *Clostridium botulinum* bacterium from the patient's stool. Infant botulism is more common in spring and

summer and is rare in winter. Infants younger than one year of age, particularly between the ages of two to four months, are at highest risk. Symptoms include muscle weakness, a weak cry, a poor suck (difficulty in feeding), feeble crying, constipation, head lag, increased heart rate and a decreased gag reflex. A baby with infant botulism is described as a “floppy baby”, as the baby will have weak muscles, especially in the arms, legs and neck.

Although there are very few cases of botulism poisoning each year, prevention is extremely important. Home canning should follow strict hygienic recommendations to reduce contamination of food-stuffs. In addition, because the botulism toxin is destroyed by boiling for 10 minutes, people who eat home-canned food-stuffs should consider boiling the food before eating it to ensure safety. A county extension home economist can provide specific instructions on safe home canning techniques. To help preventing infant botulism, infants less than 12 months old should not be fed honey.

Facts about botulism prevention:

1. The best prevention is canning or preserving food with appropriate heat, pressure and low pH.
2. Spores of *Cl. botulinum* survive 2 h at 100°C, inactivated at 120°C.
3. Boiling food before canning at high elevations may not inactivate the spores.
4. Factors favoring spore germination: low acidity (pH > 5.0); low O<sub>2</sub>; high water content.
5. Toxin: inactivated after 1 min at 85°C, or 5 min at 80°C.
6. Avoid exposure of infants to honey (may contain *Clostridium botulinum* spores).
7. There are no immunity from subsequent episodes of botulism intoxication.

**Staphylococcal food poisoning (staphyloenterotoxiosis; staphyloenterotoxemia)** is the name of the condition caused by the enterotoxins which some strains of *S. aureus* produce. *S. aureus* is a spherical bacterium (coccus) which in microscopic examination appears in pairs, short chains, or bunched, grape-like clusters. These organisms are Gram-positive. Some strains are capable of producing a highly heat-stable protein toxin that causes illness in humans.

All people are believed to be susceptible to this type of bacterial intoxication; however, intensity of symptoms may vary. The onset of symptoms in staphylococcal food poisoning is usually rapid and in many cases acute, depending on individual susceptibility to the toxin, the amount of contaminated food eaten, the amount of toxin in the food ingested, and the general health of the victim. The most common symptoms are nausea, vomiting, retching, abdominal cramping, and prostration. Some individuals may not always demonstrate all the symptoms associated with the illness. In more severe cases, headache, muscle cramping, and transient changes in blood

pressure and pulse rate may occur. Recovery generally takes two days, However, it is not unusual for complete recovery to take three days and sometimes longer in severe cases.

A-toxin dose of less than 1.0 µg in contaminated food will produce symptoms of staphylococcal intoxication. This toxin level is reached when *S. aureus* population exceeds 100,000 per gram.

In the diagnosis of staphylococcal foodborne illness, proper interviews with the victims and gathering and analyzing epidemiologic data are essential. Incriminated food-stuffs should be collected and examined for staphylococci. The presence of relatively large numbers of enterotoxigenic staphylococci is good circumstantial evidence that the food contains toxin. The most conclusive test is the linking of an illness with a specific food or in cases where multiple vehicles exist, the detection of the toxin in the food sample(s). In cases where the food may have been treated to kill the staphylococci, as in pasteurization or heating, direct microscopic observation of the food may be an aid in the diagnosis. A number of serological methods for determining the enterotoxigenicity of *S. aureus* isolated from food-stuffs as well as methods for the separation and detection of toxins in food-stuffs have been developed and used successfully to aid in the diagnosis of the illness. Phage typing may also be useful when viable staphylococci can be isolated from the incriminated food, from victims, and from suspected carrier such as food handlers.

Food-stuffs that are frequently incriminated in staphylococcal food poisoning include meat and meat products; poultry and egg products; salads such as eggs, tuna, chicken, potatoes, and pasta; bakery products such as cream-filled pastries, cream pies, and chocolate eclairs; sandwich fillings; and milk and dairy products. Food-stuffs that require considerable handling during preparation and that are kept at slightly elevated temperatures after preparation are frequently involved in staphylococcal food poisoning.

Staphylococci exist in air, dust, sewage, water, milk, and food or on food equipment, environmental surfaces, humans, and animals. Humans and animals are the primary reservoirs. Staphylococci are present in the nasal passages and throat and on the hair and skin of 50% or more of healthy individuals. This incidence is even higher for those who associate or come in contact with sick individuals and hospital environments. Although food handlers are usually the main source of food contamination in food poisoning outbreaks, equipment and environmental surfaces can also be sources of contamination with *S. aureus*. Human intoxication is caused by ingesting enterotoxins produced in food by some strains of *S. aureus*, usually because the food has not been kept hot enough (60°C or above) or cold enough (7.2°C or below).

The true incidence of staphylococcal food poisoning is unknown for a number of reasons, including poor responses from victims during interviews with health officials; misdiagnosis of the illness, which may be symptomatically similar to other types of food poisoning (such as vomiting caused by *Bacillus cereus* toxin); inadequate collection of samples for laboratory analyses; and improper laboratory examination. Death from staphylococcal food poisoning is very rare, although such cases have occurred among the elderly, infants, and severely debilitated persons.

For detecting trace amounts of staphylococcal enterotoxin in food-stuffs incriminated in food poisoning, the toxin must be separated from food constituents and concentrated before identification by specific precipitation with antiserum (antienterotoxin) as follows. Two principles are used for the purpose: (1) the selective adsorption of the enterotoxin from an extract of the food onto ion exchange resins and (2) the use of physical and chemical procedures for the selective removal of food constituents from the extract, leaving the enterotoxin(s) in solution. The use of these techniques and concentration of the resulting products (as much as possible) has made it possible to detect small amounts of enterotoxins in food.

There are developed rapid methods based on monoclonal antibodies (e.g. ELISA, Reverse Passive Latex Agglutination), which are being evaluated for their efficacy in the detection of enterotoxins in food. These rapid methods can detect approximately 1.0 ng of toxin/g of food.

**Food toxicoinfections** are acute noncontagious diseases, developing during consumption of food heavily polluted with agents ( $10^5$ – $10^6$  microbes per 1 g or 1 ml). They are characterized by:

- a) short incubation period (average 6–24 h);
- b) specific dietary history for all sick persons;
- c) outbreaks and epidemics if product was realized through centralized catering organisation or trade organisation;
- d) local epidemiology;
- e) fast outbreak cessation after removal of source (incriminated product);
- f) gastroenteritis.

Currently, there are four recognized classes of enterovirulent *E. coli* (collectively referred to as the EEC group) that cause gastroenteritis in humans. Among these are the enterotoxigenic (ETEC) strains. They comprise a relatively small proportion of the species and have been etiologically associated with diarrheal illness of all age groups from diverse global locations. The organism frequently causes diarrhea in infants in less developed countries and in the visitors there from industrialized countries. The etiology of this cholera-like illness has been recognized for about 20 years.

Gastroenteritis is the common name of the illness caused by ETEC, although “travellers diarrhea”

is a frequent sobriquet. The most frequent clinical syndrome of infection includes watery diarrhea, abdominal cramps, low-grade fever, nausea and malaise.

Volunteer feeding studies indicate that a relatively large dose (100 million to 10 billion bacteria) of enterotoxigenic *E. coli* is probably necessary to establish colonization of the small intestine, where these organisms proliferate and produce toxins which induce fluid secretion. With high infective dose, diarrhea can be induced within 24 h. Infants may require fewer organisms for infection to be established.

During the acute phase of infection, large numbers of enterotoxigenic cells are excreted in feces. These strains are differentiated from nontoxigenic *E. coli* present in the bowel by a variety of *in vitro* immunochemical, tissue culture, or gene probe tests designed to detect either the toxins or genes that encode for these toxins. The diagnosis can be completed in about 3 days.

ETEC is not considered to be a serious foodborne disease hazard in countries having high sanitary standards and practices. Contamination of water with human sewage may lead to contamination of food-stuffs. Infected food handlers may also contaminate food-stuffs. These organisms are infrequently isolated from dairy products such as semi-soft cheeses. Infants and travelers to underdeveloped countries are at most risk of infection.

With the availability of a gene probe method, food-stuffs can be analyzed directly for the presence of enterotoxigenic *E. coli*, and the analysis can be completed in about 3 days. Alternative methods which involve enrichment and plating of samples for isolation of *E. coli* and their subsequent confirmation as toxigenic strains by conventional toxin assays may take at least 7 days.

Among EEC are the enteropathogenic (EPEC) strains. EPEC are defined as *E. coli* belonging to serogroups epidemiologically implicated as pathogens but whose virulence mechanism is unrelated to the excretion of typical *E. coli* enterotoxins. *E. coli* are gram-negative, rod-shaped bacteria belonging to the family Enterobacteriaceae. The source(s) and prevalence of EPEC are controversial because foodborne outbreaks are sporadic. Humans, bovines, and swine can be infected, and the latter often serve as common experimental animal models. *E. coli* are present in the normal gut flora of these mammals. The proportion of pathogenic to nonpathogenic strains, although the subject of intense research, is unknown.

Infantile diarrhea is the name of the disease usually associated with EPEC. EPEC cause either a watery or bloody diarrhea, the former associated with the attachment to, and physical alteration of the integrity of the intestine. Bloody diarrhea is associated with attachment and an acute tissue-destructive process, perhaps caused by a toxin similar

to that of *Shigella dysenteriae*, also called verotoxin. In most of these strains the shiga-like toxin is cell-associated rather than excreted. EPEC are highly infectious for infants and the infective dose is presumably very low. In the few documented cases of adult diseases, the dose is presumably similar to other colonizers (greater than  $10^6$  of a total dose).

The distinction of EPEC from other groups of pathogenic *E. coli* isolated from patients' stools involves serological and cell culture assays. Serotyping, although useful, is not strict for EPEC.

Common food-stuffs implicated in EPEC outbreaks are raw beef and chicken, although any food exposed to fecal contamination is strongly suspected. Outbreaks of EPEC are sporadic. Incidence varies on a worldwide basis; countries with poor sanitation practices have the most frequent outbreaks.

Occasionally, diarrhea in infants is prolonged, leading to dehydration, electrolyte imbalance and death (50% mortality rates have been reported in third world countries).

EPEC outbreaks most often affect infants, especially those that are bottle fed, suggesting that contaminated water is often used to rehydrate infant formulae in underdeveloped countries.

The isolation and identification of *E. coli* in food-stuffs follows standard enrichment and biochemical procedures. Serotyping of isolates to distinguish EPEC is laborious and requires high quality, specific antisera, and technical expertise. The total analysis may require from 7 to 14 days.

*E. coli* serotype O157:H7 is a rare variety of *E. coli* that produces large quantities of one or more related, potent toxins that cause severe damage to the lining of the intestine. These toxins (verotoxin (VT), shiga-like toxin) are closely related or identical to the toxin produced by *Shigella dysenteriae*. Hemorrhagic colitis is the name of the acute disease caused by *E. coli* O157:H7.

The illness is characterized by severe cramping (abdominal pain) and diarrhea which is initially watery but becomes grossly bloody. Occasionally vomiting occurs. Fever is either low-grade or absent. The illness is usually self-limited and lasts for an average of 8 days. Some individuals exhibit watery diarrhea only.

Infective dose is unknown, but from a compilation of outbreak data, including the organism's ability to be passed person-to-person in the day-care setting and nursing homes, the dose may be similar to that of *Shigella* spp. (as few as 10 organisms).

Hemorrhagic colitis is diagnosed by isolation of *E. coli* of serotype O157:H7 or other verotoxin-producing *E. coli* from diarrheal stools. Alternatively, the stools can be tested directly for the presence of verotoxin. Confirmation can be obtained by isolation of *E. coli* of the same serotype from the incriminated food.

Undercooked or raw hamburger (ground beef) has been implicated in many of the documented out-

breaks, however *E. coli* O157:H7 outbreaks have implicated sprouts, unpasteurized fruit juices, dry-cured salami, lettuce, minced meat, and cheese curds. Raw milk was the cause of a school outbreak in Canada.

Hemorrhagic colitis infections are not too common, but this is probably not reflective of the true frequency. Because of the unmistakable symptoms of profuse, visible blood in severe cases, those victims probably seek medical attention, but less severe cases are probably more numerous. Some victims, particularly the very young, have developed the hemolytic uremic syndrome (HUS), characterized by renal failure and hemolytic anemia. From 0 to 15% of hemorrhagic colitis victims may develop HUS. The disease can lead to permanent loss of kidney function. In the elderly, HUS, plus two other symptoms, fever and neurologic symptoms, constitute thrombotic thrombocytopenic purpura (TTP). This illness can have a mortality rate in the elderly as high as 50%.

All people are believed to be susceptible to hemorrhagic colitis, but young children and the elderly appear to progress to more serious symptoms more frequently.

*Campylobacter jejuni* is a gram-negative slender, curved, and motile rod. It is a microaerophilic organism, which means it has a requirement for reduced levels of oxygen. It is relatively fragile, and sensitive to environmental stresses (e.g. 21% oxygen, drying, heating, disinfectants, acidic conditions). Because of its microaerophilic characteristics the organism requires 3 to 5% oxygen and 2 to 10% of carbon dioxide for optimal growth conditions. This bacterium is now recognized as an important enteric pathogen. Before 1972, when methods were developed for its isolation from feces, it was believed to be primarily an animal pathogen causing abortion and enteritis in sheep and cattle. Surveys have shown that *C. jejuni* is the leading cause of bacterial diarrheal illness in the United States. It causes more disease than *Shigella* spp. and *Salmonella* spp. combined.

Although *C. jejuni* is not carried by healthy individuals but it is often isolated from healthy cattle, chickens, birds and even flies. It is sometimes present in non-chlorinated water sources such as streams and ponds.

Because the pathogenic mechanisms of *C. jejuni* are still being studied, it is difficult to differentiate pathogenic from nonpathogenic strains. However, it appears that many of the chicken isolates are pathogens.

Campylobacteriosis is the name of the illness caused by *C. jejuni*. It is also often known as campylobacter enteritis or gastroenteritis. *C. jejuni* infection causes diarrhea, which may be watery or sticky and can contain blood (usually occult) and fecal leukocytes (white cells). Other symptoms often present

are fever, abdominal pain, nausea, headache and muscle pain. The illness usually occurs 2–5 days after ingestion of the contaminated food or water. Illness generally lasts for 7–10 days, but relapses are often (about 25% of cases). Most infections are self-limiting and are not treated with antibiotics.

The infective dose of *C. jejuni* is considered to be small. Human feeding studies suggest that about 400–500 bacteria may cause illness in some individuals, while in others greater numbers are required. A conducted volunteer human feeding study suggests that host susceptibility also dictates infectious dose to some degree. The pathogenic mechanisms of *C. jejuni* are still not completely understood, but it does produce a heat-labile toxin that may cause diarrhea. *C. jejuni* may also be an invasive organism.

*C. jejuni* frequently contaminates raw chicken. Surveys show that 20 to 100% of retail chickens are contaminated. This is not overly surprising since many healthy chickens carry these bacteria in their intestinal tracts. Raw milk is also a source of infections. The bacteria are often carried by healthy cattle and by flies on farms. Non-chlorinated water may also be a source of infections. However, properly cooked chicken, pasteurizing milk, and chlorinating drinking water will kill the bacteria.

*C. jejuni* is the leading cause of bacterial diarrhea in the developed countries. There are probably numbers of cases in excess of the estimated cases of salmonellosis (2 to 4,000,000/year). Complications are relatively rare, but infections have been associated with reactive arthritis, hemolytic uremic syndrome, and following septicemia, infections of nearly any organ. The estimated case/fatality ratio for all *C. jejuni* infections is 0.1, meaning one death per 1,000 cases. Fatalities are rare in healthy individuals and usually occur in cancer patients or in the otherwise debilitated. Only 20 reported cases of septic abortion induced by *C. jejuni* have been recorded in the literature. Meningitis, recurrent colitis, acute cholecystitis and Guillain — Barre syndrome are very rare complications.

Although anyone can have a *C. jejuni* infection, children under 5 years and young adults (15–29) are more frequently afflicted than other age groups. Reactive arthritis, a rare complication of these infections, is strongly associated with people who have the human lymphocyte antigen B27 (HLA-B27).

Isolation of *C. jejuni* from food is difficult because the bacteria are usually present in very low numbers. The methods require generally a microaerophilic atmosphere with 5% oxygen and an elevated concentration of carbon dioxide (10%). Isolation can take several days to a week.

*Vibrio parahaemolyticus* (and other marine *Vibrio spp.*) Both pathogenic and non-pathogenic strains of the bacterium can be isolated from marine and estuarine environments and from fish and

shellfish dwelling in these environments. *V. parahaemolyticus*-associated gastroenteritis is the name of the infection caused by this organism.

Diarrhea, abdominal cramps, nausea, vomiting, headache, fever, and chills may be associated with infections caused by this organism. The illness is usually mild or moderate, although some cases may require hospitalization. The median duration of the illness is 2.5 days. The incubation period is 4–96 h after the ingestion of the organism, with a mean of 15 h. Disease is caused when the organism attaches itself to the patient's small intestine and excretes as yet unidentified toxin.

Infective dose is greater than one million microorganisms; this dose may be markedly lowered by coincident consumption of antacids (or presumably by food with buffering capability).

Diagnosis of gastroenteritis caused by this organism is made by culturing the organism from the diarrheic stools of an individual.

Infections with this organism have been associated with the consumption of raw, improperly cooked, or cooked recontaminated fish and shellfish. A correlation exists between the probability of infection and warmer months of the year. Improper refrigeration of seafood-stuffs contaminated with this organism will allow its proliferation, which increases the possibility of infection. Major outbreaks have occurred during the warmer months of the year. Sporadic cases occur along all coasts. Diarrhea caused by this organism is usually self-limiting, with few cases requiring hospitalization and/or antibiotic treatment. All individuals who consume raw or improperly cooked fish and shellfish are susceptible to infection by this organism.

Methods used to isolate this organism from food-stuffs are similar to those used with diarrheic stools. Because many food isolates are nonpathogenic, pathogenicity of all food isolates must be demonstrated. Although the demonstration of the Kanagawa hemolysin was long considered indicative of pathogenicity, this is now uncertain.

*Clostridium perfringens* is an anaerobic, gram-positive, sporeforming rod (anaerobic means unable to grow in the presence of free oxygen). It is widely distributed in the environment and frequently occurs in the intestines of humans and many domestic and feral animals. Spores of the organism persist in soil, sediments, and areas subjected to human or animal fecal pollution.

Perfringens food poisoning is the term used to describe the common foodborne illness caused by *C. perfringens*. A more serious but rare illness is also caused by ingesting food contaminated with type C strains. The latter illness is known as enteritis necroticans or pig-bel disease. The common form of perfringens poisoning is characterized by intense abdominal cramps and diarrhea which begin 8–22 h after consumption of food-stuffs containing

large numbers of those *C. perfringens* bacteria capable of producing the food poisoning toxin. The illness is usually over within 24 h but less severe symptoms may persist in some individuals for 1 or 2 weeks. A few deaths have been reported as a result of dehydration and other complications. Necrotic enteritis caused by *C. perfringens* is often fatal. This disease also begins as a result of ingesting large numbers of the causative bacteria in contaminated food-stuffs. Deaths from pig-bel syndrome are caused by infection and necrosis of the intestines and from resulting septicemia. This disease is very rare.

In most instances, the actual cause of poisoning by *C. perfringens* is temperature abuse of prepared food-stuffs. Small numbers of the organisms are often present after cooking and multiply to food poisoning levels during cool down and storage of prepared food-stuffs. Meat, meat products, and gravy are the food-stuffs most frequently implicated.

Institutional feeding (such as school cafeterias, hospitals, nursing homes, prisons, etc.) where large quantities of food are prepared several h before serving is the most common circumstance in which perfringens poisoning occurs. The young and elderly people are the most frequent victims of perfringens poisoning. Except the case of pig-bel syndrome, complications are few in persons under 30 years of age. Elderly persons are more likely to experience prolonged or severe symptoms.

Standard bacteriological culturing procedures are used to detect the organism in implicated food-stuffs and in feces of patients. Serological assays are used for detecting enterotoxin in the feces of patients and for testing the ability of strains to produce toxin. The procedures take 1–3 days.

*Bacillus cereus* is a gram-positive, facultatively aerobic sporeformer which cells are large rods and the spores do not swell the sporangium. These and other characteristics, including biochemical features, are used to differentiate and confirm the presence of *B. cereus*, although these characteristics are shared with *B. cereus* var. *mycoides*, *B. thuringiensis* and *B. anthracis*. Differentiation of these organisms depends upon determination of motility (most *B. cereus* are motile), presence of toxin crystals (*B. thuringiensis*), hemolytic activity (*B. cereus* and others are beta-hemolytic whereas *B. anthracis* is usually nonhemolytic), and rhizoid growth which is characteristic of *B. cereus* var. *mycoides*.

*B. cereus* food poisoning is the general description, although two recognized types of illness are caused by two distinct metabolites. The diarrheal type of illness is caused by a large molecular weight protein, while the vomiting (emetic) type of illness is believed to be caused by a low molecular weight, heat-stable peptide.

The symptoms of *B. cereus* diarrheal type food poisoning mimic those of *Clostridium perfringens*

food poisoning. The onset of watery diarrhea, abdominal cramps, and pain occurs 6–15 h after consumption of contaminated food. Nausea may accompany diarrhea, but vomiting (emesis) rarely occurs. Symptoms persist for 24 h in most instances. The emetic type of food poisoning is characterized by nausea and vomiting within 0.5 to 6 h after consumption of contaminated food-stuffs. Occasionally, abdominal cramps and/or diarrhea may also occur. Duration of symptoms is generally less than 24 h.

Some strains of *B. subtilis* and *B. licheniformis* have been isolated from lamb and chicken incriminated in food poisoning episodes. These organisms demonstrate the production of a highly heat-stable toxin which may be similar to the vomiting type toxin produced by *B. cereus*.

The presence of large numbers of *B. cereus* (greater than 10<sup>6</sup> organisms/g) in a food is indicative of active growth and proliferation of the organism and is consistent with a potential hazard to health.

Confirmation of *B. cereus* as the etiologic agent in a foodborne outbreak requires either isolation of strains of the same serotype from the suspected food and feces or vomiting of the patient, isolation of large numbers of a *B. cereus* serotype known to cause foodborne illness from the suspected food or from the feces or vomiting of the patient, or isolation of *B. cereus* from suspected food-stuffs and determining their enterotoxigenicity by serological (diarrheal toxin) or biological (diarrheal and emetic) tests. The rapid onset time to symptoms in the emetic form of disease, coupled with some food evidence, is often sufficient to diagnose this type of food poisoning.

A wide variety of food-stuffs including meat, milk, vegetables, and fish have been associated with the diarrheal type food poisoning. The vomiting-type outbreaks have generally been associated with rice products; however, other starchy food-stuffs such as potato, pasta and cheese products have also been implicated. Food mixtures such as sauces, puddings, soups, casseroles, pastries, and salads have frequently been incriminated in food poisoning outbreaks.

## NON-MICROBIAL FOOD POISONINGS

There are unhomogeneous group of foodborne diseases. They are not spread so widely as microbial food poisonings but can have high incidence in the regions with poor sanitary control on food safety.

### Ciguatera Fish Poisoning

Ciguatera is a form of human poisoning caused by the consumption of subtropical and tropical marine finfish which have accumulated naturally occurring toxins through their diet. The toxins are

known to originate from several dinoflagellate (algae) species that are common to ciguatera endemic regions in the lower latitudes.

Manifestations of ciguatera in humans usually involves a combination of gastrointestinal, neurological, and cardiovascular disorders. Symptoms defined within these general categories vary with the geographic origin of toxic fish.

Clinical testing procedures are not presently available for the diagnosis of ciguatera in humans. Diagnosis is based entirely on symptomology and recent dietary history. An enzyme immunoassay (EIA) is used to detect toxic fish in field situations.

Marine finfish most commonly implicated in ciguatera fish poisoning include the groupers, barracudas, snappers, jacks, mackerel, and triggerfish. Many other species of warm-water fishes harbor ciguatera toxins. The occurrence of toxic fish is sporadic, and not all fish of a given species or from a given locality will be toxic (Fig. 31).

Initial signs of poisoning occur within six h after consumption of toxic fish and include perioral numbness and tingling (paresthesia), which may spread to the extremities, nausea, vomiting, and diarrhea. Neurological signs include intensified paresthesia, arthralgia, myalgia, headache, temperature sensory reversal and acute sensitivity to temperature extremes, vertigo, and muscular weakness to the point of prostration. Cardiovascular signs include arrhythmia, bradycardia or tachycardia, and reduced blood pressure. Ciguatera poisoning is usu-

ally self-limiting, and signs of poisoning often subside within several days from the onset. However, in severe cases the neurological symptoms are known to persist from weeks to months. In a few isolated cases neurological symptoms have persisted for several years, and in other cases recovered patients have experienced recurrence of neurological symptoms months to years after recovery. Such relapses are most often associated with changes in dietary habits or with consumption of alcohol. There is a low incidence of death resulting from respiratory and cardiovascular failure.

All humans are believed to be susceptible to ciguatera toxins. Populations in tropical/subtropical regions are most likely to be affected because of the frequency of exposure to toxic fishes. However, the increasing per capita consumption of fishery products coupled with an increase in interregional transportation of seafood products has expanded the geographic range of human poisonings.

### Shellfish Poisoning

Shellfish poisoning is caused by a group of toxins elaborated by planktonic algae (dinoflagellates in most cases) upon which the shellfish feed. The toxins are accumulated and sometimes metabolized by the shellfish. The 20 toxins responsible for paralytic shellfish poisonings (PSP) are all derivatives of saxitoxin. Diarrhetic shellfish poisoning (DSP) is presumably caused by a group of high molecular weight polyethers, including okadaic acid, the di-

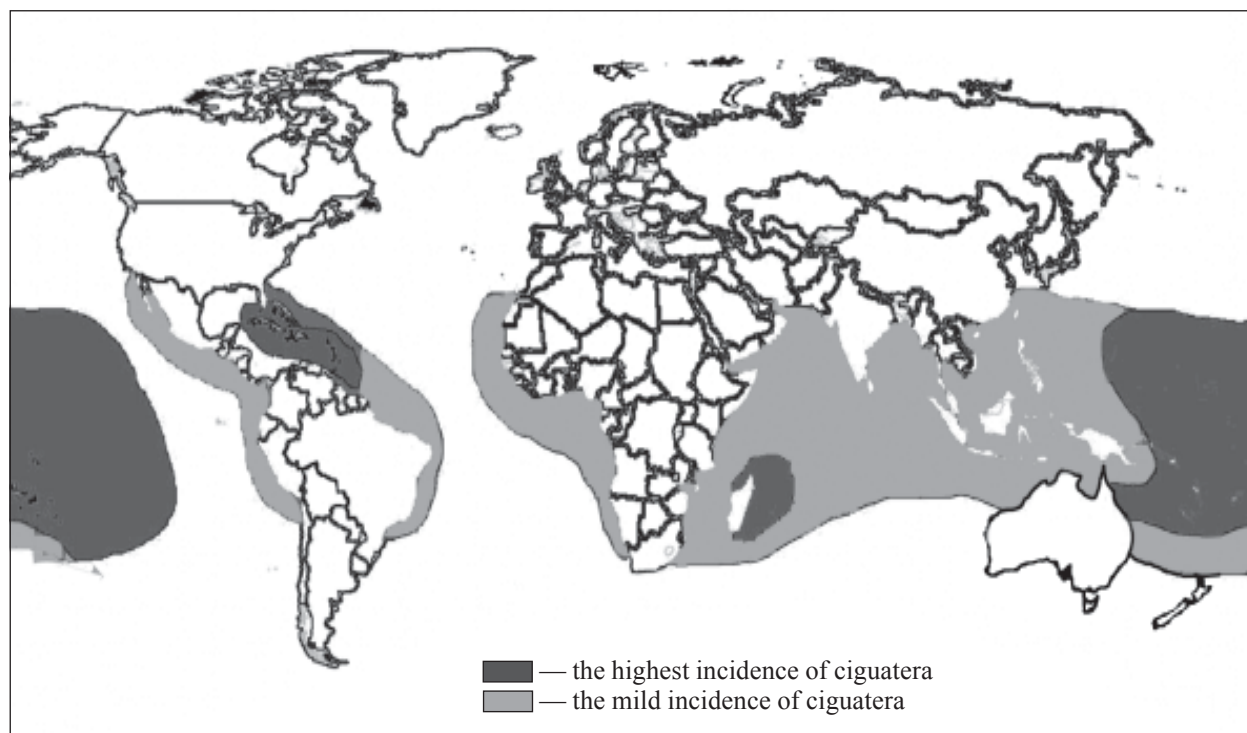


Fig. 31. Worldwide Distribution of Ciguatera Fish Poisoning

nophysins toxins, the pectenotoxins, and yessotoxins. Neurotoxic shellfish poisoning (NSP) is the result of exposure to a group of polyethers called brevetoxins. Amnesic shellfish poisoning (ASP) is caused by the unusual amino acid, domoic acid, as the contaminant of shellfish.

Ingestion of contaminated shellfish results in a wide variety of symptoms, depending upon the toxin(s) present, their concentrations in the shellfish and the amount of contaminated shellfish consumed. In the case of PSP, the effects are predominantly neurological and include tingling, burning, numbness, drowsiness, incoherent speech, and respiratory paralysis. Worse characterized symptoms are those associated with DSP, NSP, and ASP. DSP is primarily observed as a generally mild gastrointestinal disorder, i.e. nausea, vomiting, diarrhea, and abdominal pain accompanied by chills, headache, and fever. Both gastrointestinal and neurological symptoms characterize NSP, including tingling and numbness of lips, tongue, and throat, muscular aches, dizziness, reversal of the sensations of hot and cold, diarrhea, and vomiting. ASP is characterized by gastrointestinal disorders (vomiting, diarrhea, abdominal pain) and neurological problems (confusion, memory loss, disorientation, seizure, coma). Diagnosis of shellfish poisoning is based entirely on observed symptomatology and recent dietary history.

All shellfish (filter-feeding molluscs) are potentially toxic. However, PSP is generally associated with mussels, clams, cockles, and scallops; NSP with shellfish harvested along the Florida coast and the Gulf of Mexico; DSP with mussels, oysters, and scallops, and ASP with mussels.

Good statistical data on the occurrence and severity of shellfish poisoning are largely unavailable, which undoubtedly reflects the inability to measure the true incidence of the disease. Cases are frequently misdiagnosed and, in general, infrequently reported. Of these toxicoses the most serious one of public health perspective appears to be PSP. The extreme potency of the PSP toxins has in the past resulted in an unusually high mortality rate. Symptoms of the PSP develop fairly rapidly, within 0.5 to 2 h after ingestion of the shellfish, depending on the amount of toxin consumed. In severe cases respiratory paralysis is common, and death may occur if respiratory support is not provided. When such support is applied within 12 h of exposure, recovery usually is complete without side effects. In unusual cases, because of the weak hypotensive action of the toxin, death may occur from cardiovascular collapse despite respiratory support.

NSP: The onset of this disease occurs within a few minutes to a few h; duration is fairly short, from a few h to several days. Recovery is complete with few aftereffects; no fatalities have been reported.

DSP: The onset of the disease, depending on the dose of toxin ingested, may be as little as 30 min to 2 to 3 hr, with symptoms of the illness lasting as long as 2 to 3 days. Recovery is complete with no aftereffects; the disease is generally not life threatening.

ASP: The toxicosis is characterized by the onset of gastrointestinal symptoms within 24 h; neurological symptoms occur within 48 h. The toxicosis is particularly serious in elderly patients, and includes symptoms reminiscent of Alzheimer's disease. All fatalities to date have involved elderly patients.

All humans are susceptible to shellfish poisoning. Elderly people are apparently predisposed to the severe neurological effects of the ASP toxin. A disproportionate number of PSP cases occur among tourists or others who are not native to the location where the toxic shellfish are harvested. This may be due to disregard for either official quarantines or traditions of safe consumption, both of which tend to protect the local population.

The mouse bioassay has historically been the most universally applied technique for examining shellfish (especially for PSP); other bioassay procedures have been developed but not generally applied. Unfortunately, the dose-survival times for the DSP toxins in the mouse assay fluctuate considerably and fatty acids interfere with the assay, giving false-positive results; consequently, a suckling mouse assay that has been developed and used for control of DSP measures fluid accumulation after injection of the shellfish extract. In recent years considerable effort has been applied to development of chemical assays to replace these bioassays. As a result a good high performance liquid chromatography (HPLC) procedure has been developed to identify individual PSP toxins (detection limit for saxitoxin = 20 fg/100 g of meats; 0.2 ppm), an excellent HPLC procedure (detection limit for okadaic acid = 400 ng/g; 0.4 ppm), a commercially available immunoassay (detection limit for okadaic acid = 1 fg/100 g of meat; 0.01 ppm) for DSP and a totally satisfactory HPLC procedure for ASP (detection limit for domoic acid = 750 ng/g; 0.75 ppm).

### **Scombroid Poisoning (Histamine Poisoning)**

Scombroid poisoning is caused by the ingestion of food-stuffs that contain high levels of histamine and possibly other vasoactive amines and compounds. Histamine and other amines are formed by the growth of certain bacteria and the subsequent action of their decarboxylase enzymes on histidine and other amino acids in food, either during the production of a product such as Swiss cheese or by spoilage of food-stuffs such as fishery products, particularly tuna or mahi mahi. However, any food that contains the appropriate amino acids and is subject-



ed to certain bacterial contamination and growth may lead to scombroid poisoning when ingested.

Initial symptoms may include a tingling or burning sensation in the mouth, a rash on the upper body and a drop in blood pressure. Frequently, headaches and itching of the skin are encountered. The symptoms may progress to nausea, vomiting, and diarrhea and may require hospitalization, particularly in the case of elderly or impaired patients.

Diagnosis of the illness is usually based on the patient's symptoms, time of the onset, and the effect of treatment with antihistamine medication. The suspected food must be analyzed within a few h for evaluating levels of histamine to confirm a diagnosis.

Fishery products that have been implicated in scombroid poisoning include the tunas (e.g. skipjack and yellowfin), mahi mahi, bluefish, sardines, mackerel, amberjack, and abalone. Many other products also have caused the toxic effects. The primary cheese involved in intoxications has been Swiss cheese. The toxin forms in a food when certain bacteria are present and time and temperature permit their growth. Distribution of the toxin within an individual fish fillet or between cans in a batch can be unequal, with only some sections of a product causing illnesses. Neither cooking nor canning, or freezing reduces the toxic effect. Common sensory examination by the consumer cannot ensure the absence or presence of the toxin. Chemical testing is the only reliable test for evaluation of a product.

The onset of intoxication symptoms is rapid, ranging from immediate to 30 min. The duration of the illness is usually 3 h, but may last for several days. All humans are susceptible to scombroid poisoning; however, the symptoms can be severe for the elderly and for those taking medications such as isoniazid. Because of the worldwide network for harvesting, processing, and distributing fishery products, the impact of the problem is not limited to specific geographical areas.

### **Pufferfish Poisoning (Tetradon Poisoning, Fugu Poisoning)**

Fish poisoning by consumption of members of the order Tetraodontiformes is one of the most violent intoxications from marine species. The gonads, liver, intestines, and skin of pufferfish can contain levels of tetrodotoxin sufficient to produce rapid and violent death. The flesh of many pufferfish may not usually be dangerously toxic. Tetrodotoxin has also been isolated from widely differing animal species, including the California newt, parrotfish, frogs of the genus *Atelopus*, the blue-ringed octopus, starfish, angelfish, and xanthid crabs. The metabolic source of tetrodotoxin is uncertain. No algal source has been identified, and until recently tetrodotoxin was assumed to be a metabolic product of the host.

However, recent reports of the production of tetrodotoxin/anhydrotetrodotoxin by several bacterial species, including strains of the family *Vibrionaceae*, *Pseudomonas sp.*, and *Photobacterium phosphoreum*, point toward a bacterial origin of this family of toxins. These are relatively common marine bacteria that are often associated with marine animals. If confirmed, these findings may have some significance in toxicoses that have been more directly related to these bacterial species.

The diagnosis of pufferfish poisoning is based on the observed symptomatology and recent dietary history.

Poisonings from tetrodotoxin have been almost exclusively associated with the consumption of pufferfish from waters of the Indo-Pacific ocean regions. Several reported cases of poisonings, including fatalities, involved pufferfish from the Atlantic Ocean, Gulf of Mexico, and Gulf of California. There have been no confirmed cases of poisoning from the Atlantic pufferfish, *Spheroides maculatus*. However, in one study, extracts from fish of this species were highly toxic in mice. The trumpet shell *Charonia sauliae* has been implicated in food poisonings, and evidence suggests that it contains a tetrodotoxin derivative. There have been several reported poisonings from mislabelled pufferfish and at least one report of a fatal episode when an individual swallowed a California newt. From 1974 through 1983 there were 646 reported cases of pufferfish poisoning in Japan, with 179 fatalities. Estimates as high as 200 cases per year with mortality approaching 50% have been reported. Only a few cases have been reported in the United States, and outbreaks in countries outside the Indo-Pacific area are rare.

The first symptom of intoxication is a slight numbness of the lips and tongue, appearing between 20 min to 3 h after eating poisonous pufferfish. The next symptom is increasing paraesthesia in the face and extremities, which may be followed by sensations of lightness or floating. Headache, epigastric pain, nausea, diarrhea, and/or vomiting may occur. Occasionally, some reeling or difficulty in walking may occur. The second stage of the intoxication is increasing paralysis. Many victims are unable to move; even sitting may be difficult. There is increasing respiratory distress. Speech is affected, and the victim usually exhibits dyspnea, cyanosis, and hypotension. Paralysis increases and convulsions, mental impairment, and cardiac arrhythmia may occur. The victim, although completely paralyzed, may be conscious and in some cases completely lucid until shortly before death. Death usually occurs within 4 to 6 h, with a known range of about 20 min to 8 h.

All humans are susceptible to tetrodotoxin poisoning. This toxicosis may be avoided by not consuming pufferfish or other animal species containing tetrodotoxin. Most other animal species known

to contain tetrodotoxin are not usually consumed by humans. Poisoning from tetrodotoxin is of major public health concern primarily in Japan, where “fugu” is a traditional delicacy. It is prepared and sold in special restaurants where trained and licensed individuals carefully remove the viscera to reduce the danger of poisoning. Importation of pufferfish into the United States is not generally permitted, although special exceptions may be granted. There is potential for misidentification and/or mislabelling, particularly of prepared, frozen fish products.

The mouse bioassay developed for paralytic shellfish poisoning (PSP) can be used to monitor tetrodotoxin in pufferfish and is the current method of choice. An HPLC method with post-column reaction with alkali and fluorescence has been developed to determine tetrodotoxin and its associated toxins. The alkali degradation products can be confirmed as their trimethylsilyl derivatives by gas chromatography/mass spectrometry. These chromatographic methods have not yet been validated.

### **Mushroom Poisoning (Toadstool Poisoning)**

Mushroom poisoning is caused by the consumption of raw or cooked fruiting bodies (mushrooms, toadstools) of a number of species of higher fungi. The term toadstool (from the German Todesstuhl, death’s stool) is commonly given to poisonous mushrooms, but for individuals who are not experts in mushroom identification there are generally no easily recognizable differences between poisonous and nonpoisonous species. Old wives’ tales notwithstanding, there is no general rule of thumb for distinguishing edible mushrooms and poisonous toadstools. The toxins involved in mushroom poisoning are produced naturally by the fungi themselves, and each individual specimen of a toxic species should be considered equally poisonous. Most mushrooms that cause human poisoning cannot be made nontoxic by cooking, canning, freezing, or any other means of processing. Thus, the only way to avoid poisoning is to avoid consumption of the toxic species. Poisonings occur most commonly when hunters of wild mushrooms (especially novices) misidentify and consume a toxic species. In the USA and Australia immigrants collect and consume a poisonous domestic species that closely resembles an edible wild mushroom from their native land. Sometimes poisoning occurs when mushrooms that contain psychoactive compounds are intentionally consumed by persons who desire these effects.

Mushroom poisonings are generally acute and are manifested by a variety of symptoms and prognoses, depending on the amount and species consumed. Because the chemistry of many of the mushroom toxins (especially the less deadly ones) is still unknown and positive identification of the mushrooms is often difficult or impossible, mushroom

poisonings are generally categorized by their physiological effects. There are four categories of mushroom toxins: protoplasmic poisons (poisons that result in generalized destruction of cells, followed by organ failure); neurotoxins (compounds that cause neurological symptoms such as profuse sweating, coma, convulsions, hallucinations, excitement, depression, spastic colon); gastrointestinal irritants (compounds that produce rapid, transient nausea, vomiting, abdominal cramping, and diarrhea); and disulfiram-like toxins. Mushrooms in this last category are generally nontoxic and produce no symptoms unless alcohol is consumed within 72 h after eating them, in this case a short-lived acute toxic syndrome is produced.

Mushroom poisonings are almost always caused by ingestion of wild mushrooms that have been collected by nonspecialists (although specialists have also been poisoned). Most cases occur when toxic species are confused with edible species, and a useful question to ask the victims or their mushroom-picking benefactors is the identity of the mushroom they thought they were picking. In the absence of a well-preserved specimen, the answer to this question could narrow the possible suspects considerably. Intoxication has also occurred when reliance was placed on some folk method of distinguishing poisonous and safe species. Outbreaks have occurred after ingestion of fresh, raw mushrooms, stir-fried mushrooms, home-canned mushrooms, mushrooms cooked in tomato sauce (which rendered the sauce itself toxic, even when no mushrooms were consumed), and mushrooms that were blanched and frozen at home. Cases of poisoning by home-canned and frozen mushrooms are especially insidious because a single outbreak may easily become a multiple outbreak when the preserved toadstools are carried to another location and consumed at another time.

Specific cases of mistaken mushroom identity appear frequently. The potentially deadly Sorrel Webcap Mushroom (*Cortinarius orellanus*) is not easily distinguished from nonpoisonous webcaps belonging to the same distinctive genus, and all should be avoided. The Early False Morel *Gyromitra esculenta* is easily confused with the true Morel *Morchella esculenta*, and poisonings have occurred after consumption of fresh or cooked *Gyromitra*. *Gyromitra* poisonings have also occurred after ingestion of commercially available “morels” contaminated with *G. esculenta*. The commercial sources for these fungi (which have not yet been successfully cultivated on a large scale) are field collection of wild morels by semiprofessionals. Cultivated commercial mushrooms of whatever species are almost never implicated in poisoning outbreaks unless there are associated problems such as improper canning (which lead to bacterial food poisoning).

Most of the psychotropic mushrooms (*Inocybe spp.*, *Conocybe spp.*, *Paneolus spp.*, *Pluteus spp.*) are in general appearance small, brown, and leathery (the so-called “Little Brown Mushrooms”) and relatively unattractive from a culinary standpoint.

The Fly Agaric (*Amanita muscaria*) and Panthercap (*Amanita pantherina*) mushrooms are large, fleshy, and colorful. Yellowish cap colors on some varieties of the Fly Agaric and the Panthercap are similar to the edible Caesar’s Mushroom (*Amanita caesarea*), which is considered a delicacy in Italy. Another edible yellow capped mushroom occasionally confused with yellow *A. muscaria* and *A. pantherina* varieties are the Yellow Blusher (*Amanita flavorubens*). Orange to yellow-orange *A. muscaria* and *A. pantherina* may also be confused with the Blusher (*Amanita rubescens*) and the Honey Mushroom (*Armillariella mellea*). White to pale forms of *A. muscaria* may be confused with edible field mushrooms (*Agaricus spp.*). Young (button stage) specimens of *A. muscaria* have also been confused with puffballs.

The normal course of the disease varies with the dose and the mushroom species eaten. Each poisonous species contains one or more toxic compounds which are unique to few other species. Therefore, cases of mushroom poisonings generally do not resemble each other unless they are caused by the same or very closely related mushroom species.

Several mushroom species, including the Death Cap or Destroying Angel (*Amanita phalloides*, *A. virosa*), the Fool’s Mushroom (*A. verna*) and several of their relatives, along with the Autumn Skullcap (*Galerina autumnalis*) and some of its relatives, produce a family of cyclic octapeptides called amanitins. Poisoning by the amanitins is characterized by a long latent period (range 6–48 h, average 6–15 h) during which the patient shows no symptoms. Symptoms appear at the end of the latent period in the form of sudden, severe seizures of abdominal pain, persistent vomiting and watery diarrhea, extreme thirst, and lack of urine production. If this early phase is survived, the patient may appear to recover for a short time, but this period will generally be followed by a rapid and severe loss of strength, prostration, and pain-caused restlessness. Death in 50–90% of the cases from progressive and irreversible liver, kidney, cardiac, and skeletal muscle damage may follow within 48 h (large dose), but the disease more typically lasts for 6 to 8 days in adults and 4 to 6 days in children. Two or three days after the onset of the later phase, jaundice, cyanosis, and coldness of the skin occur. Death usually follows a period of coma and occasionally convulsions. If recovery occurs, it generally requires at least a month and is accompanied by enlargement of the liver. Autopsy will usually reveal fatty degeneration and necrosis of the liver and kidney.

Certain species of False Morel (*Gyromitra esculenta* and *G. gigas*) contain the protoplasmic poison gyromitrin, a volatile hydrazine derivative. Poisoning by this toxin superficially resembles *Amanita* poisoning but is less severe. There is generally a latent period of 6–10 h after ingestion during which no symptoms are evident, followed by sudden onset of abdominal discomfort (a feeling of fullness), severe headache, vomiting, and sometimes diarrhea. The toxin affects primarily the liver, but there are additional disturbances to blood cells and the central nervous system. The mortality rate is relatively low (2–4%). Poisonings with symptoms almost identical to those produced by *Gyromitra* have also been reported after ingestion of the Early False Morel (*Verpa bohemica*). The toxin is presumed to be related to gyromitrin but has not yet been identified.

The final type of protoplasmic poisoning is caused by the Sorrel Webcap mushroom (*Cortinarius orellanus*) and some of its relatives. This mushroom produces orellanine, which causes a type of poisoning characterized by an extremely long asymptomatic latent period of 3 to 14 days. An intense, burning thirst (polydipsia) and excessive urination (polyuria) are the first symptoms. This may be followed by nausea, headache, muscular pains, chills, spasms, and loss of consciousness. In severe cases, severe renal tubular necrosis and kidney failure may result in death (15%) several weeks after the poisoning. Fatty degeneration of the liver and severe inflammatory changes in the intestine accompany the renal damage, and recovery in less severe cases may require several months.

Ingestion of any number of *Inocybe* or *Clitocybe* species (e.g. *Inocybe geophylla*, *Clitocybe dealbata*) results in an illness characterized primarily by profuse sweating. This effect is caused by the presence in these mushrooms of high levels (3–4%) of muscarine. Muscarine poisoning is characterized by increased salivation, perspiration, and lacrimation within 15 to 30 minutes after ingestion of the mushroom. With large doses, these symptoms may be followed by abdominal pain, severe nausea, diarrhea, blurred vision, and labored breathing. Intoxication generally subsides within 2 h. Deaths are rare, but may result from cardiac or respiratory failure in severe cases.

The Fly Agaric (*Amanita muscaria*) and Panthercap (*Amanita pantherina*) mushrooms both produce ibotenic acid and muscimol. Both substances produce the same effects, but muscimol is approximately 5 times more potent than ibotenic acid. Symptoms of poisoning generally occur within 1–2 h after ingestion of the mushrooms. An initial abdominal discomfort may be present or absent, but the chief symptoms are drowsiness and dizziness (sometimes accompanied by sleep), followed by a period of hyperactivity, excitability, illusions, and delirium.

Periods of drowsiness may alternate with periods of excitement, but symptoms generally fade within a few h. Fatalities rarely occur in adults, but in children, accidental consumption of large quantities of these mushrooms may cause convulsions, coma, and other neurologic problems for up to 12 h.

A number of mushrooms belonging to the species *Psilocybe*, *Panaeolus*, *Copelandia*, *Gymnopilus*, *Conocybe*, and *Pluteus*, when ingested, produce a syndrome similar to alcohol intoxication (sometimes accompanied by hallucinations). Several of these mushrooms (e.g. *Psilocybe cubensis*, *P. mexicana*, *Conocybe cyanopus*) are eaten for their psychotropic effects in religious ceremonies of certain native American tribes, a practice which dates to the pre-Columbian era. The toxic effects are caused by psilocin and psilocybin. The onset of symptoms is usually rapid and the effects generally subside within 2 h. Poisonings by these mushrooms are rarely fatal in adults and may be distinguished from ibotenic acid poisoning by the absence of drowsiness or coma. The most severe cases of psilocybin poisoning occur in small children, where large doses may cause the hallucinations accompanied by fever, convulsions, coma, and death. These mushrooms are generally small, brown, and not particularly fleshy; they are seldom assumed to be edible by wild mushrooms innocent hunters. Poisonings caused by intentional ingestion of these mushrooms by people with no legitimate religious justification must be handled with care, since the only cases likely to be seen by the physician are overdoses or intoxications caused by a combination of the mushroom and some added psychotropic substance (such as PCP).

Numerous mushrooms, including the Green Gill (*Chlorophyllum molybdites*), Gray Pinkgill (*Entoloma lividum*), Tigertop (*Tricholoma pardinum*), Jack O'Lantern (*Omphalotus illudens*), Naked Brimcap (*Paxillus involutus*), Sickener (*Russula emetica*), Early False Morel (*Verpa bohemica*), Horse mushroom (*Agaricus arvensis*) and Pepper bolete (*Boletus piperatus*), contain toxins that can cause gastrointestinal distress, including nausea, vomiting, diarrhea, and abdominal cramps. In many ways these symptoms are similar to those caused by the deadly protoplasmic poisons. The chief and diagnostic difference is that poisonings caused by these mushrooms have a rapid onset, rather than the delayed onset seen in protoplasmic poisonings. Some mushrooms (including the first five species mentioned above) may cause vomiting and/or diarrhea which lasts for several days. Fatalities caused by these mushrooms are relatively rare and are associated with dehydration and electrolyte imbalances caused by diarrhea and vomiting, especially in debilitated, very young, or very old patients. Replacement of fluids and other appropriate supportive therapy will prevent death in these cases. The chemistry of the toxins responsible for this type of poisoning is vir-

tually unknown, but may be related to the presence in some mushrooms of unusual sugars, amino acids, peptides, resins, and other compounds.

The Inky Cap Mushroom (*Coprinus atramentarius*) is most commonly responsible for this poisoning, although a few other species have also been implicated. A complicating factor in this type of intoxication is that this species is generally considered edible (i.e., no illness results when eaten in the absence of alcoholic beverages). The mushroom produces an unusual amino acid, coprine, which is converted to cyclopropanone hydrate in the human body. This compound interferes with the breakdown of alcohol, and consumption of alcoholic beverages within 72 h after eating it will cause headache, nausea and vomiting, flushing, and cardiovascular disturbances that last for 2–3 h.

Young fruiting bodies of the sulfur shelf mushroom *Laetiporus sulphureus* are considered edible. However, ingestion of this shelf mushroom has caused digestive upset and other symptoms in adults and visual hallucinations and ataxia in a child.

All humans are susceptible to mushroom toxins. The poisonous species are ubiquitous, and geographical restrictions on types of poisoning that may occur in one location do not exist (except for some of the hallucinogenic mushrooms). Individual specimens of poisonous mushrooms are also characterized by individual variations in toxin content based on genetics, geographic location, and growing conditions. Intoxications may thus be more or less serious, depending not on the number of mushrooms consumed, but on the dose of toxin delivered. In addition, although most cases of poisoning by higher plants occur in children, toxic mushrooms are consumed most often by adults. Occasional accidental mushroom poisonings of children and pets have been reported, but adults are more likely to actively search for and consume wild mushrooms for culinary purposes. Children are more seriously affected by the normally nonlethal toxins than adults are and more likely to suffer very serious consequences from ingestion of relatively smaller doses. Adults who consume mushrooms are also more likely to recall what was eaten and when, and are able to describe their symptoms more accurately than children are. Very old, very young, and debilitated persons of both sexes are more likely to become seriously ill from all types of mushroom poisoning, even those types which are generally considered to be mild.

Many idiosyncratic adverse reactions to mushrooms have been reported. Some mushrooms cause certain people to become violently ill, while not affecting others who consumed part of the same mushroom cap. Factors such as age, sex, and general health of the consumer do not seem to be reliable predictors of these reactions, and they have been attributed to allergic or hypersensitivity reactions and to inherited inability of the unfortunate victim to

metabolize certain unusual fungal constituents (such as the uncommon sugar, trehalose). These reactions are probably not true poisonings as the general population does not seem to be affected.

Health promotion is very important in the prevention of mushroom poisonings. People should avoid to collect unknown mushrooms. It's prohibited to sell mixture of the mushrooms at the market.

### **Red Kidney Bean (*Phaseolus vulgaris*) Poisoning, Kinkoti Bean Poisoning, Fabism**

The onset time from consumption of raw or undercooked kidney beans to symptoms varies from between 1 to 3 h. The onset is usually marked by extreme nausea, followed by vomiting, which may be very severe. Diarrhea develops somewhat later (from one to a few h), and some persons report abdominal pain. Some persons have been hospitalized, but recovery is usually rapid (3–4 h after the onset of symptoms) and spontaneous.

Phytohaemagglutinin, the presumed toxic agent, is found in many species of beans, but it is in highest concentration in red kidney beans (*Phaseolus vulgaris*). The unit of toxin measure is the hemagglutinating unit (hau). Raw kidney beans contain from 20,000 to 70,000 hau, while fully cooked beans contain from 200 to 400 hau. White kidney beans, another variety of *Phaseolus vulgaris*, contain about one-third the amount of toxin as the red variety; broad beans (*Vicia faba*) contain 5 to 10% the amount that red kidney beans contain.

The syndrome is usually caused by the ingestion of raw, soaked kidney beans, either alone or in salads or casseroles. As few as four or five raw beans can trigger symptoms. Several outbreaks have been associated with "slow cookers" or crock pots, or in casseroles which had not reached a high enough internal temperature to destroy the glycoprotein lectin. It has been shown that heating to 800°C may potentiate the toxicity five-fold, so that these beans are more toxic than if eaten raw. In studies of casseroles cooked in slow cookers, internal temperatures often did not exceed 75°C.

The disease course is rapid. All symptoms usually resolve within several h from the onset. Vomiting is usually described as profuse, and the severity of symptoms is directly related to the dose of toxin (number of raw beans ingested). Hospitalization has occasionally resulted, and intravenous fluids may have to be administered. Although of short duration, the symptoms are extremely debilitating.

All persons, regardless of age or gender, appear to be equally susceptible; the severity is related only to the dose ingested. In the seven outbreaks mentioned above, the attack rate was 100%. Prevention: do not use raw beans and bean flour for baking.

### **Honey Intoxication**

Honey intoxication is caused by the consumption of honey produced from the nectar of rhododendrons. The grayanotoxins cause the intoxication. The specific grayanotoxins vary with the plant species. These compounds are diterpenes, polyhydroxylated cyclic hydrocarbons that do not contain nitrogen. Other names associated with the disease is rhododendron poisoning, mad honey intoxication or grayanotoxin poisoning.

The intoxication is rarely fatal and generally lasts for no more than 24 h. Generally the disease induces dizziness, weakness, excessive perspiration, nausea, and vomiting shortly after the toxic honey is ingested. Other symptoms that can occur are low blood pressure or shock, bradyarrhythmia (slowness of the heart beat associated with an irregularity in the heart rhythm), sinus bradycardia (a slow sinus rhythm, with a heart rate less than 60), nodal rhythm (pertaining to a node, particularly the atrioventricular node), Wolff — Parkinson — White syndrome (anomalous atrioventricular excitation) and complete atrioventricular block.

The grayanotoxins bind to sodium channels in cell membranes. The binding unit is the group II receptor site, localized on a region of the sodium channel that is involved in the voltage-dependent activation and inactivation. These compounds prevent inactivation; thus, excitable cells (nerve and muscle) are maintained in a state of depolarization, during which entry of calcium into the cells may be facilitated. This action is similar to that exerted by the alkaloids of veratrum and aconite. All of the observed responses of skeletal and heart muscles, nerves, and the central nervous system are related to the membrane effects.

In humans, symptoms of poisoning occur after a dose-dependent latent period of a few minutes to two or more h and include salivation, vomiting, and both circumoral (around or near the mouth) and extremity paresthesia (abnormal sensations). Pronounced low blood pressure and sinus bradycardia develop. In severe intoxication, loss of coordination and progressive muscular weakness result. Extrasystoles (a premature contraction of the heart that is independent of the normal rhythm and arises in response to an impulse in some part of the heart other than the sinoatrial node; called also premature beat) and ventricular tachycardia (an abnormally rapid ventricular rhythm with aberrant ventricular excitation, usually in excess of 150 per minute) with both atrioventricular and intraventricular conduction disturbances also may occur. Convulsions are reported occasionally.

Grayanotoxin poisoning most commonly results from the ingestion of grayanotoxin-contaminated honey, but although it may result from the ingestion of the leaves, flowers, and nectar of rhododen-

drons. Not all rhododendrons produce grayanotoxins. *Rhododendron ponticum* grows extensively on the mountains of the eastern Black Sea area of Turkey. This species has been associated with honey poisoning since 401 B.C.

The increased desire of people for natural (unprocessed) food-stuffs, may result in more cases in grayanotoxin poisoning. Individuals who obtain honey from farmers who may have only a few hives are at increased risk. The pooling of massive quantities of honey during commercial processing generally dilutes any toxic substance.

The grayanotoxins can be isolated from the suspect commodity by typical extraction procedures for naturally occurring terpenes. The toxins are identified by thin layer chromatography.

### **Pyrrolizidine Alkaloids Poisoning**

Pyrrolizidine alkaloid intoxication is caused by consumption of plant material containing these alkaloids. The plants may be consumed as food, for medicinal purposes, or as contaminants of other agricultural crops. Cereal crops and forage crops are sometimes contaminated with pyrrolizidine-producing weeds, and the alkaloids find their way into flour and other food-stuffs, including milk from cows feeding on these plants. Many plants from the Boraginaceae, Compositae, and Leguminosae families contain well over 100 hepatotoxic pyrrolizidine alkaloids.

Most cases of pyrrolizidine alkaloid toxicity result in moderate to severe liver damage. Gastrointestinal symptoms are usually the first sign of intoxication, and consist predominantly of abdominal pain with vomiting and the development of ascites. Death may ensue from 2 weeks to more than 2 years after poisoning, but patients may recover almost completely if the alkaloid intake is discontinued and the liver damage has not been too severe.

Evidence of toxicity may not become apparent until sometime after the alkaloid is ingested. The acute illness has been compared to the Budd — Chiari syndrome (thrombosis of hepatic veins, leading to liver enlargement, portal hypertension, and ascites). Early clinical signs include nausea and acute upper gastric pain, acute abdominal distension with prominent dilated veins on the abdominal wall, fever, and biochemical evidence of liver disfunction. Fever and jaundice may be present. In some cases the lungs are affected; pulmonary edema and pleural effusions have been observed. Lung damage may be prominent and has been fatal. Chronic illness from ingestion of small amounts of the alkaloids over a long period proceeds through fibrosis of the liver to cirrhosis, which is indistinguishable from cirrhosis of other etiology.

Reports of acute poisoning among humans are relatively rare. Most result from the use of medicinal preparations as home remedies. However, intox-

ications of range animals sometimes occur in areas under drought stress, where plants containing alkaloids are common. Milk from dairy animals can become contaminated with the alkaloids, and alkaloids have been found in the honey collected by bees foraging on toxic plants. Mass human poisonings have occurred in other countries when cereal crops used to prepare food were contaminated with seeds containing pyrrolizidine alkaloid.

All humans are believed to be susceptible to the hepatotoxic pyrrolizidine alkaloids. Home remedies and consumption of herbal teas in large quantities can be a risk factor and are the most likely causes of alkaloid poisonings in the developed countries.

The pyrrolizidine alkaloids can be isolated from the suspect commodity by any of several standard alkaloid extraction procedures. The toxins are identified by thin layer chromatography. The pyrrolizidine ring is first oxidized to a pyrrole followed by spraying with Ehrlich reagent, which gives a characteristic purple spot. Gas-liquid chromatographic and mass spectral methods also are available for identifying the alkaloids.

### **Food mycotoxicoses**

Food mycotoxicoses are diseases occurring as a result of consumption of food products, containing toxic metabolites of life activity of specific groups of microscopic fungi. Mycotoxins are recorded in history as far back as 5,000 years ago in China. Besides ergot and mushroom poisonings, reports as early 1861 indicate that a suspected mycotoxin affecting humans was reported in Russia, and in 1891 there was a report of mouldy rice in Japan to be toxic to man. This review reports on the early literature on mycotoxins affecting human up to 1960, which is the time of the discovery of aflatoxin, and to our present knowledge where this problem still persists. They proceed acutely, but often — chronic. Mycotoxins are resistant to influence of high temperatures (200 degree Celsius and more). At present there are no reliable methods of disinfecting of products contaminated by mycotoxins. Most significant amongst mycotoxins are aflatoxicoses, fusariotoxicoses and ergotism.

Historically, the aflatoxins were discovered as a consequence of the death of 100,000 of turkey poults (“Turkey X disease”), ducklings and chicks in England in 1960 with a loss of at least several hundred thousand dollars. The problem was eventually traced to feed contamination, specifically a shipment of Brazilian peanut meal used as poultry feed produced by Old Cake Mills, Ltd. in London. This meal, termed Rosetti meal (from the name of the ship in which it was imported), proved to be both toxic and carcinogenic and was found to be contaminated with the common fungus, *Aspergillus flavus*.

**Aflotoxicoses.** The aflatoxins are a group of secondary fungal metabolites which have been epi-

demiologically implicated as environmental toxin and carcinogens in man. They are substituted coumarins containing a fused dihydrofurofuran moiety. There are four primary aflatoxins, named B1, B2, G1 and G2, from their blue and green fluorescence, respectively, on thin-layer chromatographic plates. As was generally known to be the case with aflatoxin toxicity and carcinogenicity, a similar potency series, namely AFB1 > AFB2 > AFG1 > AFG2 > has been established for aflatoxin — induced mutagenic activity and DNA damage.

It was established that they were produced by fungi of family *Aspergillus*: *A. flavus* and *A. parasiticus*. Aflatoxins according to their chemical structure belong to furocoumarins. At present around 15 aflatoxins are known. The most toxic is aflatoxin B1. They possess highly powerful hepatotoxic and hepatocarcinogenic influence. Carcinogenic activity considerably exceeds that of benzopyrene and dimethylnitrosamine of “ethanol” cancerogens.

Aflatoxicosis is poisoning that results from ingestion of aflatoxins in contaminated food or feed. The aflatoxins are a group of structurally related toxic compounds produced by certain strains of the fungi *Aspergillus flavus* and *A. parasiticus*. Under favorable conditions of temperature and humidity, these fungi grow on certain food-stuffs and feeds, resulting in the production of aflatoxins. The most pronounced contamination has been encountered in tree nuts, peanuts, and other oilseeds, including corn and cottonseed. The major aflatoxins of concern are designated B1, B2, G1, and G2. These toxins are usually found together in various food-stuffs and feeds in various proportions; however, aflatoxin B1 is usually predominant and is the most toxic. When a commodity is analyzed by thin-layer chromatography, the aflatoxins separate into the individual components in the order given above; however, the first two fluoresce blue when viewed under ultraviolet light and the second two fluoresce green. Aflatoxin M is a major metabolic product of aflatoxin B1 in animals and is usually excreted in the milk and urine of dairy cattle and other mammalian species that have consumed aflatoxin-contaminated food or feed.

Aflatoxins produce acute necrosis, cirrhosis, and carcinoma of the liver in a number of animal species; no animal species is resistant to the acute toxic effects of aflatoxins; hence it is logical to assume that humans may be similarly affected. A wide variation in LD50 values has been obtained in animal species tested with single doses of aflatoxins. For most species, the LD50 value ranges from 0.5 to 10 mg/kg of the body weight. Animal species respond differently in their susceptibility to the chronic and acute toxicity of aflatoxins. The toxicity can be influenced by environmental factors, exposure level, and duration of exposure, age, health, and nutritional status of diet. Aflatoxin B1 is a very potent carcin-

ogen in many species, including nonhuman primates, birds, fish, and rodents. In each species, the liver is the primary target organ of acute injury. Metabolism plays a major role in determining the toxicity of aflatoxin B1; studies show that this aflatoxin requires metabolic activation to exert its carcinogenic effect, and these effects can be modified by induction or inhibition of the mixed function oxidase system.

Aflatoxicosis in humans has rarely been reported; however, such cases are not always recognized. Aflatoxicosis may be suspected when a disease outbreak exhibits the following characteristics:

- the cause is not readily identifiable;
- the condition is not transmissible;
- syndromes may be associated with certain batches of food;
- treatment with antibiotics or other drugs has little effect;
- the outbreak may be seasonal, i.e., weather conditions may affect mold growth.

The adverse effects of aflatoxins in animals (and presumably in humans) have been categorized in two general forms.

1. Acute aflatoxicosis is produced when moderate to high levels of aflatoxins are consumed. Specific, acute episodes of disease may include hemorrhage, acute liver damage, edema, alteration in digestion, absorption and/or metabolism of nutrients, and possibly death.

2. Chronic aflatoxicosis results from ingestion of low to moderate levels of aflatoxins. The effects are usually subclinical and difficult to recognize. Some of the common symptoms are impaired food conversion and slower rates of growth with or without the production of an overt aflatoxin syndrome.

In the world aflatoxins have been identified in corn and corn products, peanuts and peanut products, cottonseed, milk, and tree nuts such as Brazil nuts, pecans, pistachio nuts, and walnuts. Other grains and nuts are susceptible but less prone to contamination.

In well-developed countries, aflatoxin contamination rarely occurs in food-stuffs at levels that cause acute aflatoxicosis in humans. In view of this, studies on human toxicity from ingestion of aflatoxins have focused on their carcinogenic potential. The relative susceptibility of humans to aflatoxins is not known, even though epidemiological studies in Africa and South-East Asia, where there is a high incidence of hepatoma, have revealed an association between cancer incidence and the aflatoxin content of the diet. These studies have not proved a cause-effect relationship, but the evidence suggests an association.

One of the most important accounts of aflatoxicosis in humans occurred in more than 150 villages in adjacent districts of two neighboring states in North-West India in the fall of 1974. According to one report of this outbreak, 397 persons were af-

ected and 108 persons died. In this outbreak, contaminated corn was the major dietary constituent, and aflatoxin levels of 0.25 to 15 mg/kg were found. The daily aflatoxin B1 intake was estimated to have been at least 55 mg/kg of the body weight for an undetermined number of days. The patients experienced high fever, rapid progressive jaundice, edema of the limbs, pain, vomiting, and swollen liver. One investigator reported a peculiar and very notable feature of the outbreak: the appearance of signs of disease in one village population was preceded by a similar disease in domestic dogs, which was usually fatal. Histopathological examination of humans showed extensive bile duct proliferation and periportal fibrosis of the liver together with gastrointestinal hemorrhages. A 10-year follow-up of the Indian outbreak found the survivors fully recovered with no ill effects from the experience. A second outbreak of aflatoxicosis was reported from Kenya in 1982. There were 20 hospital admissions with a 60% mortality; daily aflatoxin intake was estimated to be at least 38 mg/kg of the body weight for an undetermined number of days.

Although humans and animals are susceptible to the effects of acute aflatoxicosis, the chances of human exposure to acute levels of aflatoxin is remote in well-developed countries. In undeveloped countries, human susceptibility can vary with age, health, and level and duration of exposure.

Maximal permitted content of aflatoxin B1 in food products is 10 µg. In the products for child nutrition presence of aflatoxin is not permitted in Ukraine.

**Ergotism.** Infection of grasses and cereals with fungal species of genus *Claviceps* produces sclerotia (compact hyphal structure). The pharmacological properties of ergot were recognized in the second half of the 16th century, and about 100 years later, cereal grains containing ergot were shown to be the cause of these epidemics in Europe. In 1951 there was an outbreak of "bread poisoning" in a small town in France. Apparently moldy rye was sold illegally (to avoid a grain tax) in central France to a miller, who ground the rye and mixed it with flour which he then sold to a baker.

On August 15, 1951, many people ate small amounts of bread which may have been made from this contaminated flour. About 200 people became ill, as did many domestic animals, dogs, cats, poultry, fish, fed the same bread. A total of 25 people suffered from severe delirium. A recent outbreak occurred in Ethiopia, 97 of 42,000 people developed gangrenous ergotism. *Claviceps purpurea* is the common ergot on rye and wheat. The fungus lives over winter in the form of sclerotium, a dense mass of fungus cells. Usually the sclerotia are somewhat larger and also less dense than the seeds of the host plant on which they are borne.

The ergot alkaloids are derivatives of Lysergic acid (ergotamine), isolysergic acid (ergocristine) or dimethyl ergoline (agoclacine). Pharmacologically, these compounds are rapid acting, powerful oxytocics, i.e. they stimulate the smooth muscle of the uterus. They are also weak vasoconstrictors.

Descriptions of ergot poisoning written in the Middle Ages were quite vivid. There were severe internal feeling of heat and intense thirst, multiple ulcerations of the skin, a burning sensation of the limbs, the feeling of ants and mice crawling underneath the skin, the drying and turning black of hands, arms, feet and legs, blindness, dementia and mental degeneration.

Acute ergot poisoning today is essentially a problem only in chemotherapy and rarely has it occurred recently as a result of eating. The symptoms include vomiting, diarrhea, intense thirst, a tingling, itchy and cold skin, a rapid, weak pulse, confusion, and unconsciousness.

Chronic ergot poisoning today seems limited to accidents in treating patients for migraine headaches. The extremities, especially the feet and legs, become cold, pale, and numb because of the constriction of the local blood vessels resulting in diminished blood flow. Walking becomes painful and eventually gangrene develops.

**Pink Rot Disease.** In 1961, Birmingham et al reported a phototoxic dermatitis which had been shown to be endemic among white harvesters of celery. It was believed that exposure to celery oil and sunlight was responsible for the dermatitis. Also, it was noted that the dermatitis was more severe when rotted celery was handled. Experimentally, only extracts of rotted celery produced the characteristic blistering lesions of celery dermatitis. Celery rot ("pink rot") is a fungus disease produced by *Sclerotinia sclerotiorum*.

Two psoralens were isolated and identified from "pink rot" celery which were not detectable in healthy extracts. The psoralens and a group of linear furocoumarins containing a furan ring fuse at the 2.3 position to the c-6 and c-7 of the coumarin structure.

The affected areas were the hands and forearms, but the lower legs, chest, abdomen, and back also affected if the worker wore shorts and no shirt. The lesions were healing with depigmentation for many months. The incidence was said to be greater after rain and before the use of fungicides to control fungal growth on the celery.

Psoralens, especially 8-methoxypsoralen and trimethoxypsoralen have been used successfully to treat vitiligo, which is a progressive, localized achromasia of the skin resulting from a functional abnormality of the melanocytes, apparently due to the loss of function of the tyrosinase system.

In apparent careless use of psoralens as suntanning agents to augment the tanning capabilities of the skin, excessive amounts of the agents were used,



and after exposure to the sun, a severe dermatitis developed.

**Alimentary Toxic Aleukia.** The bulk of the literature on blood-forming disease is written in Russian, for it is in the Soviet Union that the disease has been a problem. Perhaps as early as 1913, a foodborne disease, possibly from eating fusarium — contaminated bread, occurred in Siberia. During the war years of 1941–1945 larger outbreaks occurred more frequently than in the 1930, is involving several districts in Western Siberia and European Soviet Russia.

Soon the toxicity of rye was related to the growth of toxigenic strains of *Fusarium* on the cereal seed which absorbed much moisture and provided a suitable medium for the growth of cryophilic fungi.

It has been suggested that the epoxytrichothecenes, T-2 toxin, played a role in Russian alimentary toxic aleukia (Bamburg, et al. 1969). It is shown that T-2 poisoning in chickens resembles the mycotoxin poisoning associated with Russian overwintered grain. The trichothecenes are produced by various species of *Fusarium* especially *Fusarium graminearum* (*F. roseum*), *F. moniliforme*, etc. The trichothecenes are a complex group of sesquiterpenoids containing the trichothecane nucleus, characterized by an olefinic bond at the 9, 10 position and an epoxy group at the 12, 13 position.

The descriptions of the disease, dividing the clinical feature into four stages, indicate that the disease seems to result from toxic injury to the hematopoietic, autonomic nervous, and endocrine systems.

**First Stage.** This is a rapid onset of irritation to the upper gastrointestinal tract, beginning a few h after ingestion of the toxic cereal product, often bread. The contaminated food would have a peppery taste and produce a burning sensation from the mouth to the stomach. Within a few days, the patient develops acute gastro-enteritis, with nausea, vomiting and diarrhea. This local effect persists for 3 to 9 days and then spontaneously ends, even when the victim continues to eat the poisoned grain.

**Second Stage.** A slow degeneration of the bone marrow occurs within 9 weeks. Visible skin hemorrhage appears and hematologic examination reveals a marked decrease in the total number of leukocytes. Before hemorrhages appear, some patients display nervous system problems: irritation, weakness, fatigue, vertigo, headache, palpitation and slight asthma.

**Third Stage.** The most serious stage comes about suddenly and has four essential features:

1. Hemorrhagic syndromes begin with petechial hemorrhage on the skin, axillary and inguinal areas, arms, thighs, face and head.

2. Necrosis begins in the throat and spreads throughout the mouth and into the larynx, vocal cords, lungs stomach and bowels.

3. Impaired hematopoietic and reticuloendothelial systems permit widespread bacterial infection in the necrotic areas. Lymph nodes become enlarged.

4. Laryngeal edema and stenosis of the glottis caused by esophageal lesion, resulting in death because of asphyxiation.

**Fourth Stage.** A recovery period if clinical help is provided in time.

**Yellowed Rice Syndrome.** Epidemics of an acute heart disease broke out in rural Japan a hundred years ago, the etiology of which was never determined. Uruguchi (1971) analyzed the records of cases of the disease called acute cardiac beri-beri (Shoshinkakke) and concluded that the ailment was probably a human mycotoxicosis.

Acute cardiac beri-beri was associated with the consumption of polished rice and was initially thought to be avitaminosis. In 1910, however, the Japanese government took action to exclude mouldy rice from the markets and the incidence of acute cardiac beri-beri dropped dramatically.

Uraguchi (1971) suggested that acute cardiac beri-beri may have resulted from eating “yellowed rice”. Such a food-stuff became pigmented and toxic to rats, and produced symptoms similar to those observed in humans affected with beri-beri.

**Penicillium Poisoning.** Toxin producing fungi are *Penicillium islandicum* (Luteoskyrin and cyclochlorotine), *P. citreoviride* (citreoviridin), *P. rugulosum* (Rugutosin) and citrinum (citrinin). The empirical formula of citreoviridin is  $C_{23}H_{30}O_6$ . It contains one methoxy group and double bonds.

The clinical manifestations of acute cardiac beri-beri, begin with palpitation, precordial distress, and tachypnea; followed by nausea and vomiting, and difficult breathing.

Within a few days, the patient suffers severe anguish, pain, severe restlessness, or sometimes violent mania. The right heart is dilated, heart sounds are abnormal, blood pressure is low, and pulse is rapid, sometimes exceeding 120 beats/min, and the patient faints.

The dyspnea increases, the skin of the extremities becomes cold, dry, and cyanotic, and the voice becomes husky. Finally the pulse becomes feeble, the pupils dilated, consciousness is lost, and respiration fails.

**Balkan Nephropathy (Ochratoxicosis).** In 1957 to 1958, an unusual chronic disease of the kidney occurred endemically in Yugoslavia, Rumania, and Bulgaria with a prevalence of 3–8%, mainly in rural areas where food is home grown. It was common in 30–50-year-old females. In Yugoslavia, 6.5% of blood samples contained ochratoxin A at concentrations between 3 and 5 mg/g of serum (Hurt et al. 1982).

Barnes (1967) suggested that plant toxins or mycotoxins may be an environmental factor causing this human disease. Krogh et al. (1974) presented preliminary evidence to associate the human disease with ingestion of ochratoxin A (OTA).

This nephrotoxic compound occurs in feeds and food-stuffs and is considered a major determinant of porcine nephropathy, a form of kidney damage strikingly similar to that seen in Balkan nephropathy cases.

Renal porcine nephropathy has been reported regularly from Denmark since 1928. The law in Denmark requires that all abnormal gross appearance of kidneys must be analysed for OTA and the toxin concentration exceeds 10 µg/g which corresponds to 50 µg/ml in the blood, the entire carcass is condemned. Nephropathy has also been reported in chickens.

Toxin-producing fungi are *Aspergillus ochraceus* and *Penicillium viridicatum*. Ochratoxin is a dihydroisocoumarin derivative produced by seven species of *Penicillium* and six species of *Aspergillus* including *A. ochraceus*.

The disease is of a vague onset without acute manifestations. Among the earliest and most frequent complaints are headache, lassitude, easy fatigue, and anorexia. The typical syndrome includes a shallow, coppercolored skin, yellowing of the palms and soles, anemia in the preazotemic stage, and perhaps occasional profuse intermitent hematuria, due to tumors of the urinary passages; there is no hypertension or edema. It becomes evident that in the endemic villages, when a high incidence of urinary tract tumors and both diseases follow a similar pattern of geographic clustering, age and a sex distribution.

General principles of sanitary surveillance on the food poisoning cases shown in Figure 32.

In the Annex 4 we present summarized data about food poisonings and their prevention.

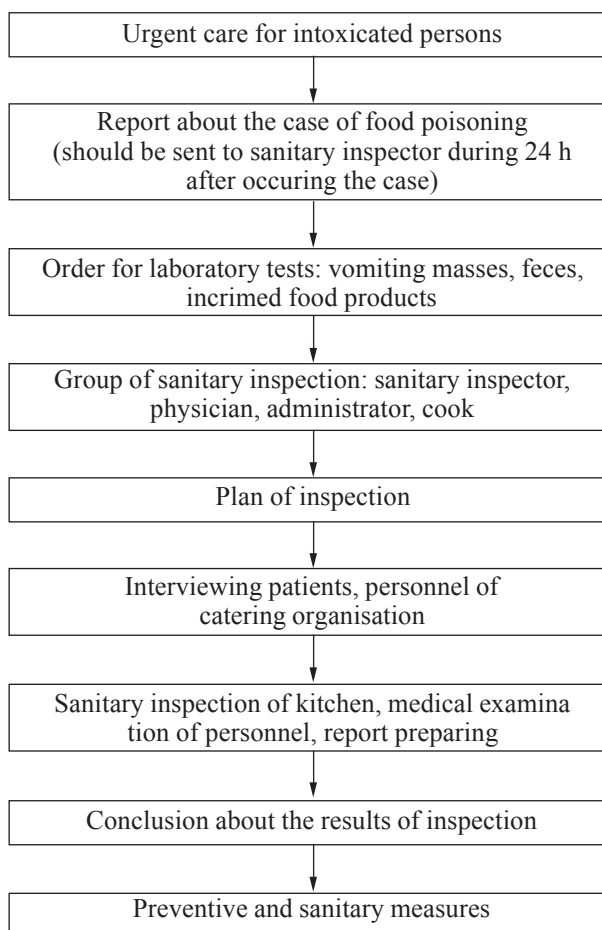


Fig. 32. The Scheme of Investigation of Food Poisoning Cases

Children and Adolescents Hygiene is a science of protection and strengthening of the growing generation health, studying influence of surrounding factors on infant organism and developing optimal conditions for its harmonic growth.

You can easily understand the importance of children hygiene if you take into consideration the following:

Children under 18 are a considerable part of the population (38–40%).

Children are the future of any country. The health state of the grown up population depends on the children's health state.

The final purpose of hygiene is prolongation of human beings life; maintenance of high productive capabilities of the organism for a long period.

The objectives of hygiene are:

1. Regular study of environmental factors influence on infant health in dynamics taking into consideration because sensibility to these factors is changing during growth and development.
2. Elaboration of scientific norms and health improving measures. Theoretical principles of such elaboration are: compulsory condition of any action of surrounding factor and morpho-functional readiness of the growing organism to interaction. So the above norms are not permanent, they are changed at different stages of age.
3. Compulsory control of health improving measures effect.

The hygiene of children and teenagers is closely connected with such biological sciences as anatomy and physiology, pediatrics, closely related hygienic disciplines (nutrition hygiene, occupational hygiene, etc. In the sphere of preventive measures against children's infectious diseases it is connected with epidemiology and medical microbiology.

The founders of this branch of science in Russia are A. Dobroslavin and F. Erisman.

In 1884 F. Erisman founded the department of hygiene in the Moscow University. He paid great attention to the problems, connected with physical development and vision of children. He found out

that children's physical development and health depended upon surrounding conditions of work and mode of life. Erisman was interested in problems connected with hygienic conditions of classes, planning of natural lighting of the classrooms. Under his leadership models of class-rooms, different types of school furniture were designed. F. Erisman synthesized the existing studies and wrote the first manual of school hygiene "The School Hygiene" in 1870.

A. Dobroslavin is the founder of the department of Hygiene in Military Academy in St. Petersburg (1871). The principal attention was paid to the problems of medical conditions of schools. He also studied the pupils' overstrain in schools. The great attention to the problems of hygiene in schools was paid by the followers of Erisman and Dobroslavin.

There are main factors that helped to create this discipline as an independent one:

1. The quantity of this group of population.
2. Peculiarities of the conditions necessary for this group of population (conditions of studies, work, life, etc.).
3. Peculiarities of the reaction of a child's organism in the same time conditions in comparison with adults.

Participants of the First Global Review and Co-ordination Meeting on Integrated Management of Childhood Illness, held in Santo Domingo, 9–12 September, 1997 recognized that:

- each year, worldwide, more than 11 million of children die before they reach the age of 5 years;
- 70% of these childhood deaths are caused by five common, preventable or easily treatable childhood conditions: pneumonia, diarrhoea, measles, malaria and malnutrition (Fig. 33);
- throughout much of the developing world families do not have access to the basic means to prevent these conditions nor to the simple treatments needed to stop them from being fatal;
- in some countries and globally, achievement of the World Summit for Children goals for childhood mortality and morbidity reduction by the year

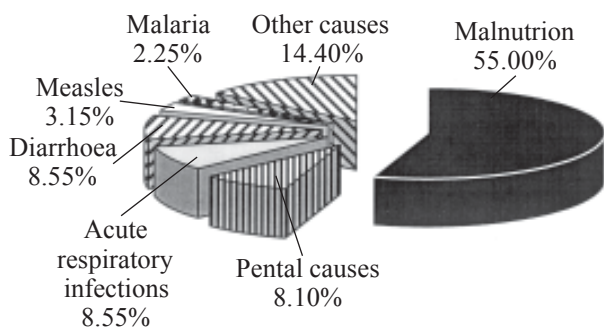


Fig. 33. Main Death Causes in Infancy

2010 will require a massive and immediate renewal of commitment and effort;

— this situation represents a failure to guarantee the fundamental rights of children as embodied in the Convention on the Rights of the Child.

## ANATOMICAL AND PHYSIOLOGICAL FEATURES OF THE CHILD'S ORGANISM

The infant's organism is not just a small copy of a grown up organism. It has some distinctive peculiarities — morphological, functional and psychological.

The different anatomical and histological structure and biochemical composition determine different functional insufficiency in comparison with an adult organs and systems. In biological plan we can see inadequacy of adopting mechanism, greater sensitivity to action of the surrounding factors and particularly, to crossing interactions: infant organism react even to insignificant deviation from optimal life conditions. On the other side an infant organism is able to develop widely mechanisms of adaptation to surrounding conditions during growth and development process. So infant development is not only a growth, i.e. increase of body weight because during growth process there are deep quality changes occur. Development consists of three intercrossing processes:

- Growth
- Differentiation of tissues and organs
- Shape building

The growth process is uneven — periods of intensive growth are followed by periods of slowing down. During this time intensive differentiation of tissue and organs, their shape building, increase of the organism functional possibilities occur. A very important feature of the infant's organism is peculiarity of metabolism:

1. Intensity of metabolism is twice more than that one of grown ups (it is necessary to take into consideration calculating daily food ration).

2. Assimilation processes prevail over dissimulation ones (importance of quality composition of the diet).

There are some age periods in child's life which differ from each other according to their morpho-functional features: the womb period; the newborn period; the infant age; the nursery age; the preschool age; the school age.

The health state of children is controlled by different doctors: neonatologists, pediatricists, hygienists, etc. Preventive measures are different for each period.

The womb period is characterised with a control of infant health state before a birth, because there is close connection between infant and mother organisms.

This connection is confirmed by existence of connection between:

- pre-birth holiday duration and new-born baby weight;
- hygienic life conditions of the pregnant woman and the still-born;
- professional features of the woman job (effect of toxic factors even of little intensity on the organism, ionising radiation — resulting in embrioteratogenic action, decrease of immune reaction of the mother and baby, hypolactation).

The most numerous group of children's population comprises the children and teens of school age. The school period demands the greatest attention of doctors because this period comprises 2 main periods in the development of the child's organism:

1) children at the age of 7 — the age between the pre-school period and the school period. At this age in the life of a child work appears as obligatory classes to which children are not used because of their anatomical and physiological development especially because of instability of the central nervous system;

2) the period of pubescence — the development of the whole organism is rapid and uneven. At this period some functional disorders in different systems of the organism can be observed and the doctor's task is to prevent the influence of different factors, according to which these functional changes can be transformed into pathological ones. It is a pity but nowadays a lot of diseases are associated with the violation of rules in the system of education. They can be observed among the pupils in our schools:

- defects of bearing — 28–28%;
- diseases of ears, throat and nose — 28%;
- disorders in vision, sometimes, a very high per cent;
- rheumatism — 23%.

Among the causes influencing the health of pupils the main causes are the violation of medical and hygienic norms — desks in schools, class-rooms being overcrowded, insufficient lighting of working places, disproportion of school furniture. Due to these problems the doctor's task are:

1. The analysis of health and physical development of pupils and organisation of medical preventive measures.

2. The organisation of anti-epidemic measures for the prevention of infectious diseases.

3. Systematic control of the medical and hygienic conditions in schools and the fulfillment of the daily routine.

4. The involvement of teachers and parents into the active work connected with health control of the children.

As it was mentioned above, the hygiene of children and adolescents is closely connected with some other biological and pedagogical disciplines and it builds its work considered the peculiarities of the child's organism at different periods of his life.

The organism of the child and the adolescents differ from the organism of the grown-up. The main peculiarity of the young organism is considered to be its general development which starts from the moment of its conception and finishes at the age of 20–25. During the process of the development of the growing organism different qualitative changes take place, we observe the development of different organs and systems as well as their interaction.

The development of the organism is a complicated process consisting of three factors:

1) the growth — the increase of proportions of the body;

2) the specific development — the distribution of tissues and organs;

3) formation of the body.

**Osseous System.** The process of ossification starts in the womb of the mother and comes to its end at the age of 16–17 (for girls) and at the age of 18–19 (for boys). The children's bones contain a lot of organic substances, little amount of calcium and phosphorus. As a result they are flexible and can be bent. The spines of children are often curved. The spine has three slight curves — one in the neck, the other in the upper back and the other in the lower back. These curves are normal and can be seen from a side view. From a back view, the spine should appear straight.

If the spine has a side-to-side curve, the curve is called scoliosis. There are two main types called postural and structural. The first one can be corrected and is caused by some irregularity of posture. Structural scoliosis can be due to abnormalities or diseases of bones, muscles or nerves. Between the ages of about 9 and 14, children's bones grow rapidly. At this time, the back-bone or spine may sometimes show signs of developing scoliosis. Early detection enables early treatment. This may control the condition and prevent other problems developing in later years. The scoliosis is closely connected with violation of the position of the body.

What are the causes of the defects of carriage?

1. The furniture does not fit the proportions of the body — a chair, a desk, a bed, etc.

2. Anomalous posture and bad habits, such as:

— standing leaning on one leg. This habit causes the wrong position of the pelvis as a result we observe the flank curvature of the spine;

— the wrong position while sitting at the table with one leg being on the chair-bottom. Such a posture violates the position of the humeral zone and the pelvis;

— reading in bed;

— identical movements; e.g. using the same leg while going by scooter or jumping on the same leg and so on.

Of all the causes mentioned above the main one is considered to be wrong proportions of the furniture. Sometimes the curvature of the spine can be observed even in preschool institution and at schools the process is progressing.

This process not only mutilates children but also affects the functioning of the organs of the chest and as a result it is very difficult to treat this illness. As it was mentioned above the main cause of scoliosis is a wrong position at the desk. As a rule in our schools pupils study in two-shifts and in the same classroom the pupil of different age can sit at the same desks (e.g. pupils of the second and the fifth forms). In such a case it is very difficult to find a solution of the problem.

The development of carriage defects can be observed when a pupil carries a heavy school-bag in his hand.

Preventive measures against the violation of the carriage and the curvature of the spine in preschool institutions as well as in schools children should sit at the convenient desks. At the beginning of the school year, a suitable desk should be chosen for each group of pupils with the help of a doctor.

The usage of correct furniture slows down the process of violation but the work of teachers becomes more difficult as they have to watch that children do not take the wrong position at the desk. Another preventive measure is the use of a satchel instead of a school bag.

The children with scoliosis should be sent to the special physiotherapy room for preventive gymnastics. Deformation of the osseous system includes the deformation of the thorax. The development of the thorax is a slow process, it is completed at the age of 21–25. Chest deformation affects negatively the development of the lungs, the heart and the large blood vessels. To prevent such violations teachers should pay attention to the position of a child at the desk.

When in a sitting position, the spine can take on many different postures ranging from the very upright, back supported sitting posture to the unsupported, relaxed posture. When the legs are crossed while sitting, the strain on the lumbar muscles increases and also creates a greater strain on the neck muscles. The neck must compensate to provide an upright head position. During long sitting without

any type of back support, the spinal cord posture deteriorates due to muscle fatigue caused by incorrectly contracted muscles and ligaments. Pressure on the intervertebral discs of the lower lumbar spinal column increases by 30% in the sitting posture. Therefore, a lumbar support was designed to decrease muscle fatigue and strain on the intervertebral discs. This support system must be compact and easily carried around.

**Muscular System.** The muscular system provides the fulfillment of children's movements. The structure and functional peculiarities of muscles develop during the long period of childhood. This process is uneven. In the beginning the muscles of extremities start to develop. At the age of 6–7 the development of upper extremities can be observed, then the muscular power, coordination and preciseness of movements go on.

The weight of muscles increases year after year. The interrelation between weight of the body and the weight of the muscles is the following:

- a baby — 23%;
- 8 year-old boy — 27%;
- 15 year-old boy — 32%;
- 17–18 year-old boy — 44%.

The chemical composition of children's muscles differs from that of grown-ups. They are rich in water and the percentage of albumen, fat and salt is low. Only at the adolescent age of the chemical composition of children's muscles becomes the same in comparison with grown-ups.

Children's muscles become tired very quickly but because of the metabolism this tiredness is not very long.

At the pre-school period the characteristic peculiarity of the muscular system is considered to be the slow development of the flexors and small muscles.

Because of the late development of the muscles of bones, it is very difficult for children at pre-school age to fulfill work with small objects. The muscular system of such children is weak and such postures as sitting and standing cause tiredness. That is why the measure against tiredness is to let children move. To prevent the strain of muscles such positions of the body should be minimized.

The negative development of the osseous muscles leads to the precipitation of fat in the child's organism. The excessive fat leads to the underdevelopment of the osseous muscles, negatively affects the activity of the heart, at the same time the excess weight of the child influences the work of the cardiovascular system leading to earlier and harder forms of tiredness.

Lately because of the specific psychology of some parents who want their children to be plummy, the number of children with obesity considerably increased. At some places the number of such children is 4–5%.

It should be explained to such parents that excessive fat may lead to the diseases associated with metabolism and cardiovascular system.

**Cardiovascular System.** The weight and the shape of the heart, its position in the thorax, the structure of tissues, vessels — all this change year after year. These changes are reflected on the functional peculiarities of the cardiovascular system of children. The cardiovascular system of babies is characterized by imperfectness, but the heart muscle is quite heavy, as a result, the greater amount of blood goes through the heart at the same time in comparison with grown-ups.

The heart of a child grows more intensively when he is one year old as well as at the period of puberty. The growth of the heart is slower than the growth of blood vessels till 6–7 years but at the period of pubescence it accelerates.

As a result, the heart pushing the necessary quantity of blood into the arteries develops some mechanic power and it leads to the high arterial pressure.

The scientific research showed that hypertension among grown-ups often started at an early age. The main causes of the development of hypertension are: the functional condition of the cardiovascular system (this was mentioned above), emotional and psychological influences, which can be observed at the periods of pubescence and physical tension (for example, among the youths who go in for sports). One of the signs of the disease is a neurotic state of the person. It can be manifested as irritability, petulance. Another sign of the disease is considered to be sleeping disorders. Hypertension among the youths is associated with the peculiarities of the cardiovascular system, it can be caused by shocks but as usual the main cause is considered to be prolonged strains that is excessive mental and physical activity, not enough sleep, troubles in the family or at school and smoking.

That is why it is very important to exclude excessive physical and emotional strains so that the development of the cardiovascular system can be normal. Pupils should constantly make physical exercises, keep to the hygienic time-table, work on the open air. Sometimes even loading at school should be changed if it negatively affects the health of a particular pupil.

**Respiratory Apparatus.** The peculiarities of the respiratory apparatus in children are the following: the upper airways are narrower in comparison with grown-ups, nasal sinuses are weaker, the mucous membrane of the respiratory airways is tender and can be easily injured. As a result, different infections penetrate into the organism of a child more often and catarrhal process leads to breathing disorders. The breathing of children is superficial and more frequent. Such breathing is not sufficient for proper ventilation of lungs, that is why children especially need fresh air and physical exercises outdoors.

Fresh air is necessary for metabolism. The volume of ventilation of the lungs per 1 kg of the body weight (per 1 min) is:

- a baby — 220 cm<sup>3</sup>;
- a 6 year-old child — 158 cm<sup>3</sup>;
- a 14 year-old boy — 128 cm<sup>3</sup>;
- a grown up — 96 cm<sup>3</sup>.

Hygiene of the organs of breathing should lead to the normal development of the thorax. The following rules should be taken into consideration:

- a) the correct posture of a child at the desk, table and so on;
- b) breathing exercises for the development of the thorax and its muscles;
- c) going in for sports especially swimming, skiing, sledges;

It is very important to teach children to breath deeply and rhythmically.

**Skin.** The relative surface of the child's skin is bigger in comparison with grown-ups'.

For 1 kg of the body weight:

- a baby — 704 cm<sup>2</sup> of the skin surface;
- a 6-year-old boy — 456 cm<sup>2</sup>;
- a 14-year-old boy — 423 cm<sup>2</sup>;
- an adult man — 221 cm<sup>2</sup>.

This peculiarity, explains great heat irradiation in children. The heating value is also higher. Every day a baby produces 91 kcal for 1 kg of weight, a 1–2 year-old child — 81 kcal, 14 year-old — 52 kcal, and a grown up — 35–41 kcal.

The skin of the child contains more capillaries and they are wider in comparison with grown ups. One third of the blood flows through the skin among grown-ups and a half and even 2/3 among children. At the same time the regulation of the circulatory system from the side of the central nervous system (CNS) is not sufficient. It results in cooling of the child's organism.

At the age of 11–14 the reaction from the side of the CNS comes to its end, the skin becomes more developed and a youth stands cooling more easily. The children's epidermis is thin and as a result different infections can easily penetrate into the organism and cause diseases of the skin. The preventive measures are the following:

1. The skin should be clean, the clearness protects the penetration of bacteria.
2. The skin should be trained to extreme environmental temperature. The training of skin with respect to the influences of environment should be fulfilled with the help of air bath, water bath and sun bath.
3. It is necessary to take care of the children's clothes. A special attention should be paid to the hands and feet:
  - a) the clothes should meet the requirements of a season, weather and work;
  - b) the clothes shouldn't prevent movements;
  - c) the clothes shouldn't prevent ventilation.

As it was mentioned above a special attention should be paid to the prevention of the hands and feet because they cool down first. The position of the hands and feet is distant and that is why the circulation of blood in them is not so good as in the other parts of the body.

**Organs of Chewing.** The first teeth erupt at the age of 6–7 months, by the end of the first year a child has 8 teeth and by the end of the second year — 20 deciduous teeth. The delay of the eruption of milkteeth is a sign of the malformation in the development of the organism. This sign can be observed when the child suffers from rachitis, when the supply of calcium is not sufficient and in some other cases. The first permanent teeth erupt at the age of 6–8 and to the age of 12–14, all 20 milk teeth are changed into permanent. The wisdom teeth are cut at the age of 18–25 (Table 30).

The children's permanent teeth are covered with thinner enamel (in comparison with grown-ups'). That is why they are more predisposed to teeth decay.

Children should be examined by the dentist no less than two times a year, only in such cases teeth decay can be revealed and treated in proper time.

**Gullet.** The food is pushed from the gullet to the stomach because of peristalsis and mechanic irritation of its lower section. But at an early age, strong mechanic and chemical irritation of the gullet because of the tender mucous membrane can lead not to the better work of peristalsis but to the spasm of its cardial part (cardiospasm). As a result, the food doesn't reach the stomach and with the help of emetic movements it is pushed of it.

**Stomach and Intestine.** The stomach of children (in volume) is smaller than the stomach of grown-

Table 30. Age of Eruption of Deciduous and Permanent Teeth

Teeth	Number	Age of eruption
Deciduous (20 total)		
Lower central incisors	2	5–9 months
Upper central incisors	2	8–12 months
Upper lateral incisors	2	10–12 months
Lower lateral incisors	2	12–15 months
1 <sup>st</sup> molars	4	10–16 months
Canines	4	16–20 months
2 <sup>nd</sup> molars	4	20–36 months
Permanent teeth (32 total)		
1 <sup>st</sup> molars	4	5–7 years
Incisors	8	6–8 years
Bicuspid	8	9–12 years
Canines	4	10–13 years
2 <sup>nd</sup> molars	4	11–13 years
3 <sup>rd</sup> molars	4	17–26 months

ups and in the beginning of life it is just a dilatation of the gullet. The acidity of the gastric juice and the digestive power of ferments are less in comparison with grown-ups. At the early period of life the intestine microflora is not developed (before the birth of a child its intestine is sterile). All these factors cause the development of dysfunctions of the alimentary canal.

Constipation among children can be explained by the insufficient development of the intestine peristalsis, its muscles and elastic fibers. The causes of constipation are also the weakness of the stomach and intestine walls which is the result of long sitting at the desk and insufficient usage of the active rest.

Taking into consideration these peculiarities of the digestive organs, the volume of the stomach, low acidity and activity of digestive ferments, weak peristalsis it is necessary to do the following:

1) children should be fed four times a day so that the stomach should not be overloaded;

2) children should consume easily assimilated meat food and especially dairy produce because these products demand little amount of gastric juice;

3) to exclude from the diet piquant, sour, irritating and hot dishes;

4) to strengthen the peristalsis, children should consume more fruit, vegetables, berries and cereals;

5) physical exercises that strengthen the abdominal cavity.

**Organs of Sense.** Newborn organs of sense are developed insufficiently. No coordination of eyes movement, no possibility to fix eyes on any objects during the first two months, non-clear sight.

Insufficient development of ears. Acoustic duct is short and narrow. This duct is in vertical position. Ear-drum is in horizontal position. The middle ear cavity is filled with liquid. Later this liquid will be dried and air enters the middle ear from the Eustachian tube and the baby begins to react to acoustic irritants.

Organs of taste are developed to the greatest extent and this should be taken into consideration while preparing meals for children.

Skin pain sensitivity is low.

The visual organs of a newborn are not prepared to the normal activity: photophobia, coordination of eye movements is weak as well as the fixation on objects. The visual characteristics develop rapidly. The difference between black and white appears in the beginning of the first year of life. Then a child distinguishes red, then green, blue and at last — yellow. Full differentiation of colours appears at the end of the 3rd year of life.

The main peculiarity of the anatomic-physiologic development of the eyes of children is the following: the crystalline lens (at preschool and early school age) is of a more curved shape in compari-

son with grown-ups. As a result the front back axis of the crystalline lens is shorter, it provides longsightedness. The development of eyes lasts till the age of 9–12. The refractive system of the eyes and the development of the character of refraction are formed till this period of life.

At the age of 9–10 the longsightedness often transforms into normal but in unfavorable conditions it can be transformed into shortsightedness. The shortsightedness can be observed among people of different age, but as usual it develops at a school period. The examples of innate shortsightedness are quite rare.

The development of shortsightedness is the following. Under the influence of the visual strain while looking at different objects at a short distance we can observe the spasm of accommodation. The crystalline lens become more curved. The shortening of accommodative muscle under the influence of unfavorable conditions becomes unchanged. As a result the accommodative muscle doesn't relax even after work, the inner membranes of the eyes are always strained. Besides the inclined position of the head worsens the outflow of blood and it leads to the increase of tension in the eyes. These factors cause the lengthening of the front-back axis of an eye that is the development of shortsightedness.

The unfavorable conditions are as follows:

1) forced close examining of the object;

2) insufficient lighting, irregular lighting, the blinding-light;

3) the wrong position of children at the desk at school, the distance between a book and eyes is not correct;

4) strained visual work during a long time.

The longer visual work goes in unfavourable conditions the bigger percentage of children suffers from shortsightedness.

It is interesting to point out that the percentage of short-sighted pupils is lower in the country. It can be explained by the fact that natural lighting prevails in the country schools and probably they have higher level of resistance of the organism.

The degree of the development of shortsightedness depends upon the following reasons:

1) the geographical latitude of the surroundings that is the light climate of the place;

2) the routine and full value of nourishment, the consumption of vitamins A, C and others;

3) norms of work and rest;

4) sufficient natural and electric lighting.

It's shown that acuity of vision becomes lower in theoretical classes and at the sport classes it remains unchanged and sometimes it becomes even higher. Low acuity of vision leads to the development of shortsightedness.

The development of myopia is considered to be caused by insufficient and irregular lighting. Light is a direct and adequate irritant of the eyes. Under



the influence of sufficient lighting, all the functions of the eyes are considerably increased:

- a) acuity of vision (shapes, sizes of objects);
- b) unstability of legible sight (acuity of vision for a long time);
- c) accommodation (the peculiarity of the eyes to accommodate to legible sight at different distances).

It was proved experimentally, that the change of lighting from 40 to 140 lx causes the increase of the reading speed by 15%.

The dependence of the sight on lighting can easily be observed among pupils with pathologic refraction. The change of lighting in the class room from 30 to 120 caused the increase of the visual capacity of work by 14% among children with normal refraction and by 22% among short sighted children.

That is why one of the main preventive measures is considered to be the creation of optimum lighting.

The basic hygienic demands of lighting are the following:

- 1) the sufficient level (it's a standard, but they are not optimum);
- 2) prevalence of light in the sphere of sight;
- 3) prevention of blinding light (tube lamps, illumination is 300 lx);
- 4) to avoid sharp and deep shadows;
- 5) the spectrum of radiation of artificial light sources should be close to the natural light.

That is why children's welfare institutions are to be built in such a way that there is a lot of lighting. But first of all sufficient natural and electric light should be provided at schools because it is there where children have constant, long visual work for the first time of their life.

The natural lighting of class rooms except the peculiarities of the school sight depends upon a season. Especially the low level of lighting is observed in autumn and winter. At this period the natural lighting should be compensated by artificial lighting.

It is worthy to point out that there is an opinion about the confusion of natural and artificial lighting badly affecting the development of sight. This opinion is widespread even among doctors and teachers. But in practice it was not confirmed, on the contrary, the most optimum indicators of sight functioning were observed with natural lighting, then with mixed and at last with artificial lighting. That is why additional lamps should be placed at any part of the day when the natural lighting is not sufficient enough.

The lighting has a great importance in specialized schools for children with poor vision and hearing. As it was mentioned above, the high level of lighting positively influences the vision functioning. That is why in those schools the norm of lighting is higher than that in the regular schools. E.g. for arti-

cial lighting the norm is 500 lx versus 300 lx in the regular schools, light coefficient is 1:3.

The high level of lightening is necessary in the schools for children with poor hearing. The fact is that the main load falls to the visual analyser, 93% of all school lessons are studied by means of sight in comparison with 40% at regular schools. The norms are the same as at schools for children with poor vision.

The main task of primary and secondary schools as well as colleges is to bring up well educated and healthy young people. However students health index is alarming. At present only 15% of secondary school final-year students can be considered to be apparently healthy. Visual organ pathology, damage of attitude, neurocirculatory dystonia, alimentary tract illnesses are mainly spread among students. Among causes of reduction of visual acuity the most frequent is myopia. Its spread increases from 3 to 5% among first-formers and up to 50% and more — among final-year students. Even small degree of myopia results in considerable reduction of visual acuity that restricts the professional fitness of first-year students. School myopia has a tendency to progress up to medium and high degree that is from 20 to 45% among seniors in the general structure of refraction anomaly. Progressing myopia still remains one of the main causes of blindness and poor vision. "School" myopia is by far the commonest, affecting 30 to 50% of the population. It starts during school age (commonly at 10–12 years old), and increases to between 1 to 10 D by early adulthood.

A correlation of the process of school myopia development and progress with pedagogical, psychological, ergonomical, hygienic, somatic factors were studied using a computer multi-factor analysis. In addition a new method of division of children diseases into prevention groups according to main bad factors was worked out in order to correct them. The method makes it possible to elaborate a complex of individual disease prevention actions for each child. On the basis of revealed regularities training methods of development and progress of school myopia prevention were worked out. This enables to increase mass character of prevention measures and to improve their efficiency and availability. The preventive program consists of 3 main sections: information and prevention, diagnostic (including monitoring), and medical correction.

**Information and Prevention.** Training students and their parents in save visual work skills, methods of visual damage prevention (lectures, training at schools, providing knowledge through teachers, instructive and educational literature, mass media).

Secondary school and college teachers training in methods of choosing optimum visual work, visual disorder prevention (lectures, seminars for school and post graduate school teachers).

Lectures for school physicians and nurses, for general practice physicians, ophthalmologists, pediatricians on control of myopia, asthenopia and other school pathology.

Thus, the curricula of medical and pedagogical universities should include training in the prevention of visual disorders in children and adolescents as well as older scholars engaged intensive visual work.

**Health Management System and Monitoring** consist in the following measures:

- preventive examination of secondary school and college students according to a plan developed by the authors of the program that allows to examine the whole staff quickly and completely within the period of 7–10 days;

- data base development with a subsequent multi-factor analysis, setting up preventive groups of students, working out recommendations for individuals and a staff.

- establishing a dispensary system for teachers. To monitor the state of their visual functions. Initial and further examination can be held both at a school and in the Center during teachers training in pre-school preventive medicine class.

**Treatment and Correction** consist in the following:

- main bad factors determined with the help of the multi-factor computer analysis;

- anomalous visual and motor stereotype of students;

- psychological correction;

- practicable recommendations on how to make hygienic conditions at school and at home better;

- school pathology so to prevent the diseases progression in the clinic of school preventive medicine center.

**Nervous System.** The nervous system development is a subject of special interest because the nervous system, from one hand, unites and controls the vital activity of the whole organism and, from the other hand, the human being psychology formation and perfection are going on the basis of the cortex development. Before the birth the central and peripheral nervous system are not developed yet, particularly, the cortex and the closest under-cortex centers. The cerebrum weight of a newborn is relatively great (1/8 of the body weight and achieves 410 g). However the surface of the big cerebral hemispheres is relatively smooth during the first months, convolutions are not distinctive. The nervous cells of hemispheres are primitive, immature, having simple shape.

The cortex is not developed well and all the vital processes are controlled by under cortex centres. In the cortex the inhibition processes prevail. Children sleep much. During the process of growth and development the cortex becomes more perfect, the cerebrum weight is increasing (the first year of life — 1,100 g, the seventh year — 1,250 g, adults — 1,400 g).

The cortex develops considerably during the third year of life, at this time the language formation is going on. Stock of words is about 500. Some words are not pronounced distinctly. For further infant development it is necessary to meet more and more people.

The peculiarities of infant development are: during the nursery period the children only imitate the behaviour of the adults. At this time the real irritants are very important. The infant's parents and teachers are perfect in his eyes. So proper bringing up is very important. The other feature is infant's word-building, critical attitude to the words and their meaning. The most important age for proper bringing up is up to 5 years.

During junior school age the cortex development continues; some nervous cells become perfect, the new nervous ways are developing, the considerable growth of the frontal parts of the cerebrum is taking place and makes physiological basis for abstract thinking. Talking about peculiarity of the higher nervous system of children it is necessary to emphasize:

- processes of dynamic equilibrium between exaltation and inhibition processes are manifested poorly;

- inhibition zone around the exaltation zone is weak so children can easily pay attention to a new irritant;

- self-induction is expressed well (inhibition zone may occur inside of exaltation zone);

- morphofunctional inefficiency of the cortex.

The nervous system unites and regulates the activity of the whole organism. The development of the nervous system and the brain in children and youth is considered to be the process of great interest because during childhood the formation of personality can be observed.

The psychology forms on the bases of the development of the brain cortex. To the moment of birth the central and the peripheral system are not developed at all. Especially it concerns the cerebral cortex.

The weight of the brain of a newborn is 1/8 of the body weight and in grown ups it is 1/40. The surface of the cerebral hemispheres is comparatively smooth, convolutions of the brain are weak. In the functional respect of all parts of cerebrum, the cortex is not developed, that is why all living processes of children are regulated mainly by subcortical centres.

In the first 2–3 months conditioned reflexes can't be formed because of poor development of cortical innervations, more than that the usual irritants bring the cerebral cortex to the deep physiologic sleep.

In the second half of the first year of life the development of conditioned connections goes from all organs of perception: eyes, ears, skin, etc. During this period the basis of future speech sounds is laid.

During the second year of life simultaneously with the development of cerebral cortex and its activity the creation of new conditioned reflexes can be observed. At the age of 2–2.5 a child possesses all features of the development of cortical system, and the general structure of the cerebrum slightly differs from that of a grown up.

In the functional respect the cerebral cortex develops more intensively during the 3rd year of life. At this period the development of speech can be observed.

In the last years of preschool period (from 4 to 6) the functional development of cerebrum is increased, analytic and synthetic activity of the brain is more complicated. At the early school period and at the period of pubescence we observe the continuation of the brain development through the formation of new nervous cells and pathways, i.e. the functional development of all nervous systems. At the same time the intensified growth of frontal lobes leads to the exactness and coordination of movements. The cerebral cells finish their formation and go through the special energetic structural development, the formation of convolutions as well associative tissues correcting some parts of cerebrum comes to its end. The number of associative tissues increases at the age of 16–18. All this forms the more logical basis for the processes of associative, logical abstract thinking.

The development, and physiologic activity of cerebrum at the period of pubescence are influenced by the changes in the organism — the high activity of the thyroid gland, sexual glands which raise the activity of the CNS and cerebrum.

The teachers should take into consideration all these facts while communicating with youths.

Functionally the child's brain at the preschool and early school periods is not matured. The younger the child, the more the processes of excitement prevail over the inner. This process can easily irradiate that is spread all over the cerebral cortex, it violates the work of concentration of these processes. The result is a low level of attention and of the nervous system among children; especially when the organisation of educational work is not good enough.

Psychomotor and intellectual development are affected by innate intelligence (in general, the higher the intelligence, the more rapid the development); familial patterns (e.g. late walking, talking, and bladder control all commonly occur in a particular family); environmental factors (e.g. a lack of appropriate stimulation can impede normal development); and physical factors (e.g. hypotonia or deafness may alter normal development).

For the development of the nervous system and its cerebral hemispheres it is important:

- 1) the correct organisation of daily routine;
- 2) the rate of thinking load;

- 3) the correct organisation of physical education that includes interesting and non-excessive physical work.

If children have classes, prepare the homework, have meals, go to sleep at the same time and their daily routine is constant and regular, all the processes of the organism go normally and rhythmically.

Hygiene of the nervous system of children and adolescents is closely connected with the hygienic organisation of all educational work. The excessive overstrain of children and adolescents leads to the overstrain of the nervous system. It results in:

- 1) quick tiredness;
- 2) unsound sleep and even sleeplessness;
- 3) headache;
- 4) high excitability;
- 5) low level of mental functions such as memory, attention, perception and learning.

The normal development of the nervous system depends upon the conditions and influence of the surroundings.

The atmosphere in the family and at school should create high spirits. Cleanliness and order, good attitude of teachers and parents are favourable for the normal development of the nervous system. The well balanced nourishment is also of great importance (especially the usage of products containing B group vitamins). But the most significant factor for the nervous system of children and adolescents is considered to be correct organisation of sleep. Shakespeare called sleep the "Chief nourisher in life's feast". The normal sleep provides the full rest of the organism, especially of the CNS, organs of sense and muscular system. The main hygienic demand to the sleep of children and adolescents is considered to be the rate of its length according to the age. The younger the child, the longer his sleep must be.

Children and adolescents should go to bed at the same time. The regular succession of sleep and being awake leads to the fact that children fall asleep more easily. Insufficient duration of sleep leads to inertia, tiredness, lowering of mental functions, exhaustion of the nervous system, low level of resistance of the organism.

For correct (in hygienic respect) organisation of sleep the time after supper should be spent in calm atmosphere excluding the possibility of being awaked. Of course before sleep, thinking work, reading of books, noisy plays, telecasts should be avoided. The best way out is to go for a walk for 15–20 min before going to bed. At this time children may listen to the calm music, speak to the parents, etc.

At the same time parents should not let children eat before going to bed. Because of the reflection, diaphragm rises and weighs the heart and lungs violating their normal activity and it leads to restless sleep. It is forbidden to give children before sleep

such food, exciting the nervous system, as chocolate, coffee, strong tea etc. The supper of children should be light and no later than one hour before going to bed. The temperature in the room should be no more than 15–16°C and remain constant during the sleep.

## GROWTH AND PHYSICAL DEVELOPMENT

*Growth is a normal process of increase in size; physical development is a normal process of growth and differentiation (progressive change in function and/or morphology).* Growth and physical development are multifaceted processes involving genetic, nutritional, and environmental (physical and psychologic) factors. Disturbances in any of these may alter growth and development. Optimal growth and development require optimal health.

Growth from birth to adolescence occurs in two distinct patterns. The first (from birth to about the age of 2 years) is one of rapid but decelerating growth. The second (from about 2 years to the onset of puberty) shows more consistent annual increments.

A child's height relative to his peers tends to remain the same. An exception may occur during the first year of life, when some children grow faster or slower than their peers before establishing their ultimate pattern, which is primarily genetic in origin. Growth variation during the first year is due in part to maternal factors (e.g. uterine size). Boys demonstrate little difference from girls in height and growth rate during infancy and childhood.

It is well known that during ontogenetic growth process human body's resistance to risk factors is diminished, which interferes with development process. Under these circumstances, environmental adjustment can be looked at as an expression of biological and psycho-intellectual dynamics. Therefore the concept of natural and social history of children and teenagers health and illness has to be in close connection with human growth process and also with child's physical and neuro-psychic development.

The level of physical development as a quantitative expression of biological potential represents, time wise, a dynamic strictly determined by either positive or negative oscillations of the welfare. In Eastern Europe mean values for basic somatic parameters: height, weight, chest circumference, cranial circumference, have gone through following changes: 1950–1978 highly increasing, stationary or even decreasing between 1978–1985 and starting 1992 stabilization of the values with slight tendency of increasing mean values and prepuberty, puberty development acceleration.

Dynamics of physical development as an increasing process followed by decreasing period has pointed out the somatic development parameters variability with social and regional aspects that reflects living conditions and socio-economic transformation. These modifications not only reflect quantitative aspect of development but also interest the bi-morphosis as well as specific pathology.

**Height/Length.** Linear growth is measured as length (child lying down) in those younger than 2 years of age, and as height (child standing) after that. Typically, the infant increases in length about 30% by the age of 5 months and more than 50% by the age of 1 year; height at 5 years is about double birth length. Linear growth continues to slowly decrease until the onset of puberty. If puberty is delayed, growth in height may virtually cease.

The extremities grow at a faster rate than the trunk, leading to a gradual change in relative proportions. The crown-to-pubis/pubis-to-heel ratio is 1.7 at birth, 1.5 — at 1 year, 1.2 — at 5, and 1 — at 10.

**Weight.** Increase in weight follows a curve similar to that of height. The infant doubles his birth weight by 5 months of age, triples it by 1 year, and almost quadruples it by 2. Between ages of 2 and 5, the annual increments are fairly similar. Subsequently, yearly increments increase slowly until the onset of puberty.

A baby weighs about 3 kg at birth, and loses 150–200 g in the first three to four days. After that he grows rapidly and gains about 25 to 30 g a day for the first three months and a little less rapidly after that. The widely accepted formula that a baby doubles his birth weight at five months and trebles it at one year is not universal and large true even though some smaller babies weighing around 2.5 kg at birth may be four times their birth weight at one year of age.

The length of the baby at birth is 48 to 50 cm and at one year of age becomes 1.5 times as much. Average growth in weight and height during the first five years.

Age-weight growth per week is:

0–3 months — 200 g

4–6 months — 150 g

7–9 months — 100 g

10–12 months — 50–75 g

Weight growth per year:

1–5 year — 2.0 kg

Age-height growth per year:

1st year — 25 cm

2nd year — 10–12 cm

3rd year — 7–9 cm

4th year — 6–8 cm

5th year — 6–8 cm

You should remember that these data are averages and all babies will not conform to this pattern. There is a wide range within which a baby's growth is considered normal. The following table gives you some idea of the expected weights and heights of

well-nourished Indian children at various ages. It should be emphasized once again that children vary a great deal in their weight and height at different ages. Some are taller, others — shorter, which may be due to family characteristics. Some have narrower, lighter bones, others are broad built. What is more important is the growth rate of the child and the direction of his growth curve at a particular point of time (Table 31).

Growth and size depend on environmental conditions as well as genetic endowment. Physical development of the children is an important index of public health. It depends on two groups of the factors: biologic (congenital) and environmental.

The physical development is set of the phenotypical, morphological and functional characteristics of the organism of the individual reflecting influence of the factors of external environment. The physical development is defined by two groups of the factors: constitutional-biologic (genotype, the current of embryogenesis) and external (physical, chemical, biological and information factors of the surroundings) also is one of the most informative parameters of a condition of public health.

The physical development of children and teenagers is estimated with the help of the following groups of parameters:

- Anthroposcopic (somatoscopic)
- Anthropometric (somatometric)
- Physiometric
- The data of medical examination

Anthroposcopic parameters are defined by a method of the inspection. Estimate a constitution, habitus, form of the chest, backbone, legs, feet, degree of development of secondary sexual attributes (hairs in armpit, on the pubis (mons veneris), on the face, development of laryngeal cartilages, the mutation of a voice in the young men; in the girls — degree of breast development, etc.).

The survey will be carried out at natural illumination, the child should be undressed up to underwear. The researches will be carried out in a premise with a comfortable microclimate (temperature of air 18–20°C, humidity 40–60%), equipped by a hanger for clothes, low couch, little carpet for legs.

Basic constitutional types are astenic, normostenic and hyperstenic. The proportional constitution smoothed bony prominence (claviculi, spinae iliacaе, spinae scapularum, etc.), thickness of the skin-fatty fold up to 2 cm is characteristic for the child with a normal constitution and satisfactory nourishment. Children have clearly expressed bony prominences, the thickness of the fold does not exceed 1 cm. Well nourished children have smoothed bony prominences, significant thickness of skin-fatty fold.

The chest can be normal, conic, cylindrical, infundibular, rachitic in shape.

The back is estimated as round, flat or normal. Physician should assess expression of physiologi-

cal curvatures (cervical and lumbal lordosis, thoracal kyphosis), presence of pathological curvatures of a backbone (hyperlordosis, hyperkyphosis, scoliosis). The legs can be normal, O-shaped or X-shaped.

For an estimation of sexual development of the girls there are used the following parameters:

- M — degree of development of mammas
- Ax — axillary pilosis
- P — pubical pilosis
- Me — menarche

Ax<sub>0</sub>P<sub>0</sub>Ma<sub>0</sub> — absence of secondary sexual attributes

Ax<sub>1</sub>P<sub>1</sub> — an individual direct hair at the centre of the pubis and armpit

Ax<sub>2</sub>P<sub>2</sub> — growth of hair only at the centre of the pubis or armpit

Ax<sub>3</sub>P<sub>3</sub> — rich twisted hair on all area of the pubis and armpit

M<sub>1</sub> — edematous areola and increase of its sizes, under the nipple a small site of a glandous tissue

M<sub>2</sub> — conic breast, the areola is pale, the nipple is flat

M<sub>3</sub> — form of the breast is hemispheric, the areola is pigmented, the nipple is towers above it

Me<sub>0</sub> — absence of menstruation

Me<sub>1</sub> — menarche at the moment of examination or about 1 month prior to examination

Me<sub>2</sub> — irregular menstruation

Me<sub>3</sub> — regular menstruation

Estimation of the boys:

Ax — axillary

P — pubical pilosis

L — condition of laryngeal cartilages

Ax<sub>0</sub>P<sub>0</sub>L<sub>0</sub> — absence of secondary sexual attributes

Ax<sub>1</sub>P<sub>1</sub> — an individual direct hair at a root of the penis and in the armpits

Ax<sub>2</sub>P<sub>2</sub> — growth of a hair only at the centre of the pubis or armpit

Ax<sub>3</sub>P<sub>3</sub> — rich twisted hair on all area of the pubis, scrotum and armpit

L<sub>0</sub> — absence of the laryngeal prominence, children's timbre of a voice

Table 31. Average Weight of Well-Nourished Indian Children at Different Ages (WHO, 2002)

Age	Boys, kg	Girls, kg
Birth	3	2.9
6 months	7.5	7
1 year	9.5	9
2 year	11.5	11.0
3 year	14.0	13.5
4 year	15.5	14.5
5 year	17.5	16.5

- L<sub>1</sub> — beginning of the voice mutation
- L<sub>2</sub> — incomplete voice mutation, developed laryngeal prominence
- L<sub>3</sub> — male timbre of the voice

For exception of errors in measurements of anthropometric research will be carried out in the morning time.

The measurement of growth is made with the help of length-meter in standing and sitting position. The examined should contact to a vertical rod of a length-meter by a nape, scapulas, glutei and heels (for children with X-figurative deformation of legs — knees). In measurement of growth for sitting child he should contact to a rod of a length-meter with shoulder blades and buttocks. Feet should be placed separately (at the angle of 45°). The head of the examined is in such position that the line connecting the outside corner of the eye with the tragus of the concha of the auricle is horizontal. The turns of a head in the parties are excluded. A rod of the length-meter is being moved down easily, without effort.

The measurement of the chest circumference will be carried out in quiet breathing of the examined (small children are distracted by a toy or conversation). For definition of excursion of the thorax define a circle of the chest at height of the maximum breath and exhalation. A centimetric tape impose behind under the bottom corners of shoulder blades, in front at a level of the IV rib (in boys — on nipples, in girls with advanced mammas — under the breast).

The measurements of weight are made with the medical scales. The child stands on middle of a platform of the sliding-weight scales. Weight is recorded on scale with the maximum accuracy (up to 50 g). After measurement the scale lock should be closed.

With the help of a special tool it's defined a biacromial diameter, the sizes of a pelvis (are more often a bicristaric diameter), transversal and sagittal diameter of the breast. Other anthropometric indices are presented by the circumferences of the shoulder, thigh, calf, forearm and head, as well as by craniometric data and lengths of the extremities and their segments.

The physiometric parameters are united by results of various functional tests. The vital capacity of the lungs is determined with the help dry and damp spirometers, with the manual dynamometer — force of a hand, with back-force dynamometer — force of the spine muscles. The measurements are repeated two-three times. The best result is recorded.

The data of medical examination unite results of the physical examination of the child and reflect the valid condition of health at the moment of survey. Usually data of physical development are distributed normally (Fig. 34).

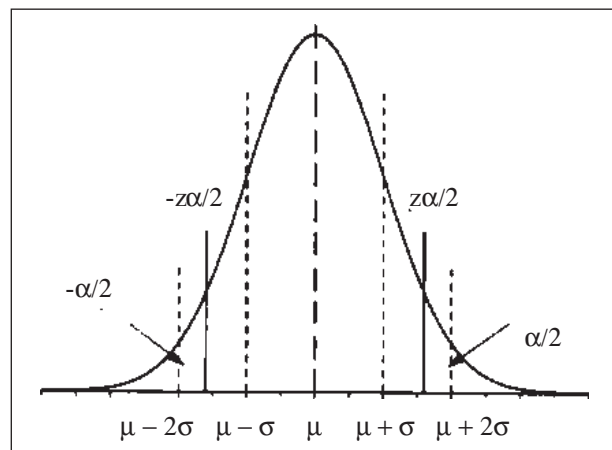


Fig. 34. Normal Distribution

There are two approaches for the assessment of growth development. The first one is based on the population surveys and allows to determine risk groups and problem territories both on a local and international level (Fig 35, 36). The second approach is based on the assessment of individual growth development in comparison with standards. This approach is presented by the methods of indices, standard deviations, regression seals and percentile scales.

## SCHOOL HYGIENE

Kindergarten is an institution of preschool education. In Ukraine there are both types of kindergartens — private and governmental. They should be placed in the residential area far from sources of noise and pollution. Area size is determined by the number of children. If a kindergarten has up to 160 children so area for each child should be 45 m<sup>2</sup>, if more — 35. A kindergarten serving area has a radius of 300 m. The area is subdivided into such functional zones: economic (includes warehouses, garage, boiler building, laundry, kitchen), the zone of playgrounds, the zone of vegetations and zone of kindergarten building. The kindergarten area should have 2 entrances as minimum. Percentage of building area does not exceed 25%, minimum percentage of the area occupied by vegetations is 55%. The maximum quantity of floors for kindergarten building is 2. Premises for children of young age should be placed at the ground floor.

The kindergarten building should have centralized water supply (in the country — local water supply system), sewage disposal. They provide kindergarten with hot water (autonomic boiler or two independent intakes of hot water pipes).

The main principle of building planning is “group isolation”. It means that every age group has own set of premises. In the observation it makes possible do not close kindergarten. A set of premises includes a dressing room, a group room (used as

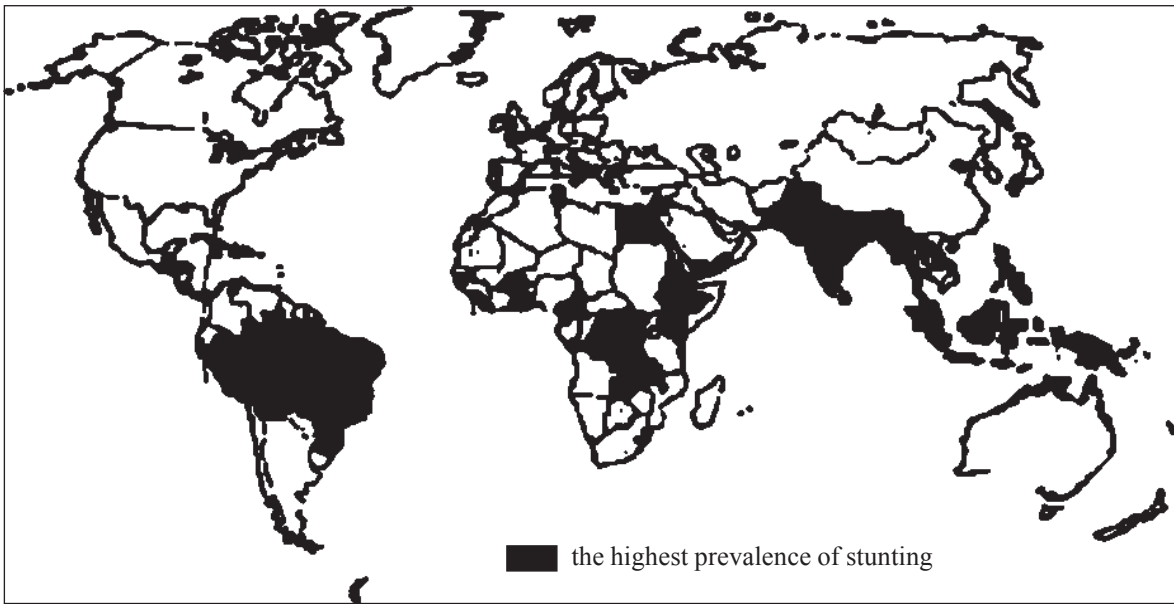


Fig. 35. Geographical Distribution of Stunting in Infants

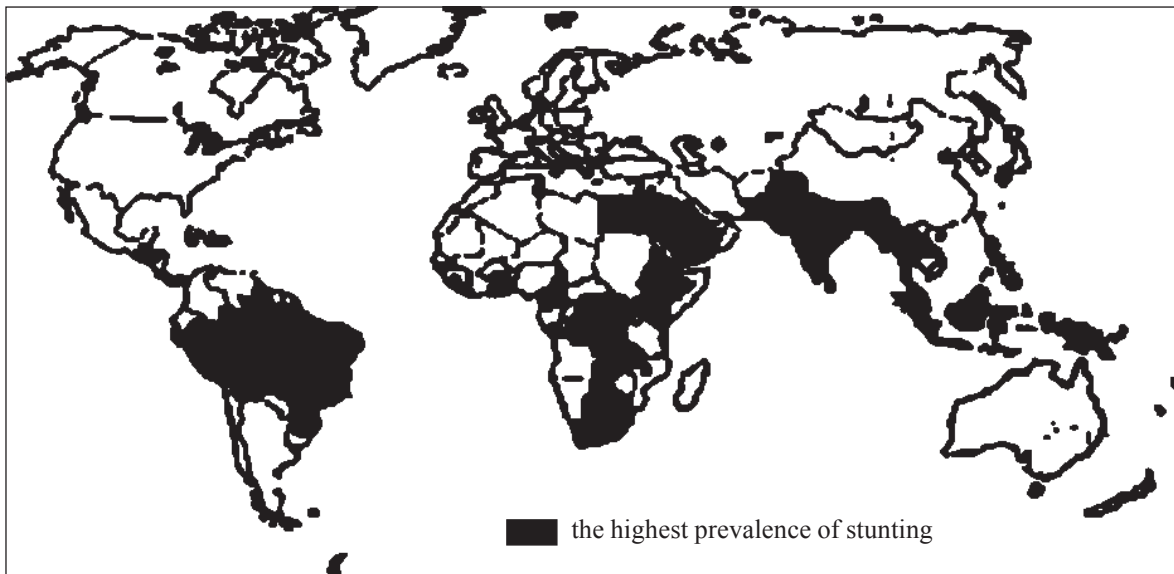


Fig. 36. Geographical Distribution of Stunting in Children at Ages Less than 2 Years

a dining-room and class room also), a bedroom, a service room and lavatory. Every “group section” has two entrances — one to the street and another — to internal corridor of the kindergarten. If two groups have common exit they should use it by the schedule. Toys in the group room should be according to the children’s age. It’s prohibited to use toys from the other groups. Every week all premises should be washed with disinfectants, regular cleaning is made 3–4 times during a day. Disinfectants are changed every 7 days, laundry — every 10 days. Drinking water for children should be stored in the group, it’s forbidden to use tap water for drinking. Children eat in the group room, after every meal all dishes are washed and disinfected.

A medical room should have an isolator. It’s situated at the ground floor and has a separate exit to

the street. If they inoculate children in the kindergarten (not in the polyclinic), all vaccines have to be stored in the refrigerator. The temperature inside a refrigerator should be no more than  $+5^{\circ}\text{C}$ , it’s measured daily and data are recorded in the special register. Also the nurse of the kindergarten has a register of antropometry and complete set of medical documentation (individual charts of children and medical books of staff). Every morning before reception to the group the nurse inspects children for signs of infection (fever, coughing, rhinitis, rash, etc.). Data of examination are recorded in the register.

Demands to personal hygiene of staff and children are very strict. A staff person should be ensured that a child’s hands are washed before meals, snacks, after toileting and after being diapered. Cloth

towels and washcloths should be labeled with the child's name, used only by the named child and laundered weekly. The operator shall arrange a laundry schedule with the parent. Paper towels may be used as towels and washcloths. Paper towels should be discarded after each use. A child shall have a labeled toothbrush. Toothbrushes should be stored with the bristles up and exposed to circulating air. Paper cups for drinking water are discarded after one use, or water fountains should be used for between-meal drinking by children who are not bottle-fed. Lavatory for staff should be isolated from children lavatories.

Good health is essential for learning. Health is not only the absence of disease but also complete physical, mental, and social well-being. When school aged children are not in good health, they become distracted, unable to concentrate in school, keep up with their demanding schedules, and sometimes even unable to attend school. Years ago the biggest threat to the health of school children came from contagious diseases such as tuberculosis, diphtheria, measles, mumps, and rubella. Today most health risks have their roots in social or behavioral conditions. When these problems emerge, they can disrupt students' lives, classrooms, and the school environment. When students are sick, distracted, or absent, schooling becomes ineffective. For students to become productive, responsible citizens, schools must help them develop health-promoting skills and behaviors and attend to the physical, mental, and social components of their lives. For the past decade, education and health experts have suggested that a coordinated school health program that goes beyond classroom instruction and integrates eight components in the most efficient way for schools to ensure the health of their students. There are:

*Comprehensive School Health Education.* This classroom instruction addresses the physical, emotional, and social dimensions of health; develops health knowledge, attitudes, and skills, and is tailored to each age level. It is designed to motivate and assist students to maintain and improve their health, prevent disease, and reduce health related risk behaviors.

*Physical Education.* This instruction that promotes lifelong, safe, physical activity. It is designed to develop basic movement skills, sports skills, and physical fitness, as well as to enhance social and emotional abilities.

*School Health Services.* These are preventive services, education, emergency care, referral, and management of acute and chronic health conditions. They are designed to promote the health of students, identify and prevent health problems and injuries, and ensure care for students.

*School Nutrition Services.* These services integrate nutrition education, nutritious and appealing meals, and an environment that promotes healthy dietary behaviors for all children. They are designed

to maximize each child's education and health potential for a lifetime.

*School Counseling, Psychological, and Social Services.* These activities focus on the cognitive, emotional, behavioral, and social needs of individuals, groups, and families. They are designed to prevent and address problems and to facilitate learning and healthy behaviors and development.

*Healthy School Environment.* This is the physical, emotional, and social climate of the school. Designed to provide a safe physical plant as well as a healthy and supportive environment that fosters learning.

*School-Site Health Promotion for Staff.* This includes assessment, education, and fitness activities for school faculty and staff. It is designed to maintain and improve the health and well-being of school staff who serve as role models for students.

*Family and Community Involvement in Schools.* These are partnerships among schools, families, and community groups and individuals. They are designed to share and maximize resources and expertise in addressing the healthy development of children, youth, and their families.

Schools have evolved from purely educational facilities into sources of employment, social and health services, cultural opportunities, and recreation and entertainment for their surrounding communities.

A healthy school environment encompasses both the physical and psychosocial surroundings in which students and school personnel are expected to work. A healthy school environment supports learning and contributes to students' health by: minimizing distractions; minimizing physical, psychological, and social hazards; creating a climate in which students and school staff do their best work; expecting that all students can succeed; implementing supportive policies.

The physical school facility represents the external, tangible environment. Physical conditions can include school bus safety, adequate water and classroom supplies, physical security of the building, as well as acoustics, ventilation, heating and air conditioning, and lighting. As mentioned before, at least half of the nation's public schools contains an environmental hazard, such as asbestos, contaminated water, or poorly ventilated indoor air. Psychosocial conditions, on the other hand, encompass the attitudes, feelings, and values of the students and staff and may require more extensive changes. The presence of gang violence as well as weapons, drugs, alcohol and tobacco on school grounds contribute to this aspect of a school's environment. Class size and the availability of community-based extra-curricular activities also facilitate the psychosocial environment of a school. To ensure healthy development, a number of model health practices can be integrated into core curriculums. For instance, schools could promote participating in active lifestyles, eating well-balanced meals, abstaining from alcohol,



tobacco and other active drug use, and minimizing risk-taking behaviors, including sexual activity.

Equally important are student and staff perceptions of the interactions that take place within the school environment. This less tangible component of environmental health is frequently referred to as school climate. Climate encompasses both social and physical elements, and creates an infrastructure that makes physical, social and emotional health.

Ergonomic studies comprised scholar adaptability and scholar's psycho-intellectual capacity, approaching issues of mental load and psychological fatigue. Specific investigation methodology was established and evaluation criteria of adaptability and mental fatigue were structured. Scholars' psychological limits are conditioned by their functional particularities of nervous system and sensorial and motor abilities. Disregard of these limits makes improbable determination of scholar activity dysfunction.

Studies carried on between 1994–1998 on secondary and high school pupils revealed that normal physically and psycho-intellectual developed students showed both objective (cardiovascular, muscular, sensorial indicators) and subjective (health status self-evaluation) modifications that demonstrate scholar fatigue. Collective administration of anxiety test Cattell showed increased anxiety on the studied group indicates disorders varied from mild anxious neurosis to severe anxious neurosis that requested psychiatric assistance. Relation between high school performance with high level of anxiety in schoolgirls has been demonstrated.

Study of knowledge functional modifications indicators (attention tests, test on work capacity) has showed modifications in work capacity curve even in the conditions of reduction of working week from 6 to 5 days. Previous studies showed that the academic performance increases from Monday through Wednesday, under the new conditions Tuesday is the maximum, starting Wednesday performance decreases gradually, so that on Friday it is the lowest.

Study of time allocation revealed manifestations of overload syndrome on the account of scholar manuals, subject's planner both saturated with information, data, and inappropriate structure of scholar schedules. Another finding of our researches was scholar disadaptive syndrome considered as a form of social disadjustment that creates premises for further difficult integration.

Children's confrontation with scholar demands generates typical sets of attitudes that lay at the basis of behavioral changes, related to the pupils'. The level and establishment of scholar education are significantly influenced by definitory variables for socio-familial environment especially cultural factors and mainly the level of parental instruction. The study on pupils who were institutionalized since pre-school period and now attending mass general

schools, disclosed a decreased level of adjustment to scholar demands, situated 0–12 months below normal.

Inclusion of these children into mass general schools has had an obvious benefit input towards their IQ which became 10–20 points greater than a pre-school period scores (93.8 in first grade of school over 82.5 in pre-school). Acquisitions on speech level are shown by increased values of IQ in the first and second grade of primary school (97.2 and 92.8). Delayed behavior and psycho-intellectual development of institutionalized children are explained by the monotony of life conditions, lack of exercise, the absence of individualization in care and education, insufficient development of affective and social contact, lack of warmth from care staff, lack of contact between children who play one next to another and not one with other. Researches need to be orientated in the future, with priority, towards the activity that implies a high level of mental load and a high volume of abstract and creative thinking.

## SCHOOL DISEASES

The top ranked diseases are: ocular chronic diseases, failure to thrive, rickets consequences, chronic disease of Waldayer lymph nodes, gained deformations of the spine. Studies found a high percentage of pupils with disharmonic development, weight deficit in pupils from all grades and all counties taken into study.

Risk factors with impact on health status are: non-ergonomic school furniture, effort curve is not taken into account, artificial illumination is inappropriate in classrooms, craft rooms, laboratories, deficient potable water supply. Inappropriate microclimate, deficient ventilation and sometime lack of furniture, floors and toilets hygiene put pupils at risk for diseases. Epidemiological triade after holidays is an active surveillance method into schoolchildren collectivities that enables information on epidemiological potential and risk for health in school children. Diseases diagnosed at triage are found in 1.5% of scholar population and are mainly infectious, both contagious and parasitical. Incidence of angina is increasing so that in 2,000 it reaches the value of 0.56%. Pediculosis and scabies are at constant percentage: 0.03-0.07% scabies and 0.8–1.2% pediculosis. There are though differences between counties related to local/regional particularities. There is a need for hygienic and sanitary, epidemiological, education for health measures with national dimension aiming to reduce the incidence of these diseases and to eradicate scabies and lice.

School building should be placed in the residential area far from sources of pollution. The service area has 500 m in radius, for lyceum and colleges — without limits. School area has from 0.5 to 3 ha and is subdivided into economic zone, zone of veg-

etation, zone of sports grounds and school building zone. The built area can occupy up to 25% of school area, vegetation takes 55% as minimum. Sports zone takes about 30% of the area. In Ukraine it is established that maximum height of school building is 3 floors. School building has two or more entrances. They use the systems of school building:

a) centralized — all premises are situated in one building. It's typical for the most urban schools;

b) decentralized — school has some buildings (for primary school grades, secondary school, catering unit, administrative unit, sports unit, dormitory (hostel) for board schools, etc.);

c) combined — has features of the both systems.

School is provided with systems of water supply, canalization, gas and electricity.

Primary grades are placed at the first floor of the building. Their square is 1.25 m<sup>2</sup> per a pupil.

For secondary school this ratio is 1.5 m<sup>2</sup>. The height of school premises should be no less than 3.5 m. For classrooms of chemistry, biology, informatics, physics two premises units are used. They consist of study room and laboratory (for IT class — server room). Chemistry classroom should be equipped with local exhaustion and be placed on the upper floor of the school building.

The school furniture should be ergonomic, e.g. accord with the height of the child. They use terms *differentia* (distance between table and chair by the vertical), *distance of the back support* (between back edge of the desk table and back of the chair) and *distance of sitting* (between back edge of the desk table and front edge of the sit of the chair). Differentia should be equal to level of the elbow of the sitting pupil +5 cm. Distance of sitting should be negative (2–3 cm). If distance of sitting is positive it can cause thoracic hyperkyphosis. High differentia cause right-side scoliosis, low differentia — left side scoliosis.

In the West they use height of sitting in inches (14", 16", 18", etc) as the desk size. Modern desk can be combined as a unit. It's light, safe and ergonomic.

In Ukraine we use the system of sizes of furniture marking by Cyrillic letters and color marks (Table 32). These marks are used only for school desks.

Table 32. The Sizes of School Desks

Group of school furniture	Pupil's height	Color mark (a ring with D=25 mm or strip with width 20 mm)
A	Up to 130 cm	yellow
Б	130–145 cm	red
В	145–160 cm	blue
Г	160–175 cm	green
Д	175 cm and more	white

## ERGONOMIC WORKPLACE FOR PC STUDIES

Computers should accord to TCO 99 or TCO 95 (glare reducing screen, ergonomic monitor). The top of monitor screen is approximately on the eye level. The best is use indirect lighting. The keyboard and mouse should be ergonomic. The elbow angle should be physiological (70–90°) and wrist angle does not exceed 10°. The chair should support the correct posture — the thigh is horizontal, the knee is bent at 90° or more. Feet should be flat on the floor or foot rest (Fig. 37).

**School Syllabus.** The hygienic organisation of the educational classes at school is aimed at saving the work ability during the whole day of study, to remove the fatigue, i.e. to make this work hygienic and pedagogically effective. There are five school days in a school week. The weekly workload in terms for students should be determined by the school curriculum. The maximum permitted workload should be:

- 1) 20 h in grade 1;
- 2) 23 h in grade 2;
- 3) 25 h in grades 3 and 4;
- 4) 28 h in grade 5;
- 5) 30 h in grades 6 and 7;
- 6) 32 h in grade 8;
- 7) 34 h in grade 9;
- 8) 35 h in grades 10–12.

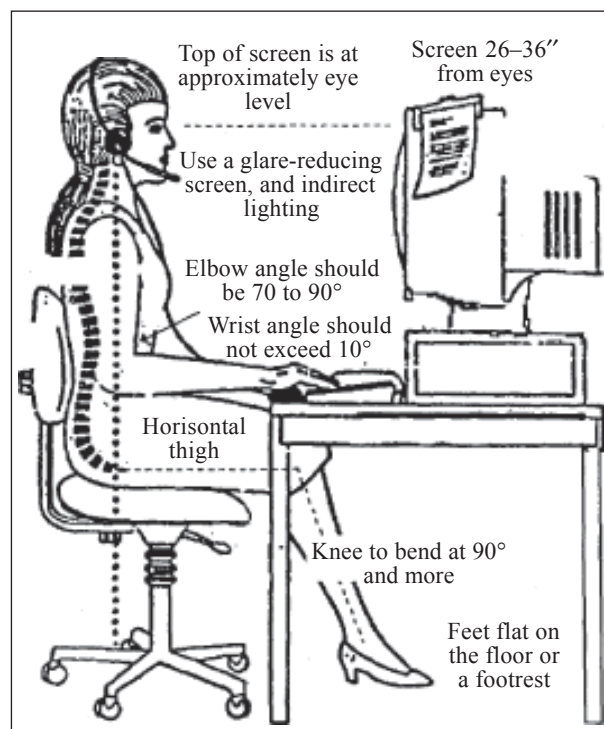


Fig. 37. Hygienic Requirements to the Workplace in IT Department.

Limit duration of a lesson in the first grade is up to 35 minutes. The best regimen for the first grade pupils is the following: September-October — 3 classes × 30 min; November-December — 4 classes × 30 minutes and from January — 4 classes × 35 minutes. Short breaks in the lesson are used for fatigue prevention. The least ability to work is on Monday and Friday, the maximum — on Wednesday. So test papers should be excluded during these days.

It's very important to change kinds of children activities from the intellectual work to the physical — from classes of mathematics, foreign language — to craft, drawing or music. It's forbidden to place difficult subjects after sports classes. It's necessary to avoid doubling of lessons.

The breaks between classes should be no less than 10 minutes, for lunch children have 30 min break. For children rest recreation premises should be organized.

The maximum number of students in a class should be 36. In case of a small number of students, a combined class should be formed of students from different classes. From grades 1–4, there may be up to 20 students in a combined class formed from 2 classes, from 3 classes up to 15, and from 4 classes up to 10 students. In grades 5–9, there may be up to 15 students in a combined class formed from 2 consecutive classes. There may be up to 30 students in an extended day group. There may be up to 25 students in a group at a boarding school.

**Homework Policy.** Homework is an important part of the learning process, and you should expect to have homework assignments each day. On the average, students in grades 5 and 6 should expect 1 to 1.5 h of homework each night; students in grades 7 and 8 should expect 2 to 2.5 h of homework each night. Summer reading assignments will be the only ones required during vacation time. Homework assignments may require reading and/or writing. Sometimes you will need to spend time reviewing classroom assignments material so that you are prepared for quizzes and tests. You will also be given some long-term assignments like special projects and reports. Learn to tackle these assignments by doing a little each day instead of waiting until the last minute. It would be helpful for you to block out your work time on a calendar for long-term projects. Budgeting and organising pupil's time are very important skills which he/she should develop during school years.

**Hygienic Basis of the Regime of Children.** Children develop in the course of organised activity of various forms and duration. This activity (if its organisers keep in mind children's anatomic and physiological peculiarities, their possibilities and health) can stimulate the development of nerve system, speech, analyser, promotes a normal growth and development. But children's activity is far from being unlimited, and tiredness comes after it.

Tiredness after a mental work is a result of the violation of cortex-subcortex interrelations followed by breeches in a cortex neurodynamic and efficiency on the one hand and negative changes in the reactions of vegetative system on the other hand. The prophylaxis of tiredness prevents from the violation of high nervous activity and vegetative functions, cardiovascular system; it helps to maintain the capacity for work.

To observe the day's regimen means to divide the day's time into certain fixed periods and to spare each period some sort of activity or relaxation so that all kinds of rest and activity would be embraced taking into consideration children's age and state of health. The regimen is considered to be right if it gives enough time for all the necessary elements of life activity and at the same time maintains a high capacity for work:

- various kinds of activity (studies at school and at home for schoolchildren), their optimum duration, reasonable alternation and regularity;
- rest with the maximum stay in the open air;
- regular and sufficient feeding;
- sleeping of full value.

Children of 6 years old are to sleep 11.5 h (10 h at night, 1.5 hour in the afternoon).

Studies at school are conducted according to a curriculum. To restore capacity for work and prevent tiredness rest must be given. It's efficiency to a great extent depends upon it's organisation.

If children rest in the open air and their rest is planned and organized carefully it may have an additional positive effect on children's organisms. Such rest promotes blood oxygentaion, increases lungs ventilation. Children must stay in the open air no less than 2–2.5 h (best of all before the beginning of classes, after them and before going to bed. Children must have some free time (1–1.5 h a day for younger schoolchildren and 1.5–2.5 h a day for senior ones), which they stand by their own option. But there are some kinds of activity within this time which must be under control. This is seeing films and especially TV-programs. It's known that children under 7 spend about 12–24 h a week in front of TV-set which leads to tiredness, but not relaxation.

According to the modern researches younger schoolchildren may watch TV maximum 1 hour while senior pupils can do it 2 h a day, no more than 2–3 times a week. Age peculiarities, state of health must be taken into consideration as well as what children are interested in, how well they do at school etc. Enough time for self service, hygienic procedure must be envisaged in the regimen. It's necessary to keep strictly to the routine for those children who are in extended-day groups at school. The requirements here are the same as for children who go home after classes. So schools where such groups exist are to have special conditions.

Wrong organisation of the day regimen has a negative effect on the state of health, causes tiredness, delays growth and development of children. So the day regimen is an indispensable condition for bringing up children successfully.

**General Health Education in the Developing Countries.** Health and Hygiene lessons cover most of the tropical diseases found in the area, e.g. malaria, bilharzia, sexually transmitted diseases including HIV/AIDS. The lessons are structured to cover causes, symptoms, treatments and prevention of these diseases. Most of the family members have improved their living standard in the areas of health and hygiene. This is shown by decrease in malaria, diarrhoea, STDs cases in clinics. Through motivation, creativity and initiatives, self reliance has been the promoted in the sense of income generating activities which address the problem of unemployment nationally and internationally through self-employment, as well as creating jobs for others. Families receive lessons and campaigns on the importance of sanitation. As a result of the lessons, families dig pits for latrines, mould bricks, pay the builders, while the project provides materials such as cement, mash-wire, reinforcement and fly-screen together with other NGOs.

**Physical Training.** Physical training is one of the factors of external environment, which can strengthen a condition of health, raise stability of the organism to the influence of the adverse factors.

The basic way of physical education is the physical exercises and training of the organism. Under the action of physical training positive changes take place in the organism:

- the metabolic processes are normalized; immunological properties of the organism are rised;
- the functions of the organism are improved;
- the coordination of movements is improved;
- the endurance, stability to the factors of external environment is increased;
- new conditionally-reflexive connections, the improved nervous-emotional tonus, protective mechanisms.

The following principles should form the basis of physical training: systematic training; gradual training; integrated approach; individual approach.

Medical control of physical training includes the following complex of measures:

- medical supervision on the condition and dynamics of health;
- study of reactions of the organism on physical loading;
- participation in measures on preventive maintenance of traumatism during employment, in tourist campaigns;
- sanitary supervision at places for physical training.

Therefore before starting physical education the doctor should:

- carry out medical examination of children;
- divide them into groups of health;
- divide them into groups for training;
- define a kind of physical exercises and training procedures indicated to this or that child.

By condition of health and physical development children can be divided into 3 groups.

The basic group includes healthy children with slight functional deviations in the cardiovascular system or insignificant deviations in physical development. It's possible to carry out all kinds of physical education.

The preparatory group — poor trained children, with functional deviations of the cardiovascular system or the respiratory system, who has chronic bronchitis or recover after acute infections. It's necessary to observe moderate dosage of physical loading, to limit running, jumping, etc.

The special group are children with rheumatic fever, etc. The sport classes are limited or absolutely forbidden.

Special tests are made to determine a degree of training state. In improvement of health condition and physical development of the child, the doctor can transfer him from the third group to the second one, from the second to the first one after examination. While transferring children from one group of physical training to another one the basic parameters should be study of functioning of the organism with the help of functional tests on dosed muscle loading. For children of preschool age the Levi-Gorinevsky's test — 30 jumps for 20 seconds is used. Pulse rate, breathing rate and blood pressure are considered as functional parameters of the organism.

Three types of reactions are observed:

- 1) the reaction of a usual type: the pulse becomes frequent in the first 10 s, pressure increases by 5–10 mm Hg;
- 2) the insignificant deviations consist in increase of pulse and breathing rate after received loading. The restitution of pulse is delayed about 3 minutes but no other signs of poor health are observed;
- 3) significant dyspnoe, deterioration of health, arrhythmic pulse, disturbance of blood pressure reaction:

- systolic pressure reduction;
- diastolic pressure reduction.

The doctor working at school should also provide:

1. Scheduled primary and repeated surveys of children for division into groups of physical training. It's necessary for the admission to lessons of physical training in sports sections, to participation in competitions, in tourist campaigns, for a direction into sports schools).

2. Control of lessons of physical training, realization of “physical culture pauses”, competitions, etc., prevention of traumatism, consultive work with the teachers.

To prevent sport traumas the following actions are forbidden:

a) the premature admission to training of recovering children, suffering from chronic diseases, poor trained;

b) lengthening of training, disturbance of rules of personal hygiene (exercises after meal, on an empty stomach, in poor sleeping, training with children having skin lesions, excoriations, etc.).

The correctly constructed lesson consists of four parts:

The introduction — 5–7 min.

The preparatory part — 12–15 min.

The main part — 20–25 min.

The final part — 3–5 min. Restoration of the organism to initial condition.

Physical loading should be given in the main part.

“Tempering” — special training of adaptive capacities of the organism which increase the level of antistress resistance. Main target of the hardening techniques is thermoregulation system. In English speaking nations they use terms “heat acclimatization” and “cold acclimatization”. The main idea of body tempering (like in tempering steel) is the concept that everyone can increase “natural immunity” by air baths, water procedures and sun bathing (Table 33).

Cold acclimatization is a process of gradually increasing resistance to cold through regular cold exposure. Major examples of acclimatization to cold are the indigenous people of the African Kalahari, the Australian desert, and Tierra del Fuego in Southern Chile. Many sleep outdoors nearly naked in freezing temperatures. Acclimatization occurs in people working outdoors year round and fishermen who dunk their hands in cold water all winter to tend their nets. Children acclimatization to cold is an important measure in the prevention of overcooling and acute respiratory diseases.

True cold acclimatization involves at least three adaptations. Cold-acclimatized children people be-

gin shivering at lower body temperatures, because they generate more heat without shivering. A big hallmark of cold-acclimatized people is improved ability to sleep in the cold. Cold acclimatization may involve either increased or decreased skin temperatures, depending on circumstances. In some cases, skin blood flow increases to keep extremities warm and to resist cold injury. In other cases it decreases to reduce heat loss. For example, skin temperatures of Australian Aborigines were lower while sleeping than those of the unacclimatized Europeans.

The main principles of body tempering are the same as for physical training:

(1) systematic training; (2) gradual training; (3) integrated approach; (4) individual approach.

Air bathing is an effective and simple method of tempering. The air bath should be pleasant and if it is taken progressively will prove to be so. Its duration must depend on the temperature and on the age of a child. He/she must not be permitted to chill.

Cold water removes heat from the body 25 times faster than cold air. The immediate effects of sudden immersion in cold water (15°C) can be a debilitating, short duration (approximately 2–3 min), reflex response called cold shock. This response includes life-threatening respiratory and cardiovascular effects. The respiratory effect involves quick onset (less than 30 s) uncontrollable rapid breathing which impairs breath-holding and facilitates aspiration of water (which can lead to drowning). The cardiovascular response involves an immediate constriction (closure) of the blood vessels near the surface of the body, an increase in heart rate and a surge in blood pressure.

For pouring it is recommended to use warm water (30–32°C). Every 2–3 days temperature of water is reduced by 1°, reaching till 19–20 for the younger schoolboys and 16–17 for adolescents.

Duration of taking shower is 1–2 min. After shower it is necessary to wipe a body carefully and massage it. The duration of all water procedures should be no more than 1–3 min. The especially strong influence is rendered by sea bathing in a combination with swimming (temperature of water, movement of waves, chemical structure of water). All this trains mechanisms of thermoregulation resulting in metabolism raising, optimizing in lung ventilation, increasing of pulse and blood pressure, increasing of red blood cells quantity, training of the nervous system. The swimming renders positive influence on physical development of the children.

To begin sea bathing the temperature of water should be no less than 20°C. The duration of bathing during first days should be no more than 3–5 min with subsequent lengthening of bathing time up to 20–30 min.

The sanction for usage with a reservoir for bathing children is given by local sanitary epidemiological station. The depth of water in a place of bath-

Table 33. Kinds of Tempering Procedures

Procedures	General (whole body)	Partial
Convective	Air bathing	
Conductive	Showering Bathing Winter swimming	Wiping Pouring Barefoot walking
Others	Sun bathing Sauna Russian bath Hamam (Turkish bath)	

ing of the younger schoolboys should be no more than 1–1.5 m. A place, up to which it is authorized to children to float follows, to designate by identification marks. During bathing children the presence of the adults is necessary.

The action of ultraviolet irradiation on the organism is a complex process. Under influence of ultraviolet irradiation denaturation of fiber occurs, that causes increase of quantity of proteolysis products including histamine. These products irritate the nervous terminations in the skin, vessels, that causes changes in the functional condition of the nervous centers. It conducts reflective reactions on the part of a number of organs and systems.

The solar baths for children can be organized on a river or sea side or in the special solarium. The greatest pressure UV-radiation is observed at the noon. To avoid excessive strong action of UV rays on the child's organism, the best time for solar baths is considered to be 9–10 a. m. Also children should avoid direct solar irradiation and use some other rules:

1. The reception of solar baths is supposed only after 1.5–2 h after meal.
2. Solar baths after vigorous physical activity (playing football, volleyball, athletics, gymnastics) are contraindicated.
3. Prior to the beginning and after termination a solar bath it is necessary to accept an air bath by duration in 15–20 min.
4. Head should be covered by the light hat or cap.
5. After a solar bath the bathing in the river or a cool shower is recommended.
6. The duration of solar baths should be strictly regulated.

In children of the senior school age the first bath can last for 5 min, with the subsequent daily increase by 5 min. The general duration of baths should be no more than 1.5–2 h.

During solar bathing it is necessary to supervise a condition of pulse and state of health of the pupils. Acceleration of pulse by 30%, occurrence of nausea, the headaches require the immediate termination of a solar bath.

Children are at a higher risk of suffering damage from over-exposure to UVR than adults, in particular because of the following:

1. The child's skin is thinner and more sensitive, and even a short time outdoors in the midday sun can result in serious burns.
2. Epidemiological studies demonstrate that frequent sun exposure and sunburn in childhood set the stage for high rates of melanoma in later life.
3. Children have more time to develop diseases with long latency, more years of life to be lost and more suffering to be endured as a result of impaired health.
4. Children are more exposed to the sun. Estimates suggest that up to 80% of a person's lifetime exposure to UVR is received before the age of 18.

5. Children love playing outdoors but usually are not aware of the harmful effects of UVR.

The most noticeable acute effect of excessive UVR exposure is erythema, the familiar inflammation of the skin commonly termed sunburn. The symptoms of a mild sunburn are reddening of the skin caused by vascular dilatation and some swelling, while in severe cases the skin will blister. In addition, most people will tan from darkening of existing melanin or through the UVR stimulation of melanin production, which occurs within a few days following exposure. A further, less obvious adaptive effect is the thickening of the outermost layers of the skin that attenuates UVR and decreases the penetration to the deeper layers in the skin. Current estimates suggest that a suntan can offer a sun protection factor (SPF) of between 2 and 3. Depending on their skin type, individuals vary greatly in their skin's initial threshold for erythema and their ability to adapt to UVR exposure. Chronic exposure to UVR also causes a number of degenerative changes in the cells, fibrous tissue and blood vessels of the skin. These include freckles, naevi (moles) and lentigines, which are pigmented areas on the skin, and diffuse brown pigmentation. UVR accelerates skin aging, and the gradual loss of the skin's elasticity results in wrinkles and dry, coarse skin.

Although the data remain preliminary, there is increasing evidence for an immunosuppressive effect of both acute high-dose and chronic low-dose UVR exposure on the human immune system.

Children require a special protection, as they are at a higher risk of suffering damage from exposure to UVR than adults. Encouraging children to take simple precautions will prevent both short-term and long-term damage while still allowing them to enjoy the time they spend outdoors. Shade, clothing and hats provide the best protection.

Before accepting child of 6 years old in Ukrainian primary schools they check out *school maturity* of children. School maturity is a complex characteristic of the readiness for studies to school. They use medical and psychological criteria of school maturity (Table 34).

The indications for delay of school are as following: absence of the permanent teeth; body length

**Table 34. Criteria of Readiness of the Six-Year-Old children for Studies in the Secondary School**

Criteria	Characteristics
Medical-biological	teeth age (permanent dentition) physical development health state (status praesens and diseases history)
Psychophysiological	quality of articulation results of the Kern-Iracek's test

less than M-15D (by local standards); increase of the growth less than 4 cm per year; infectious hepatitis; pyelonephritis, diffuse glomerulonephritis; myocarditis (nonrheumatic); epidemic meningitis, meningoencephalitis; tuberculosis; rheumatic fever-blood diseases; frequent respiratory viral diseases (more than 4 times a year); vegetative dystonia (of hypotonic or hypertonic type); valvular defect (congenital or rheumatological); chronic bronchitis, bronchial asthma, chronic pneumonia (if its exacerbation or there is no steady remission in the year); ulcerous diseases of the stomach or duodenum, chronic gastritis, chronic gastroduodenitis (in aggravation stage, with frequent relapses and with uncomplete remission); anemia (Hb 8.0–10.7 g%); adenomatous vegetation of III degree, chronic adenoiditis; hypertrophy of faucial tonsils (of III degree); endocrinopathy, goiter, diabetes mellitus, etc.; neurosis (logoneuroses, hysteria, etc.); retardation of the mental development; child's cerebral paralysis; trauma of the cranium; epilepsy; enuresis; eczema, neurodermitis (if there are widespread skin lesion); myopia with progressing tendency (> 2.0 D).

#### Discription of Kern — Iracek's test

*Equipment:* a sheet of paper (A4), cards 7–8 × 13–14 cm with the inscription: "He ate a soup" and grouped dots. (The inscription has vertical size of the letters 1 cm, capital letter has size of 1.5 cm; the dots have diameter of 2 mm, distance between the dots across and vertically is 1cm).

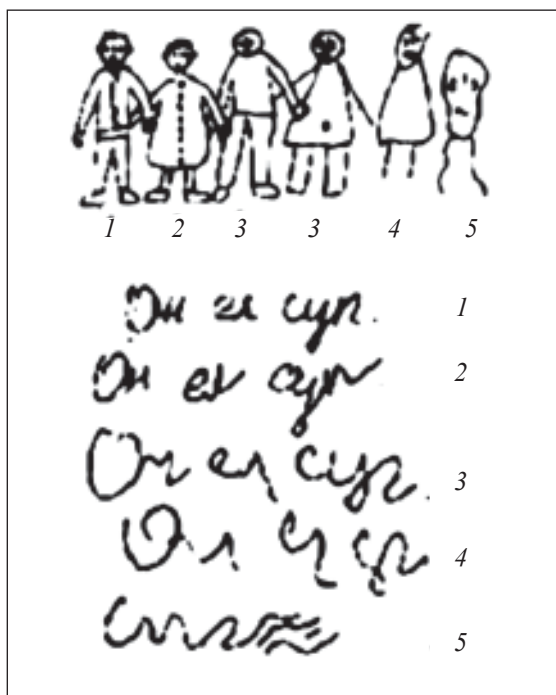


Fig. 38. The First and Second Subtest of the Kern — Iracek's Test

The test of Kern — Iracek can be conducted individually or in a group of 10–15 children. The final investigation is carried out with each child separately in a special room. A child (or a group of children) is given a sheet of paper. In the right top corner of the sheet the investigator writes the name and surname, the age of the child, the number of the nursery school, the date of the investigation. The pencil is put so that the child could easily take it with his right or left hand (Fig. 38, 39).

#### Instructions:

1. Draw a man, please.
2. Copy the written sentence.
3. Copy the dots.

Before doing the first task a child gets the following instruction: "Here draw a man as you can". The other explanations assistance or remarks concerning the mistakes and faults of the picture are forbidden. If the child can not get down to the work the investigator can encourage him like this: "Good for you. You've begun your work very well. Go on drawing." If the child wants to draw a woman, the investigator should explain to him (her) that all the children draw a man and he (she) must draw a man. If the child has already begun to draw a woman, he (she) may be aloud to finish the picture but after that the investigator insists on drawing a man next to the picture of woman.

After the picture has been finished the reverse side of the sheet is divided into 2 parts by a horizontal line.



Fig. 39. The Third Subtest of the Kern — Iracek's Test

Before fulfilling the second task 5–10 cards (7–8 cm × 13–14 cm) must be prepared. The sentence “He ate soup” (the vertical size of the letters — 1 cm, of the capital letter — 1,5 cm) is written on the cards. The card with the sentence is placed in front of the child.

*Evaluation:* the best result is 1, the worst — 5 scores (by every subtest). If the child has more than 9 scores he’s unready for school.

To estimate the *quality of pronunciation* a child is asked to call the subjects (in the pictures) in whose names the following sounds are used:

— sonoric R — hard and palate, L — hard and palate;

— whistling S — hard and palate, Z — hard and palate;

— hissing gh, sh, ch, shch.

Pictures are picked out so that each of the sounds would be used at the beginning, in the middle and the end of the word. All the faults in pronouncing the word are recorded.

The existence of the defects in pronouncing at least one of the above-mentioned sounds means that the task hasn’t been fulfilled. A child isn’t considered to be fit for schooling if he (she) gets 9 and more balls for the test of Kern — Iracek and has a fault in pronunciation.

To correct the deviations revealed it’s recommended:

— to do exercises for small muscles or bones development: modelling, embroidering, etc.;

— this work must be conducted under the guidance of grown-ups;

— the studies in order to help a child to get rid of the faults in pronouncing (conducted by a doctor-logopedist).

So, the children whose biological age corresponds to their passport age or passes age, whose morphological and functional development are harmonic, whose speech and pronunciation are well developed, who are healthy (I and II groups of health) and have passed successfully the test of Kern — Iracek are fit for schooling.

Scientific research of hygienists, physiologists and teachers have shown that children under 6 can be taught at school but some requirements must be satisfied:

— their state of health must be taken into consideration;

— they must be ready functionally for schooling;

— they must have enough room and favourable conditions for studies;

— the curriculum and methods of teaching must be adjusted to the functional peculiarities of the age;

— hygienic recommendations concerning the regime of studies must be kept;

— the normal feeding and physical training must be organized taking into consideration age peculiarities of children.



## Chapter 6

# RADIATION HYGIENE

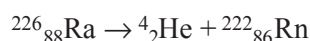
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Radiation hygiene includes dosimetric (investigation of radiation sources and levels) and radiobiologic directions (experimental and epidemiological researches of ionising radiation influence upon health), theory and methodology of hygienic certification of admissible levels of irradiation and sanitary-organisation direction making ways for antiradiation protection.

**Radioactivity** — spontaneous transformation of elements nuclei in other ones with formation of ionising radiation.

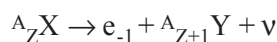
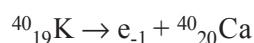
There are the following kinds of radioactive decay:

$\alpha$ -decay is very typical for natural radioactive elements with high numbers (they have low link energy):



$\alpha$ -particles are helium nuclei. Their energy is spent on exaltation and ionising of atoms in the interaction with matter mainly (but if  $\alpha$ -particles has penetrated in nucleus it's able to do nuclear reaction). Length of  $\alpha$ -particles track depends on their initial energy, number, atom mass and substance density. Linear density (quantity of ion pair on the unit of track) of ionisation depends on the particles energy but volume density of ionisation depends also on a depth of their penetrating. Penetrative capacity of  $\alpha$ -particles is low (for  $\alpha$ -particles with energy 4MeV length of track in air is 2.5 cm, in biologic tissue — 31  $\mu$ , in aluminum — 16  $\mu$ ) because they have big mass and charge, but indices of linear and volume density of ionisation are high.

*Electronic  $\beta$ -decay* is typical for natural and artificial elements:

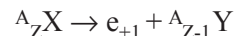


There are an elastic and inelastic interactions of  $\beta$ -radiation with substance. Inelastic interaction are

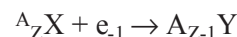
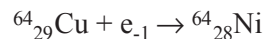
inelastic dispersion, atom ionising, nuclei exaltation, brake radiation. Length of  $\beta$ -particles track formula is: for air —  $R = 400 \times E_\beta$ ; for light materials (aluminum, glass) —  $R_\beta = 0.2 E_\beta$ , if  $E < 0.5$  MeV.

For  $\beta$ -particles volume density of ionising is in 1,000 times less than for  $\alpha$ -particles. For  $\beta$ -particles with energy 4 MeV the length of track is 17.8 m in air, 2.6 cm — in water, 9.8 mm — in aluminum.

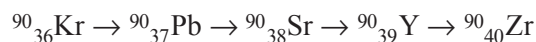
*Positronic  $\beta$ -decay* occurs for some artificial isotopes:



*K-capture (orbital electron capture)* is concurrent process with positronic  $\beta$ -decay:

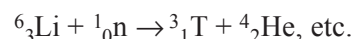
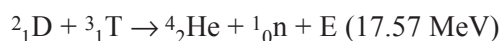


*nuclear fission:*



If nuclear fission is being carried out for radio-nuclides with high atom number and mass more than critical the process has a chain character (*chain reaction*) and goes to explosion.

*Thermonuclear reaction* occurs only at temperatures about several millions of degrees of Celsius:



$X$ - and  $\gamma$ -rays have interaction with irradiated substances in form of photoelectric effect (mainly for  $E = 1-500$  keV), dispersion and forming of pairs "electrone-positrone." They have high penetrating capacity and their track length is hundreds meters in air.

Neutrons have elastic and inelastic interaction with substance. Neutrons are classified into slow neutrons: cold neutrons ( $E < 0.025$  eV), hot neutrons (0.025–0.5 eV) and overheat neutrons ( $>0.5$  eV), and fast neutrons.

The radioactive decay law: quantity of isotope atoms transformed in 1 s is proportional to their general quantity or in equal time intervals there takes place the nuclear transformation of equal parts of active isotope atoms:

$$\frac{dN}{dt} = -\lambda N$$

after integralization of the equation we have:  $\lambda = 0.693/T$ , where T — a half-life period (time for decaying of an half of all isotope atoms) and ( $\lambda$  — is the constant of life. Isotopes are divided into short-living (period of half-life is calculated in seconds, minutes, hours, days) and long-living (from some month to billions of years).

The radioactivity unit in System International is *becquerel* (Bc) — 1 decay per second. Another unit is *curie* (Cu) =  $3.7 \cdot 10^{10}$  Bc.

For characterizing of ionising radiation interaction with substances it's being used *exponential, absorbed, effective and equivalent doses*.

Exponential dose characterizes the ionisation of air with X-rays or  $\gamma$ -rays. In SI the unit is *coulomb on kilogram* (C/kg). But it's very often used *roentgen* (R) as the unit of the dose.  $1R = 2.58 \cdot 10^{-4}$  C/kg = 1 unit of CGS/cm<sup>3</sup> ( $1.08 \cdot 10^{10}$  ion pair in 1 cm<sup>3</sup>)

Absorbed dose shows how much energy of ionising radiation is absorbed by the unit of mass. We use *Gray* (Gy) = 1J/kg in SI and *rad* (radiation absorbed dose) = 0.01 Gy = 100 erg/g.

Equivalent dose is absorbed dose multiplied on radiation coefficient. SI has especial unit for it: *Sivert* (Sv) = 1J/kg. We use *rem* (biologic equivalent of rad) = 0.01 Sv also.

Effective dose characterizes the biologic effect for all human body and its organs from influence of ionising radiation. The units are the same as for equivalent dose.

In practice of radiation hygiene it's being used capacity of dose — ratio of dose gain to time interval.

Ionizing action of every  $\gamma$ -radiation sources is expressing in *mg* or  *$\gamma$ -equivalent of radium* = 8.4 R/h·cm<sup>2</sup>.

*Biologic action of ionising radiation:*

Interaction of ionising radiation with biologic tissue has three stages:

1. Physical — absorption of ionising radiation energy in described interactions. It takes only  $1 \cdot 10^{-19}$  s. It's able to destroy cells if energy of radiation is enough high. Intracellular water absorbed 50% of energy and organelles and biomolecules take 50% too.

2. Physical-chemical — production of active radicals. The main process is water radiolysis, the process takes about  $10^{-11}$  s.

3. Biochemical — interactions of primary and secondary radicals with biosubstances. The most sensitive process is oxidative phosphorylation; the enzyme dysfunction expresses in damage of ATP production system. Protein molecules and deoxyribonucleic complexes (DNA in complexes with proteins, RNA and enzymes). Proteins change their configuration, it takes place aggregation of proteins because disulfide links are forming. The protein denaturation is the result of deep changing in its structure. Dose about 5–10 Gy realized in transformation of mucopolysaccharides. Peroxidative oxidation of lipids (POL) which has a character of chain reaction occurs.

The cells with haploid chromosome set (spermatozoids, ovocytes) are more sensitive to ionising radiation action than diploid cells. Cells especially sensitive for radiation in anaphase and kataphase of mythosis. Hypoxy decreases the tissue sensitivity for ionising radiation.

The biologic effects of ionising radiation is divided into three groups: somatic, somato-stochastic and genetic (Fig. 40). The first group is presented by deterministic effects, includes acute and chronic ray disease, ray combustions, alopecia, ray cataract, clinical registered frustration of hemopoiesis, temporary or constant sterility. This effects have close link with radiation dose and they forms in short time after action of radiation factor. For example the dose of 1–2 Sv makes the light form of acute ray disease but the dose of 10 Sv is absolutely mortal. The threshold character of the effects is used for prognosis and for reconstruction of the doses.

**Somato-stochastic** effects include effects manifesting in the life of the individual (from the moment of fertilisation to death). There are cancerogenic and teratogenic effects.

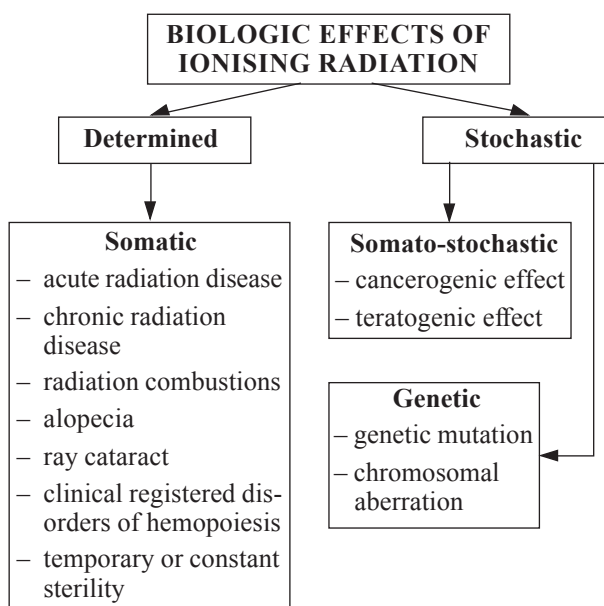


Fig. 40. Biological Effects of ionising Radiation

For calculation of cancer risk they use laws of “dose-effect” interaction in the low doses. There are simple statistic models (linear, square, linear-square). The preference is given back to the last. The question about threshold level for cancerogenic effect is unclear now. If they are found, all the system of hygienic reglaments should be changed.

*Genetic* effects include genetic mutation and chromosome aberration.

At present the most of specialists consider teratogenic effects can be determined. The action of the ionising radiation in the early stages of embriogenesis and gestation has as the threshold absorbed dose of 0.1 Gy.

*Gormesis* — is a recently discovered beneficial effect of low doses of ionising radiation upon the human health. It expresses in high tolerance to environmental factors actions.

*The principal tasks* of radiation safety system are: 1) to prevent the determined effects by limiting irradiation dose under threshold values; 2) to use all maintenance and measures to increasing of probability of stochastic consequences taking into account social and economical vectors.

*Principles of radiation safety*: 1) the principle of the norm setting not to exceed an established dosage limit; 2) the principle of evidence practice (exclusion of any ungrounded, additional to prognosed, irradiation); 3) the principle of optimization (lowering of radiation dose to a possible low level).

Limit of the dose (LD) is the maximal average value of individual equivalent dose of ionising radiation per year for the critical group if equal irradiation during 70 years did not lead to unfavourable changing in human health detecting by contemporary diagnostic technology.

*The critic group is the biggest by quantity group of the category B persons with uniform life condition, age, gender or other factors if it had a maximal level of radiation influence in the limits of institution, its sanitarc-guarding zone and observation zone.*

*Sanitary-guarding zone is the territory around institution or the source of radiation contamination where it is a risk of highing of admissible levels of irradiation (in the state of normal work of institution).*

*Observation zone — is the territory where there is a possibility of irradiation due to established levels.*

The critical organs group:

I — gonades, marrow.

II — lens; endocrinic, muscular, parenchimatous, lymphoid tissue etc.

III — bones, fibrous connective tissue.

Categories of irradiated person:

A: people working with radiation sources (constantly or temporary): physicists, radiologists, workers of atomic power station, roentgenologists, etc.

B: people living or working in condition with possibility of irradiation (near atomic power station, in geochemical provinces with a high level of radiation background, surgeons, nurses of radiological department in hospital, etc).

C: other population.

The following limits of the dose in Ukraine are used (NRB-97) (Table 35):

For category A there are established:

Admissible limit of inhalation input  $ALI_{inhal}^A$ .

Admissible concentration of the radionuclide in the air of working zone  $AC_{inhal}^A$ .

Admissible density of the particles in the air of working zone ADPA.

Admissible power of an external radiation dose APED.

Admissible contamination (ACA) of the skin, overalls and working surfaces.

*For category B:*

Admissible limit of inhalation income  $AI_{hal}^B$ .

Admissible concentration (AC) of the radionuclide in the air of working zone  $AC_{inhal}^B$ .

Admissible density of the particles in the air of a working zone.

Admissible power of an external radiation dose

Admissible contamination (ACA) of the skin, overalls and working surfaces.

*For category C:*

Admissible inhalation  $MAI_{inhal}^C$  and ingestive  $MAI_{ingest}^C$ .

Admissible air concentration  $PC_{inhal}^C$  and water concentration  $PC_{ingest}^C$ .

Admissible eject (AE) into the objects of environment.

Dose loading should accord to these equations:

$$\frac{E}{D_{\text{ext}}} + \sum \frac{I_{\text{ingest}}}{AL_{\text{ingest}}} + \sum \frac{I_{\text{inhal}}}{AL_{\text{inhal}}} \leq 1$$

$$\frac{H_{\text{lens}}}{DL_{\text{lens}}} \leq 1$$

$$\frac{H_{\text{skin}}}{DL_{\text{skin}}} \leq 1$$

$$\frac{H_{\text{exterm}}}{DL_{\text{exterm}}} \leq 1$$

Table 35. Ukrainian National Standards of Radiation Safety

Limits of dose	Effective dose, mSv/year		
	A	B	C
$LD_e$	20	2	1
$LD_{\text{lens}}$	150	15	15
$LD_{\text{skin}}$	500	50	50
$LD_{\text{extrem}}$	500	50	—

It is used an additional limited dose for women in the reproductive age (< 45): an equivalent dose should not exceed 1 mSv/month on the hypogastrum skin and the receipt of radionuclides per year does not exceed 1/20 of the admissible limit for personnel. The purpose of these measures is to limit the equivalent dose of fetus irradiation so it exceeds less than 1 mSv in 2 month of unrevealed pregnancy.

For pregnant women it's forbidden to work with ionising radiation source. After the pregnancy has been verified the woman should change her occupation place to a safe one for all pregnancy and lactation period. For students younger than 21 the sources of ionising radiation used for studies must not exceed DL.

At zones of radiation disaster only men-volunteers can work. They should know about possible doses of irradiation and risk for health and give a written consent to take part in dangerous works. The dose should be no more than 100 mSv/year by the permission of regional state sanitary institutions, in the dose less than 200 mSv/year — by the permission of the State Sanitary Department. It is forbidden to increase the doses of ionising radiation for the following categories: the workers who have taken 200 mSv/year as a result of radiation disaster and workers having medial contradictions.

For limitation of internal radiation they use the limits of annual receipt. Its value depends on the radiotoxicity of radiation elements. Radiotoxicity — the feature of radioactive isotopes to cause the pathologic changes after ingestion or inhalation. Radiotoxicity depends on: (1) kind of radioactive decay; the most dangerous is  $\alpha$ -active substances (an equivalent dose is 20 times as much than for  $\beta$ -action substances); (2) the average energy of a decay; the absorbed dose is directly proportional to the energy of radiation. (3) the scheme of radioactive decay; (4) way of income to the organism.

There are 3 ways of radionuclides income to the human's organism: inhalation, ingestion, percutaneous introduction. The first is the most dangerous because the volume of inspired air is about  $7.3 \cdot 10^6$  years and coefficients of assimilation are higher. The ingestion of radionuclides usually less and resorption coefficient is enough low.

Distribution of radionuclides by the bodies and systems is following: osteotropic isotopes cumulate in the bones (Ge, Sr, Ba, Ra, It, Zr, Plutonium citrates), hepatotropic isotopes cumulate in the liver (Ce, La, Pm, plutonium nitrate, etc.; equally dispersed (T ( $^3_1\text{H}$ ),  $^{14}\text{C}$ , Rn, Cs) and with tendency to cumulate in muscles (K, Rb, Cs).

All radionuclides are classified by their radiotoxicity: very high radiotoxicity, high radiotoxicity, middle radiotoxicity, low radiotoxicity.

The time of radionuclides stay in the organism depends on the half-life period (T) and the period of half-excretion ( $T_e$ ).

For various radioactive isotopes  $T_{\text{eff}}$  form from some h (for example  $^{24}\text{Na}$ ,  $^{64}\text{Cu}$ ), days ( $^{131}\text{I}$ ,  $^{32}\text{P}$ ,  $^{35}\text{S}$ ) to some decades ( $^{226}\text{Ra}$ ,  $^{90}\text{Sr}$ ).

Chronic ingestion or inhalation is more risky than single income.

For calculation of the part in general radiation they use the sum of multiplication of every element per year on its dose coefficient. Time for calculation of the expected effective dose is established as 50 years for categories A and 70 years — for all population.

The admissible average annual volume activity is the limit of annual receipt to volume of air (water) contaminated with radionuclide.

The total effective dose for population of categories B and C should not exceed 5 mSv/year if the duration of work is less than 2000 h/year. Average healthy velocity is  $1.2 \text{ m}^3/\text{y}$  and nuclides of uranium family is in equal balance.

Average power of  $\gamma$ -radiation dose:  $3.8 \mu\text{Sv}/\text{h}$ .

Average annual equivalent volume activity of  $^{222}\text{Rn}$ :  $310 \text{ Bc}/\text{m}^3$ ,  $^{220}\text{Rn}$  (toron)  $68 \text{ Bc}/\text{m}^3$ .

Average activity of  $^{238}\text{U}$  in the industrial dust  $\sim 28/f \text{ kBc}/\text{kg}$ , where f — dust pollution in breathy zone ( $\text{rg}/\text{m}^3$ ).

Principles of optimization and evidence based are necessary to limit radiation by technogenic and natural sources. The radiation of population by man-made sources is limited by control of the technological processes.

Natural radiation background is formed by the natural sources of ionising radiation: external sources of extraterrestrial origin (cosmic rays); external sources of terrestrial origin (radionuclides of minerals, waters, air); internal air sources (incorporated radionuclides). There are primary and secondary cosmic rays. Primary cosmic rays consist of protons (92%),  $\alpha$ -particles (7%) and nuclei of other elements. Secondary cosmic rays consist of mesons (80%) and  $\beta$ -particles (Fig. 41).

Natural radioactivity with terrestrial origin depends on the geochemical and geophysical peculiarities of the territory.

Natural radioactivity of the air is connected with emanation and  $^{14}\text{C}$  and other substances in nuclear reaction to upper layers of atmosphere (above 9,000 m).

Natural radioactivity of waters depends on their condition. Meteoric water has low activity. Underground water cavity caused by salts of  $^{40}\text{K}$ ,  $^{226}\text{Ra}$ ,  $^{222}\text{Rn}$  mainly. The lowest activity has waters of sedimentary rocks. Waters of open reservoirs has an activity depending on geochemical hydrogeological and climatic conditions.

## RADIATION SAFETY

There are open and closed sources of ionising radiation. There are four main principles of radiation protection:

“Protection by time” has been used for work with low active sources. For protection they use manipulators and other distension tool, system of automatic control and operating include multi-media technology. A principle of protection by shielding is used in combination with other principles. The best material for protection from X-rays and  $\gamma$ -rays is lead and steal. For protection from radiation they use water, paraffin, concrete and other materials containing a lot of hydrogenous atoms. For shields absorbing  $\beta$ -radiation they use light material organic glass, plastic, aluminum, but for very power  $\beta$ -sources they should use additional shields for protection from brake radiation.

Open sources of ionising radiation are risky for radioactive contamination of surrounding. The radionuclides pass to the environment as the gases ( $^{222}\text{Rn}$ ,  $^3\text{H}$ ,  $^{89}\text{Cr}$ ,  $^{133}\text{Xe}$ , etc).

The radiation protection for work with open sources is presented by principles of protection by quantity, time, distance, shielding, as well as isolation of technological processes; optimization of sanitary-technical equipment; using of individual protective means; personal hygiene of staff; dosimetric control; decontamination.

Works of I class are provided only in a separate building with an isolate entrance. All buildings are divided into 3 zones:

I — “hot” (“dirty”) — for placing equipment of chambers (boxes), communication and other main sources of radioactive pollution.

II — periodically served repairing — transport rooms.

III — rooms for personnel: operating rooms, etc.

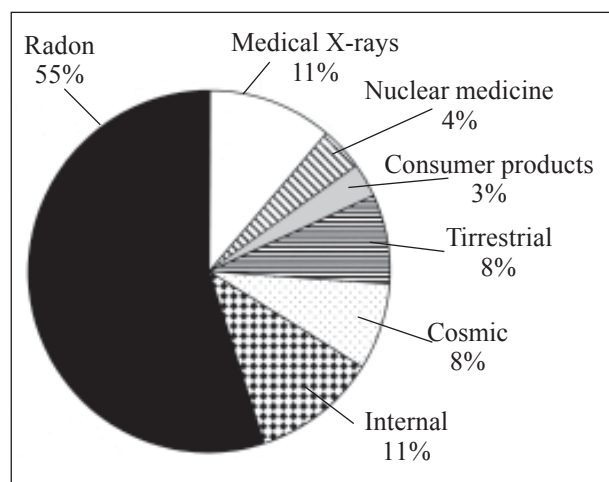


Fig. 41. Natural Radiation Background

Works of II class should be provided in isolated departments, III class — in special rooms. The air changes rate in the second class rooms is 5, and in the third class — 3.

Laboratories of I–II classes have 2 sewage systems: household-fecal and special. If daily volume of liquid radioactive waste does not exceed 200 l so these are collected in special containers for future transfer to centralized special burial place. Internal decoration of premises for III class work include: painting walls with oil paint by 2 m from floor, and other surfaces — with glue oil. The floors should be covered with linoleum or plastic. Corners should be rounded, covering of floor — rised to walls without cracks. Using of soft furniture is forbidden. Water supply is provided from independent inputs. The tops should have mixers and turn on with pedal or elbow device.

Individual protective equipment can be for everyday using or for short-time using. All equipment should be suitable for decontamination, be steady to chemical agents.

The important direction of radiation safety is “radiation aseptic”. It’s a prevention of contamination of worker’s overall and skin. Decontamination — is the complex of preventive measures for decreasing of radiation pollution of environmental objects.

They use physical (mechanical means, dissolving, using of electro-magnetic fields, ultra-sonic, etc.) and chemical (complexones, detergents, mineral acids and oxidants). For control of efficiency of desactivation measures and radiation loading on personal (population) they use dosimetry.

Sanitary dosimetric control is an important element of radiation safety. Radiometry is measuring of radioactivity in food-stuffs, building materials, industrial raw materials and dosimetry is the sanitary control of irradiation of personnel.

The main tasks of dosimetric service are: control of power of  $\gamma$ - and neutron pencils in industrial premises; control of radioactive gases and aerosols in the working zone air; dosimetric control of all work with radionuclides; individual dosimetric control of external radiation; individual control on the contents of radionuclides in the organism or separate critical body; training of personnel; control of radionuclide emission into the atmosphere; keeping of special documentation (operative register of the duty team).

Principles of dosimetry equipment are based on the processes of ionisation and scintillation; they use photochemical (and photographic); thermoelectrical and biological dosimetry.

Radiation disasters include: the detonation of a nuclear weapon; a nuclear power plant event; the dispersal of radionuclides by conventional explosive or the crash of a transport vehicle; losses of radioactive waste.

Any of these events could occur unintentionally or as an act of terrorism. Nuclear facilities (e.g. pow-

Table 36. Classification of Radiation Disasters

Level	Disaster	Criterion	Example
0		No influence on the safety	
I	Insignificant	Functional deviation in the operating, no risk	
II	Middle gravity	Disrepair of equipment, deviation in normal exploiting. Problems with evaluation of radiation safety measures	
III	Serious	Escape of radioactive substances (no more than 5-time admissible day load) Over-irradiation of personnel (>50 mSv)	Bandellos, Spain, 1989
IV	Restricted	Contamination of environment without irradiation of population	St-Saurent, France, 1980
V	With the environmental risk	Significant emission	Tri-May-Iland, USA, 1979
VI	Grave		Windscale, UK, 1957
VII	Global		Chernobyl, USSR, 1986

er plants, fuel processing centers, and food irradiation facilities) are often located in highly populated areas, and with time the risk of mechanical failure increases.

Modern classification of radiation disasters is following:

I — without radiation loading to personnel (population) or contamination;

II — personnel (population) took external irradiation higher than DL;

III — contamination of environment;

IV — external and internal irradiation of the personnel (population);

V — contamination of environment and external and internal irradiation of the personnel (population).

They use also classification of industrial radiation disaster presented in Table 36.

#### INTERNATIONAL SCALES DISASTERS AT A-POWER STATION

Chernobyl A-power station is placed in the eastern part of Belorussian-Ukraine Polesie, at the river Pripiat side. Water-cooling reactors with graphite retardants are heterogenic chained reactors on hot neutrons. There used uranium bars enriched with  $^{235}\text{U}$  as the fuel, the graphite as the retardator and boiling water as the heat conductor.

At the moment of explosion content of radionuclides was their content in the fuel, but it was enriched with isotopes of iodine, tellure, cesium and inert gases.

From 26.04 to 02.05.1986 the power of escape was decreased. The height of jet was 1,200 m on 27.04 maximum of radionuclide concentration — at 600 m. fission elements (I, Cs) were detectable at high altitude (6–9 km). Refractory elements (Ce, Cr, Ne) was found only at territory of USSR, as a result of local sedimentation. Contamination of the air was registered in Sweden, Finland, Poland, DDR (on 27.04.1986), in France, Belgie and Netherlands (on 1.05.1986), in the Northern Balcanes (on 2.05.1986), in the southern Greece (on 3.05.1986), in Israel, Kuwait, Turkey.

All Northern hemisphere was contaminated with radionuclides. High radioactivity of air was recorded in Japan (on 2.05.1986), China (4.05.1986), India (5.05.1986), Canada and USA (5–6.05.1986).

Total collective effective dose for Chernobyl disaster was 600,000 man-Sv, where 53% of this dose fall on the Europe, 36% — on the NIS, 8% — Asia, 2% — Africa, 0.3% — America.

On the ground of radiation monitoring data they evacuate from Kiev, Gomel, Bryansk and Gytomir regions about 115,000 people. From 26.04.1986 they are given to population lived nearby power plant the tablets of sodium iodide. After they forbid consumption of food-stuffs produced in the contaminated area.

All preventive measures include: liquidation of the radionuclide waste; decontamination of territory; conservation of 4th block; decontamination of 30-km zone and restoration of household activity in this zone; organisation of control system on the radiation situation.

## BASIC CONCEPTS OF INDUSTRIAL HYGIENE

Industrial hygiene is a science of anticipating, recognizing, evaluating, and controlling workplace conditions that may cause workers injury or illness.

DSTU 2293-93<sup>1</sup> gives the following definition: occupational hygiene is a complex of measures and means on preservation of health of the workers, preventive maintenance of adverse influences of industrial environment and labour process.

Subjects of occupational hygiene study are the following:

1. Labour processes and physiological reactions of the workers' organism.
2. Productions and adverse factors of industrial environment.
3. The health condition and morbidity of the workers.

Objectives of the discipline are:

1. Assessment of influence of working conditions on the organism.
2. Development and introduction of measures capable of ensuring the maximal productivity of work in absence of harmful influence on health.
4. Improvement of working conditions.
5. Prevention of occupational diseases.
6. Development of the hygienic specifications, standards, instructions and recommendations.
7. Assessment of efficiency of improving measures.

A set of the factors of physical, chemical, biological nature influencing the man together with socio-economic factors during his labour activity refers to the industrial environment.

The major harmful physical factors of industrial environment include: mechanical influences, increased dust pollution of the working zone air, uncomfortable microclimate of industrial premises, increased level of infrared, ultraviolet radiation in-

creased level of vibration, noise, infra- and ultrasound; increased or lowered barometric pressure, increased level of ionizing and/or electromagnetic radiation in a working zone; increased intensity of electrical and/or magnetic field; the elevated level of static electricity, dangerous level of voltage in electrical network; the elevated (lowered) ionization of the air; conditions of visual work; influences of laser radiation, etc.

Among chemical production factors it is necessary to distinguish:

- substances with expressed specific toxic action (in Ukraine we use index "O"): oxydes of nitrogen, cyanic hydrogen, bromine, chlorine and its dioxide, etc.;
- substances-allergens (index "A"): acrilonitrile, beryllium, nickel, chlorophos, etc.;
- substances-cancerogens (index "K"): benzyl, beryllium, chlorvinil, emanation of coal pitches, arsenium, nickel, etc.;
- dispersed substances with mainly fibrogenic action (index "F"): dolomit, iron, silicon dioxide and minerals, containing them;
- substances potentially dangerous in percutaneous exposure (index "+"): acrilonitril, bromine, benzyl.

(The above mentioned indices are given in the lists of MAC after the name of the substance.)

Pathogenic microorganisms (bacteria, viruses, rickettsia, spirochetes, fungi, protozoa) and products of their ability to live (having, as a rule, high sensibilization property (index "A"), and also a number of organic substances of natural and semisynthetic origin belong to a group of harmful production factors of a biological nature.

The special place in a number of harmful industrial factors is taken by psychophysiological features of a labour process. The labour process is associated with physical (static and dynamic) and psychological overloads (intellectual overloading, sensoric overloading, monotony of work, emotional overloads).

It is obvious, that irrespective of nature of the production factor, a part of them is inherent to ex-

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<sup>1</sup> Ukrainian State Standard.

tremely productive activity of a man, the other part represents preformed natural factors and the intensity of influence in conditions of production has got new quality. The first group includes the artificial light exposure, vibration, exposure to artificial or synthesized chemical substances, products of microbiological synthesis; the second group includes infrared radiation from liquid metal, noise generated by the equipment, elevated and lowered barometric pressure, professional contact with activators of zoonanthroposis and antroposis diseases.

## **OCCUPATIONAL HAZARDS AND EXPOSURES**

Hundreds of millions of workers in both developed and developing countries are at risk from exposure to physical, chemical, biological, psychosocial or ergonomic hazards in the workplace. For many of these people there is often the risk of combined exposures to different occupational hazards.

Approximately 30% of the labour force in developed and between 50 and 70% in developing countries may be exposed to heavy physical workloads or ergonomically poor working conditions, which can lead to injuries and musculoskeletal disorders. Those most affected include miners, farmers, lumberjacks, fishermen, and construction workers, warehouse workers and healthcare personnel.

Physical hazards, which can adversely affect health, include noise, vibration, ionizing and non-ionizing radiation, heat and other unhealthy microclimatic conditions. Between 10 and 30% of the labour force in industrialized countries and up to 80% in developing and newly industrialized countries are exposed to a variety of these potential hazards.

Exposure to hundreds of biological agents — viruses, bacteria, parasites, fungi and moulds — occurs in many occupational environments from agriculture to offices. The hepatitis B and C viruses, HIV/AIDS infection and tuberculosis (particularly among healthcare workers), and chronic parasitic diseases (particularly among agricultural and forestry workers) are some of the most common occupational diseases resulting from such exposures.

Thousands of toxic chemicals pose serious health threats potentially causing cancer, respiratory and skin diseases as well as adverse effects on reproductive function. Workers can be and often are exposed to hazardous chemical agents such as solvents, pesticides and metal dusts.

Workers may also be exposed to various types of mineral and organic dusts. For example, silica, asbestos and coal dust cause irreversible lung diseases, including different types of pneumoconioses. Known since the time of Hippocrates, silicosis is still the most widespread occupational lung dis-

ease. Silicosis can predispose workers to tuberculosis and lung cancer; it is progressive and incurable but preventable. Organic dusts can cause a number of respiratory conditions (such as byssinosis) and allergic reactions (such as asthma).

The risk of cancer from workplace exposure is of particular concern. Around 350 chemical substances have been identified as occupational carcinogens. They include benzene, hexavalent chromium, nitrosamines, asbestos and aflatoxins. In addition, the risk of cancer also exists from exposure to physical hazards such as ultraviolet (UV) and ionizing radiations. The most common occupational cancers include lung, bladder, skin and bone cancer, leukaemia and sarcomas. In the European Union, approximately 16 million of people are potentially exposed to hazards at work, including carcinogenic agents.

Exposure to thousands of allergic agents, including vegetable dusts, is a growing cause of work-related illness. A large number of allergens have been catalogued which can cause skin and respiratory diseases (e.g. asthma). The number of these disorders, registered in several industrialized countries, is increasing steadily.

Social conditions at work, which raise serious concerns about stress, include inequality and unfairness in the workplace; management style based on the exclusion of workers from the decision-making process; lack of communication and poor organisation of work; strained interpersonal relationships between the manager and employees. Stress at work has been associated with elevated risks of cardiovascular diseases, particularly hypertension, and mental disorders.

In the least developed countries, occupational health problems are found essentially in agriculture and other types of primary production. Heavy physical work, often combined with heat stress, pesticide poisoning and organic dusts, is frequently aggravated by non-occupational factors such as chronic parasitic and infectious diseases. Poor hygiene and sanitation, nutritional problems, poverty and illiteracy heighten the risk of disease and/or occupational injury.

Practically in all spheres of labour activity the man has professional contact to that or other chemical substance. Industrial poisons, substances meeting during labour activity of the man as initial, intermediate, or the final products of synthesis, at infringement of the safety precautions regulations and hygiene of work can get in the workers organism in quantities dangerous to their health.

## **CHEMICAL HAZARDS AND EXPOSURES**

In modern conditions industrial poisons are met practically in all industries and agriculture. So at



reception both processing of polycondensated and polymeric plastic masses in air space of a working zone the containing initial monomeasures, catalytic additives, products incomplete polymerization and thermooxidative destruction, dust particle of powder polymers and ready products act with complex steam-gas and steam-aerosol complexes at their machining. The representatives of metals (wolfram, molibden, chromium, nickel, beryllium, lithium, etc.) appear in metallurgy except for a long time well known oxides of carbon and sulfur as industrial harms. In collieries, mines, open carriers, where the production of minerals by an explosive way in air will be carried out the oxides of nitrogen, carbon and high-dispersed aerosol are allocated. In a metalcutting industry the motor oils and antifrise liquids containing in the structure aggressive substances — naphten acid, alkalis, etc. are widely used. The significant quantity of industrial poisons is connected to technological process in a chemical industry (basic chemistry, coxochemical manufacture, manufacturing of dyes, synthetic polymers and plastic weights). In an agriculture in the large assortment and volumes there are used pesticides and mineral fertilizers.

In the study of influence of harmful chemical substances on the worker's organism with the purpose of contents safe and harmless working conditions on manufactures the section of hygiene of work named industrial toxicology is engaged.

Its basic sections — toxicometry and pathogenesis of intoxication. Toxicometric research precedes studies on pathogenesis of intoxication, with their help establish parameters of toxic ability and danger of substance, the clinic of a poisoning is described at unitary and repeated contact to the agent, the toxicodinamics (dynamics of infringements of separate functions of an organism is studied), the pathomorphology of a poisoning is described. Pathogenesis of intoxication — adjacent section of toxicology and pathological physiology studies toxicokinetics of poison (route of exposure, distribution, metabolism and deducing), and also the conducting mechanisms of a toxic action are established: biochemical, biophysical, pathophysiological, immunological, etc.

Industrial toxicology has as the goal to warn, to distinguish and to treat professional poisonings, to warn and to eliminate the remote consequences of harmful influence of the chemical agents on workers and their children and decides the following tasks:

1. Establishment of parameters of toxic ability and danger of new chemical substances.
2. Development of the hygienic standards in view of complex and combined action industrial poisons.
3. Study of ability of substances, used in manufacture, to cause change of reactivity of the organism and to cause the remote effects — cancerogen-

ic, embriotoxic, teratogenic, mutagenic, atherogenic, premature aging, etc.

4. Research toxicokinetics and toxicodinamics of industrial poisons and development of ways of early diagnostics, pathogenetic therapy and preventive maintenance of professional intoxications.

5. Study of dependence of biological action of industrial poisons on chemical structure and physical-chemical properties for development of express methods of a toxicological estimation of new chemical substances; search and synthesis of less toxic and dangerous chemical compounds.

As a whole, the briefly listed tasks can be reduced up to three:

- 1) hygienic norm setting of the contents of harmful substances in objects of industrial environment;
- 2) hygienic examination of toxic substances;
- 3) hygienic standardization of raw material and products.

It is necessary to take into account, that the modern technological processes are frequently connected to risk complex (influence of one chemical substance at simultaneous receipt in an organism by various ways), combined (action of several chemical substances) and combining action (combination of industrial harms with chemical and another (physical, biological) nature).

The modern classifications of industrial poisons are based on allocation of separate classes of substances on their chemical structure, modular condition, degree of toxic ability and danger, character and mechanism of influence on the organism and other attributes.

By the chemical nature industrial poisons is divided into inorganic, organic and elementary-organic.

To the basic groups inorganic industrial poisons belong: galogens, compounds of sulfur, nitrogen, phosphorus, arsenium, carbon, cyanides metals, etc. Poisons of an organic nature are carbohydrides of aliphatic and aromatic lines and their derivative, aliphatic spirits, simple and complex ethers, aldegides, ketones, heterocyclic compounds, etc.

By a modular condition of substances in the air environment all substances could be divided into gases (for example, chlorine), steams (concentrated alkalis and acids) and aerosols (with a firm or liquid phase).

By the route of exposure they distinguish inhalatoric, ingestive and percutanic poisons.

In the practical purposes it's used the division of industrial poisons on their application in various branches of a national economy: the industrial solvents, varnishes and paints, polymers and plastic weights, pesticides, mineral fertilizers etc.

By the mechanism of action the industrial poisons for all flying industrial substances are divided into 4 large groups (Henderson, Haggard):

1. Asphyctive substance: simple asphyctive (mechanism of action — replacement of oxygen

Table 37. Classification of the Chemical Hazards

Safety	Safety standards according to classes of danger			
	1	2	3	4
MAC mg/m <sup>3</sup>	< 0.1	0.1–1.0	1.1–10	> 10
DL <sub>50inh</sub> mg/kg	< 15	15–150	151–5,000	> 5,000
DL <sub>50cut</sub> mg/kg	< 100	100–500	501–50,000	> 50,000
CL <sub>50</sub> mg/m <sup>3</sup>	< 500	500–5,000	5,001–50,000	> 50,000
Zone of acute action	< 6.0	6.1–18.0	18.1–54	> 54
Zone of chronic action	> 10	10–5.0	4.9–2.5	< 2.5
FOIP	> 300	300–30	29–3	< 3

from inhaled air) — nitrogen, hydrogen, helium; chemically active (cause hypoxic, hemic or tissue hypoxia) — carbon monoxide, hydrocyanic acid.

2. Irritating substances: oxides of sulfur, nitrogen, chlorine, hydrochlorine, hydrofluore, ammonia, etc.

3. Flying narcotic substances:

— having no expressed afteraction (hypoxides of nitrogen, ethers, aliphatic carbohydrates);

— toxic for parenchima (galogenic carbohydrates of an aliphatic line);

— toxic for hemopoiesis (aromatic carbohydrates);

— neurotoxic (alcohol, sulfurous compounds of carbohydrates of a greasy line);

— toxic for blood and cardiovascular system (aniline, nitrobenzyl).

4. Protoplasmic poisons (inorganic and metal-organic substances) — mercury, lead, phosphorus, arsenic acid, etc.

Henderson and Haggard have divided all chemical substances according to their toxicokinetics and toxicodynamics into reacting and non-reacting. The toxic action of reacting substances can be caused both by substance and its metabolites, e.g. the toxic action in poisoning with benzyl is connected also by its derivatives — phenol, pyrocatechine and hydrochinone. In some cases the metabolites are more toxic than initial substance (lethal synthesis).

More modern classifications allocate such classes of chemical compounds into the character of influence on the human organism: rendering general toxic, irritating, sensitized, cancerogenic, mutagenic action influencing reproductive function.

By localization of display of harmful action of chemical substances there are distinguished industrial poisons: local, resorptive and mixed (local-resorptive) action.

From positions of a hygienic science the classification by a degree of toxic ability and danger is especially important.

Toxic ability is a property of chemical compounds to cause harmful action. It is defined as size to absolute meaning of an average lethal dose or concentration:  $1/DL_{50}$ ;  $1/CL_{50}$ .

By the level of toxic ability all chemical substances are divided into extremely toxic, very toxic, moderately toxic, low toxic; by the intensity of influence on the organism — extremely dangerous, very dangerous, moderately dangerous, low dangerous. According to GOST 12.1007-76 SSBT<sup>1</sup> “Harmful substances. Classification and the general requirements of safety” as a basis of classifications should be assumed such criteria as maximally admitted concentration (MAC),  $DL_{50}$  at introduction of substance in the stomach and drawing on the skin,  $CL_{50}$  for inhalatory receipt, factor of an opportunity of inhalatory poisoning (FOIP), zone of sharp and chronic action (Table 37):

Basic toxicometric parameters are the parameters of potential danger — perspirative activity of compounds, their solubility in water and in fats, dispersity of aerosole and parameters of real danger.

Toxic ability (value is inversely proportional to  $DL_{50}$  and  $CL_{50}$  and directly proportional to danger), absolute meanings of thresholds of harmful action (acute general toxic  $Lim_{ac}$ , chronic general toxic  $Lim_{ch}$ , specific  $Lim_{sp}$ ) — inversely proportional dangers, and also derivative parameters (zone acute ( $Z_{ac}$ ) and chronic general toxic ( $Z_{ch}$ ) action, zone selective (specific ( $Z_{sp}$ ) action)

The routes of exposure of chemical substance are determined, first of all, by its modular condition. The inhalatory route of exposure is probable for gases, steams and aerosols. This route of exposure to industrial poisons in the organism is basic and the most dangerous (the area of alveolar membranes exceeds 100 m<sup>2</sup>). The speed of absorption of the agent in blood depends on its modular condition, solubility in water and bioenvironments, partial pressure in the alveolar air, level of pulmonary ventilation, speed of blood stream in lungs, condition of tissues of lungs (presence of inflammatory processes, transsudates, exsudates), character of chemical interaction of the agent with biosubstrates of the respiratory system.

The mechanism of absorption through the skin is combined. Direct transepidermic penetration

<sup>1</sup> Special standards of occupational safety.

through epidermis, hair folliculi and sebaceous glands, through ducti of sudoriferous glands is probable. The sites of the skin on a medial surface of thighs and hands, in the inguinal area skin of genitalia. The breast and the abdomen are most sensitive in this respect. The most dangerous for percutaneous penetration are the substances which are soluble both in water and fats.

To industrial poisons capable to cause intoxication at contact to the unprotected skin and mucouses they distinguish aromatic amino- and nitrocompounds, phosphororganic insecticides, chlorinated carbohydrates, metallorganic compounds. Electrolytes will not penetrate through the skin, they are lingered over, as a rule, in a horn or brilliant layer of epidermis. The exception is only for heavy metals (lead, tin, copper, arsenium, bismuth, mercury, antimony) and their salts, which are combining with greasy acids on a surface or inside a horn layer of epidermis and forming fat-soluble salts. Not only liquid penetrate through the skin, but also flying gases and steams.

Resorption of toxic substances from the digestive channel in most cases has selective character, since its various departments have a special structure, chemical environment and enzyme system.

Some poisons (all fat-solvable substances, phenols, some salts (special cyanides)) are soaked up already in the mouth cavity. Thus their toxic ability grows, since they are not exposed to the action of gastric juice and miss portal circulation, so they are not neutralized in the liver. In the stomach all fat-solvable substances and not ionized molecules of organic compounds are absorbed by a simple diffusion. Through pores of a cellular membrane of gastric epithelium the penetration of substances is possible also by filtration. Many toxic compounds are inactivated at contact with gastric juice: kurare, tetanotoxine, poisons of the snakes and insects. On the other hand, many poisons, including the compounds of lead, in gastric contents are dissolved better than in water, therefore they are absorbed better. The character and speed of adsorption depend upon a degree of filling of the stomach, solubility of substance in gastric contents and its pH. The substances accepted on an empty stomach are most intensively soaked up.

The biggest part of the toxic agents is absorbed in the thin intestine.

Proteins of plasma especially albumins play a basic role in transportation of poisons by blood. A part of substances is transferred in erythrocytes by the formation of temporary compounds with hemoglobin.

A certain role in the pathogenesis of poisonings belongs to chemoreceptors of vessels of the lesser (bulbar innervation) and the greater (spinal innervation) circulation.

The basic transformations of toxic substances are oxidation, restoration, hydrolysis, synthesis (forma-

tion of pair compounds) and conjugation. The biotransformation of poisons, as a rule, has their detoxication as a result with formation of low toxic polar water-soluble substances easily excreting with urine. The biotransformation can have a character of the lethal synthesis (it's very characteristic for phosphororganic and some chlorinorganic substances). The basic bodies participating in neutralization of the toxic agents, are the liver, kidneys, lungs, walls of the stomach and intestine.

Industrial poisons and their methabolites in the kidneys, gastrointestinal tract and skin excrete from the organism through lungs. Excretion of toxic substances can occur simultaneously by several ways: through the lungs — flying nonelectrolytes through the kidneys it's possible the allocation both electrolytes and nonelectrolytes. Through the digestive tract there excrete poor-soluable and insoluble industrial poisons: with saliva (lead and mercury), with gall, etc. Through sebaceous glands some fat-soluble industrial poisons excrete, with sweat — mercury, copper, oxydes of iron, hydrogen sulfide, etc.

Some soluble in lypoides substances (benzyl, ethanol, chloroform) may be excreted by mammae with milk.

The selective action in relation to those or other bodies and systems is characteristic for many industrial poisons. On the other hand, depending on dozens industrial poisons are capable to cause all known pathologic processes: inflammation, dystrophy, fever, allergy, remote results (growth of malignant and benign tumors, infringements of development of the fetus, infringement of the cell genome). The inflammatory reaction at action of the toxic agents can have expressed exsudative character (gases of asphyctic action — oxides of nitrogen, ammonia, phosgen), alterative-inflammatory change are characteristic for high grade active chemical compounds (phenol, calcium carbide, salts of chromium and nickel), a proliferation prevails at chronic influence of small concentration of substances with irritating and fibrogenic action (ammonia, chlorine, asbest). Dystrophic changes are accompanying an influence of any toxic substance, their localization (the liver, the kidneys, the myocardium, the brain, etc.) is determined by toxicodinamics and toxicokinetics of a substance. The fever of non-infectious genesis frequently is connected with intoxications by compounds of metals. So, the pathogenesis of a "foundry" fever is explained with protein denaturation and changing of antigenic properties of proteins under action of the oxidated forms of metals. Aromatic, amines, nitric and nitrose substances, arsenium, mercury, cobalt, nickel, chromium, platinum, beryllium, phormaldegide, turpentine, organic oxides and hydroxydes, plenty of synthetic polymers and plastic have an allergic property. Allergens with molecular weight less than 1,000 Da are gaptenes, which are conjugated with proteins through  $\text{NH}_2$ -,  $\text{SH}$ - and  $-\text{S}-\text{S}$ - groups.

Remote consequences of the intoxications with the industrial poisons include embriotoxic (teratogenic), mutagenic, cancerogenic effects.

The substances with cancerogenic action are classified by the International agency on cancer research with allocation into three groups by degree of their cancerogenicity. The first group includes 23 substances (arsenium, asbest, chromium and their compounds, the soot, pitches, petroleum, benzyl, benzydine, 2-naphthalamine, 4-aminobiphenil, bis-(chlormethyl) ether, technical chlormethyl ether, vinilchloride, some medicinal means) and 7 industries (production of oramine, rubbers, production and repair of footwear, furniture, isopropilic spirit (because of use of the concentrated acids, refined nickel), cancerogenic effect of which is most authentic.

The second group represents substancies with potential danger for a man. There are 14 compounds with a high degree of cancerogenicity (3,4-benzpiren, berillium, nickel and their compounds, etc.) and 47 compounds with low cancerogenicity (for example, compounds of cadmium).

The third group includes substances with low evidence of cancerogenicity.

Besides, industrial poisons can cause non-specific reactions: to reduce work capacity and resistance of the organism for various exo- and endogenic factors, to weak immunologic reactivity, to aggravate course of diseases, to promote occurrence of atherosclerosis, essential hypertension, premature aging, infertility. Such an action refers to paratoxic.

In some cases they observe the methatoxic action of a poison — the follow-up exacerbations after acute intoxication. (For example, occurrence of acute psychosis many months later the acute poisoning with irritating gases.)

The phenomena of methatoxic and paratoxic action for small dozes of the industrial poisons connect to phenomena of their *material* and *functional cumulating*.

Material cumulating consists in selective accumulation of the agent by biosubstrates (depot), functional — in summation and accumulation of functional changes (fermentative, reflectoric etc.)

Material cumulating is characteristic for poisonings with metals and their salts, cyanides, charcoal gas, functional — for a poisoning with chlorined carbohydrides, benzyl, petrol, trinitrotololum and many other gases and steams. Material cumulating can be combined with functional, but the conducting role in development of a chronic intoxication belongs to functional cumulating. So, for example, carriage of some poisons (mercury, lead) can not be accompanied by clinical displays, and on the contrary, at many poisonings poisons themselves and their metabolites in bioenvironments of the organism are not defined (flying narcotic compounds).

The accustoming to toxic substance has three phases — the phase of primary reactions, the phase of development of accustoming (in which a number of authors distinguish the periods of pseudo-adaptation and identification of pathological process) and the phase of expressed intoxication.

The combined action of the industrial poisons can be realized as homogeneous joint (components work on the same system of receptors, in which the replacement of one component by another does not influence the toxicity of a mix), independent joint (the components work on various physiological systems, at what the effect from influence can be caused by action only of one of the agents), synergic and antagonistic joint (toxicity of a mix is defined by interaction of poisons and biosubstrate). For a quantitative estimation of the combined effect use concepts of additivity and its two gradation: antagonism (effect less additive) and synergism (effect more additive). Synergism is named also potentioning.

Additivity is characteristic for the majority of industrial poisons combinations. Potentioning is often explained as blocking by one substance of biotransformation of another. So synergism of the effects of various POS mixes is explained by an oppression of cholinesterase to one of the agents and thereof, breaking of detoxication others.

The antagonistic effect takes place at interaction of components of a gas mix with formation of less toxic compounds (sulforous anhydride and chlorine, ammonia and carbonic gas) or antagonistic action (competition for same receptors — for example, sympathomimetics and sympatholytics).

For a hygienic estimation of air environment under condition of additive action of industrial gases the Averyanov's formula is used:

$$\frac{C_1}{MAC_1} + \frac{C_2}{MAC_2} + \dots + \frac{C_n}{MAC_n} \leq 1$$

where  $C_1, C_2, C_n$  are the concentration of substances in the air, and  $MAC_1, MAC_2, MAC_n$  are their maximal allowable concentration.

The combined influence of the toxic substances with the physical factors can be realized both as antagonism, and as synergism. So the noise (85–95 dBA) is acting a role of adaptogen to raise stability of the organism to influence of a line of the organic solvents (acetine, etc.). General low-frequency vibration and noise in a combination with separate toxic substances and complexes of toxic substances in quantities close to MAL and MAC are working by a type of synergism (it is explained by that the nose-vibrating complex, breaking hystohematic barriers and permeability of cellular and mitochondrial membranes, promotes penetration of the toxic agents into a cell, but also general vibration and noise reduce antitoxic and protein-synthetic function of the liver). The ionizing radiation strengthens an action of the chemical cancerogens; the ul-

tra-violet irradiation in small doses raises the resistance of the organism, and at an excessive irradiation strengthens an action of the industrial poisons.

Complex action of chemical substances is not only simultaneous exposure to the industrial poisons by several routes (organic solvents, salt of heavy metals simultaneously inhaled and penetrating through the skin), but also characteristic of situations, when the chemical substances act in the organism from various objects of environment. So, the compounds of polyvinylchloride can act in the organism from the air of a working zone, with drinking water and food-stuffs, through clothes and footwear, from the air of the occupied places. For industrial poisons, which except for inhalation have also a skin-resorptive action establish alongside with MAC for air of a working zone also MAL of pollution of the skin. As the criterion of a hygienic estimation of environment at the combined and complex influence of harmful substances is offered a parameter of a maximum safe load (MSL), i.e. the maximal intensity of action of all set of the factors of external environment which is not rendering direct or indirect influence at the human's organism and his posterity, without worsening sanitary life conditions.

Professional intoxication is divided on into acute and chronic. The acute poisonings arise owing to rather short-term (during one working change), but it is enough intensive (concentration exceeds MAC hundred and thousand times) actions of the toxic agents. The reasons of acute professional intoxications can be emergencies, significant infringement of the technological rules (especially temperature mode), safety precautions regulations and industrial sanitary. In a line of cases the acute poisoning develops immediately (poisoning with petrol at clearing tanks), in other cases after a certain latent period.

Chronic professional intoxications are met much more often, which development is connected to cumulative action of the industrial poisons. The chronic professional poisonings occur in action of small concentration of the poison at long expositions or as a result of several acute poisonings.

For prevention of professional poisonings the regulation and standardization of the industrial poisons will be carried out. The basic principles of hygienic norm setting are the principle of stage norm setting and the principle of control on the established specifications, principle of thresholds and principle of the priority of the medical indications. The principle of threshold provides presence of a threshold of adverse influence of the chemical agent, the principle of the priority of the medical indications puts forward the requirements to an establishment of the hygienic specification not from reasons of technical practicability or economic issues, but under the medical-biological indications.

As the official hygienic specification for air of a working zone in Ukraine MAC are accepted. The

MAC establishment, as a rule is preceded by definition of Relative Safe Level of Action (RSLA) which is established for a 2 year-period. Then RSLA was replaces into MAC or reconfirmed into a new term (if the substance's use is limited the complete toxicological experiment is not justified). RSLA is a legal basis of the current sanitary supervision realization at laboratory and semi-factory installations with quantity of workers not exceeding 100 men. RSLA, as a rule, can not be used at designing multitonnage manufacture.

In the process of new data accumulation about toxic ability of regulated harmful toxic substances, their MAC are reconsidered. So, MAC of benzyl has changed 4 times (from 200 mg/m<sup>3</sup> up to 100, 50, 20 and 5 mg/m<sup>3</sup>), MAC of aniline — three times (from 10 mg/m<sup>3</sup> up to 5, 3 and 0.01 mg/m<sup>3</sup>).

Hygienic norm setting of new chemical compounds is carried out in three stages. At a stage of laboratory synthesis, skilled and semi factory tests of new compounds with RSLA establishment it will be carried out the preliminary toxicological estimation. The design stage of multitonnage manufacture and wide introduction of substance in the national economy requires the complete toxicological estimation of MAC definition under the complete circuit of researches on laboratory animals. The correction of MAC on the basis of natural (clinical-statistical) researches is made during the first years of functioning of the enterprise and at studies of the late consequences of the exposure and in later terms.

These principles of toxicological norm setting are used not only in Ukraine. In the USA five basic systems are used to describe safe workplace exposure limits for potentially hazardous environments. They are as follows:

- Threshold Limit Value (TLV)
- Permissible Exposure Limits (PEL)
- Recommended Exposure Limits (REL)
- Immediately Dangerous to Life and Health (IDLH)
- Lethal Dose 50 (LD<sub>50</sub>)
- Lethal Concentration 50 (LC<sub>50</sub>)

Hygienic norm setting has a huge meaning for professional selection and dispensarization of workers at harmful chemical manufactures. The preliminary (primary) and repeated medical surveys will be carried out by the experts in necessary volume, with application of laboratory and instrumental methods of diagnostics, in view of a structure working. The person responsible for realization of medical survey as a rule is workshop ordinator. In some cases the responsibility for realization of medical survey assign to the doctors of other specialities (for example, neurologist at survey of the workers having contact to compounds of mercury). The doctors conducting physical examination should be well prepared both in the field of a professional pathology, and on hygiene of work. For preparation of the doc-

tors the managers in branches of occupational hygiene SES are answering. Before the beginning of survey the doctors get acquainted with manufacture, working conditions, professional harms.

The most effective way of preventive maintenance of professional poisonings is the replacement of the toxic agent by other compounds. The other change of the technological circuit consists in automatization of the most dangerous sites of works. For decrease of pollution of objects of industrial environment the equipment should be germetized carefully. The sanitary-technical measures of preventive maintenance include the rational device of ventilation, with maintenance of workplaces by local air exhausted ventilation, with application of absorbers and other clearing structures.

The dangerous works are made with application of individual protective means. The last ones are subdivided into individual protection means of the respiratory organs, the skin, the organ of vision. The individual protective equipment is subdivided into filtering and isolating. Filtering equipment is prevented by gas masks and helmets ensuring purification of the inhaled air from harmful substances.

Filtering respirators are subdivided into three groups: antidust (antiaerosole) — “Astra”, “Kama”, “U-2K”, “ShB-1” a “Petal” (filter-mask), antigas (RPG-67) and universal (RU-60Mb). According to the way of submask space ventilation antiaerosole respirators may be with and without valves. By conditions of operation there are distinguished expendable and reusable use. The industrial filtering gas masks have got a wide spread usage for respiratory organs and eyes protection.

Isolating air-supplied respirators (with submission of the air from a clean zone) and the independent respiratory devices provide protection by isolation of respiratory organs from the environment.

For eyes protection at having poured of aggressive liquids the closed glasses with direct ventilation or tight glasses-cans are recommended.

The means of the skin protection include protective pastes, ointments and creams, as well as special clothes and boots. For protection against the action of fat-soluble organic substances there are used hydrophylic ointment and paste (on a basis of glycerin, gelatin, etc.), for protection against water-soluble compounds — the hydrophobic ointment and paste (on a fatty basis).

Work and rest conditions have great importance.

The Ukrainian legislation provides a special care for the persons working with harmful substances: shortening of the working day, increase of annual holidays duration, establishment of the raised tariff rates, granting of pensions on favorable terms (decrease of pension age, reduction of the required experience). At some manufactures the women and teenagers are not allowed to work.

The medical-biological measures include also application of special medical diets and some other measures. The raised contents of protein in a diet promotes a reparation of the damaged structures and fermentative systems. With the meal enriched with vitamins (especially ascorbic acid and the B group vitamins), the workers consume products containing calcium and iron, capable to combine with acid radicals and to participate in taking out toxic anions. It's limiting quantity of fats, since the raised contents of fats in a diet promotes an increase of fat-soluble compounds absorption. The carbohydrate-rich diet promotes synthesis of glycogen and strengthens antitoxic function of the liver. The presence in a diet decorporators-demineralizators (pectins, lignine, cellulose) promotes taking out and reduces resorption of toxic compounds. At work with producing phosphoric acid it is expedient to add sodium sulphate small quantities in drinking water.

The complex realization of measures of administrative-organisational, technological, sanitary-technical and medical-biological character is a pledge of effective preventive maintenance of professional poisonings.

A number of professional poisonings is widely known. It is poisonings with salts of heavy metals (on an example of compounds of lead and mercury), methyl spirit, benzen, petrol, phosphorus, cadmium, compounds of fluorine, pesticides and with other toxic compounds.

**Lead** (Plumbum (Pb), nuclear weight — 207.19, density 11.34 g/cm<sup>3</sup>) — silver-gray soft metal with temperature of melting 327.5°C and temperature of boiling — 1,740°C. In a nature there are five stabil isotopes of a lead — Pb<sup>208</sup>, Pb<sup>207</sup>, Pb<sup>206</sup>, Pb<sup>204</sup>, Pb<sup>202</sup>. Inorganic compounds of lead are two-valentic, the element also forms four-valentic organic compounds (tetraethyllead, tetramethyllead) (Table 38).

The greatest quantity of lead is spent in manufacture of electrical recharged batteries. The significant quantity of lead is used in a cable industry. The compounds of lead are used for manufacturing

Table 38. Major Occupations and Industries Associated with Lead Overexposure

Battery manufacturing	Pigment manufacturing
Chemical industry	Pipe fitters
Construction	Plastics industry
Demolition	Pottery
Firing-range instructing	Printing industry
Foundry	Radiator repairing
Gas-station attending	Rubber industry
Gasoline additives production	Soldering of lead products
Jewelry	Solid waste production
Lead mining	Stained-glass making
Lead smelting and refining	Welding

paints, in a porcelain-faience industry and in the production of crystal glass. The stability of lead oxides to corrosion has served as the reason of wide application of lead sheets in a building industry (roofing, hydro- and sound-proof material). Lead easily forms alloys, that allows to use it in manufacture of solder, cases of the stitches-in of bearings, font for polygraphic needs, folding pipes, screens for protection from ionizing radiation, for manufacturing an ammunition. The leaden soldering by a hydrogen flame is widely used. Tetraethyl- and tetramethyllead are used as antiknocking additive to petrol. Thus determined in industrial environment (in particular, in the air of a working zone) the concentration is high enough:

- in glasing of porcelain — 0.25 mg/m<sup>3</sup>;
- in manufacture of crystal — 0.6 mg/m<sup>3</sup>;
- in manufacture of separate kinds of plastic — 0.5 mg/m<sup>3</sup>;
- manufacture of batteries — 1.0 mg/m<sup>3</sup>;
- air dispersion of lead-containing paints — 3.0 mg/m<sup>3</sup>;
- manufacture of lead-containing paints — 2.5 mg/m<sup>3</sup>.

Accordingly, the risk of lead poisoning for various professional groups is not the same. By the WHO documents high risk of the intoxication is characteristic for such technological processes, as the smelting of primary and secondary lead, welding and cutting of metal constructions painted of lead-containing paints, welding of sheets with galvanic or zinc — siliconic leaden covering, disassembling of ships for scrap metal, leaden moulding, manufacture of accumulators (filling in the leaden paste, assembly, welding of plates), manufacture of leaden dyes, colouring by dispersion, mixing manually of leaden stabilizers in manufacture of polyvinichloride, mixing (manually) of the crystal glass-mass, clearing of surfaces from lead-containing paints, burning of lead in enamel shops and repair of automobile radiators. The average degree of risk is characteristic for leaden ore production, manufacture of cables, potentioning of wire with cooling in lead, casting (“garte”) and stereotyping in a printing house; the low risk degree — in plumber works, the assembly and repair of automobiles, etc. Many occupations are exposed to professional risk of leaden poisoning occurrence.

The basic way of lead’s getting to the organism under conditions of production is inhalatory. The poison will penetrate in the organism as steam and aerosols of condensation. The lead entering through the skin (from the polluted overalls), and per os (from the polluted hands, food, water) are possible. Lead inhalating in the concentration about 270–795 mg/m<sup>3</sup> causes fatal poisoning, 9.9–11.4 mg/m<sup>3</sup> — acute leaden posoning, 0.3–0.6 mg/m<sup>3</sup> — saturnism manifestations (chronic defeats of different organs and systems).

In blood lead circulates as lead phosphate and colloid lead. In bowels lead transforms in insoluble sulphate and in such kind excretes from the organism. A part of lead excretes through kidneys, sweat, salivary and mammary glands. A small quantity of lead excretes in the lumen of the stomach. From the organism it excretes not completely — accumulates in all tissues, but its basic part forms depot in bones as triphosphate. At conditions accompanying with infringement of the acid-base balance and infringements of phosphoric-calcium metabolism (overnutrition, starvation, food poisonings, infections, alcoholism), insoluble lead triphosphate turns in soluble diphosphate. There is a mobilization of the toxic agent from depot, lead goes to the blood, causing an aggravation of chronic intoxication.

Lead and its compounds are strong protoplasmatic poisons, oppressing functional (amine, carboxylic, thylic) group of proteins playing an important role in all biochemical processes. It results in changes in all organs and systems of the organism, first of all in the central nervous and haemopoietic systems. In particular, lead breaks biosynthesis of hem, hemoglobin and breaks methabolism of iron in red blood cells.

The infringement of regenerative function of the red medulla is accompanied by occurrence of young degenerative forms — basophylic and vital-granular red blood cells (more than 500 and 80,000 in 1 million of the normal red blood cells). The contents of the reticulocytes (up to 2–2.5% is increased at the norm of 0.5–0.8%). For the saturnism is characteristic a sideroachrestic anemia — reduction of the contents of red blood cells (up to 2.5–3 T/L) and hemoglobin (by 50%) in blood at the normal or raised contents of iron in the serum (norm: 12.5–30.4 μmol/L). There is simultaneously observed aniso- and poikilocytosis; for leucogram it is characteristic the high lymphocytosis and monocytosis.

The first symptoms of the CNS defeat are non-specific, it can be conducted with asthenovegetative syndrome. Further the organic defeats of the peripheral and the central nervous system develop, depending on character and localization of the centers of defeat, the neurosaturnism can proceed as peripheral polyneuritis (“a trailing hand”, “of trailing stop”), encephalopolyneuritis, encephalopathy.

Neurosaturnism is quite often accompanied with “leaden colic” — the spasm of smooth musculature of the intestine of the central origin. Leaden colic is shown by a sharp pain in the stomach, nausea, constipation (some days), meteorism, increase of blood pressure, bradycardia.

In defeat of the digestive system, gastritis with infringements of secretoric function of the stomach, spastic colitis develop. A “leaden line“ of dark blue or dark grey (chalk-aspide) colour occurs on the gums. The occurrence of leaden line is connected with excretoric gingivites characteristic for all in-

toxications by salts of heavy metals. The mucous colouring is caused by reaction of free sulfuric hydrogen, present in the oral cavity, with kationes of lead, circulating in blood. Thus insoluble lead sulphide, having dark tint forms. The toxic defeat of the liver parenchyma is shown with hepatomegaly, morbidity, sometimes acute atrophy develops.

The changes in the urine analysis (proteinuria, hypostenuria, microhematuria) are characteristic. The damage of the kidneys has a character of the chronic interstitial nephritis, in severe cases — malignant nephrosclerosis.

Characteristic symptom of saturnism, known to antique authors, is the “leaden colour” — pale-grayish colour of the face skin. Its occurrence is connected with anemia and spasm of periphery vessels; a certain role has a photosensitizing action of porphyrines — the products of incomplete synthesis and destruction of the hem.

The diagnostic importance has the raised contents of lead in the blood (more than 1.4  $\mu\text{mol/L}$ ) and in the urine (more than 0.05 mg/L), presence in the urine of  $\delta$ -aminolevulinic acid and coproporphyrine.

The acute poisonings with lead under production conditions are met seldom. The most often clinical syndromes of chronic leaden poisoning are anemic, gastrointestinal, hepatic, asthenovegetative and asthenoneurotic; can be polyneuritic, seldom — encephalopathic, cardiovascular and renal syndromes.

Four stages of the chronic lead poisoning are distinguished:

1. Carriage of lead: “leaden line”, hyperplumburia.

2. Light lead poisoning: astheno-vegetative syndrome, reticulocytosis, basophilic granularity of red blood cells, porphyrinuria.

3. Lead poisoning of middle degree: syderoachestic anemia (Hb no more than 5 mmol/L), leaden colic, toxic hepatitis, periphery polyneuritis.

4. Heavy lead poisoning: anemia (Hb less than 5 mmol/L), heavy leaden colic, encephalopathia.

**Prevention of Lead Poisoning.** Maximal single MAC of lead in the air of a working zone makes 0.01 mg/m<sup>3</sup>, average-workdaily — 0.005 mg/m<sup>3</sup>. The important measure is the replacement of lead and its compounds by less toxic substances and materials (gart by a plastic font, leaden bleached — by titanite, etc.); mechanization and automatisation of transporting, loading and unloading of loose materials; hermetic sealing of cabins of crane operators and operators of management boards.

The installations for splitting, polishing and watering of materials containing lead should be equipped with rational devices of local ventilating pipe. Premises, where lead is melt and spilled, besides of local ventilation are also equipped with central ventilation with 7–8-fold air exchange. The inner design of industrial premises should allow to

carry out damp and vacuum cleaning. At the high contents of lead in the air of a working zone the individual means of protection of breath are used.

The teenagers, pregnant women and nursing mothers are not allowed to work with lead and its compounds. Contraindications to employment are blood diseases, essential hypertension, endarteriitis and others. The periodic medical surveys are carried out 1–2 times per one year by a brigade of the doctors, experts, such as: the physician, neurologist, stomatologist and, under the indications, psychiatrist. The laboratory examinations include obligatory clinical blood and urine analysis.

An important role in chronic lead poisonings prophylaxis belongs to a diet with pectin-containing products (vegetables, fruit candy, juices with pulp).

The concentration of lead in the air of a working zone is defined by a nephelometric method (according to a degree of turbidity of solution at the expense of lead chromate formation (comparison with a standard scale). Sensitivity of the method — 0.006 mg/m<sup>3</sup>. More exact data could be received at use of the atomic-adsorptive method, as well as atomic-emission spectrometry, X-rays-fluorescent spectrometry, mass-spectrometry, direct potentiometry, pulsing polarography and inversive voltamperometry.

**Tetraethyllead (TEL)** ( $\text{C}_2\text{H}_5$ )<sub>4</sub>Pb ( $t_{\text{boil}} = 200^\circ\text{C}$ ) and **tetramethyllead** ( $\text{CH}_3$ )<sub>4</sub>Pb ( $t_{\text{boil}} = 110^\circ\text{C}$ ) are colourless flying liquids used as antidetonator additives to fuel for internal combustion engines. The solubility of TEL in the organic solvents is rather high, the compound is easily sorbed by plaster, concrete and other porous materials. Ethylic (leaden) liquid contains up to 49% of TEL. Ethylic petrol used in a number of countries in aircraft and motor transport and contains from 1.5 up to 6–8 ml of ethylic liquid on 1 l of petrol (1.2–6.6 weight parts of TEL on 1,000 weight parts of petrol). For the purpose to identify ethylic liquid is painted in red colour, ethylic petrol — in pink.

At combustion TEL is decomposed with allocation of lead, oxidating in the air up to its oxide (PbO).

With tetraethyllead and its mixes the workers can contact during its production, the workers of mixing stations and other objects, in which ethylic liquid and ethylic petrol are obtained. Besides, the contact with these substances is possible at their transportation and storage in warehouse premises, at service, test, operation and repair of internal combustion engines working on leaden petrol; at service station, auto garages, etc.

Under conditions of production TEL can enter the organism through respiratory ways, and be soaked up through the intact skin as well.

TEL renders toxic influence by a complete molecule. It penetrates through a hemato-encephalic



barrier, easily cooperates with lipid components of the neurons, which explains its huge neurotoxic action. Circulating in the organism TEL effects on chemoreceptors of the vessels. A part of TEL is splited and removed from the organism with urine and feces, a part cumulates in parenchymatous bodies and in the brain (an ability to material cumulation is less expressed in TEL than in inorganic compounds of lead). Functional cumulation has great importance in pathogenesis.

Tetraethyllead is a strong poison. In acute poisoning within several h (days) a latent period (a period of imaginary well-being) is observed. Its duration is defined by a doze of the agent and reactivity of the organism. In unfavourable cases a lightning progressing course is possible resulting in death. In the initial stage of acute poisoning there are acute headache without a certain localisation, metal taste in the mouth, general weakness. Quite often patient is in euphoria or in depression. One of early symptoms is dessormia — faltering superficial sleeping with dreadful dreams; paresthesia (sensation of a hair on the tongue). It's characteristic hypothermia in a combination with hypotonia and bradycardia; hypersalivation is possible. Neurologic symptomatic aggravates: tremor, nistagm, atactic gait, swinging in Romberg's pose, infringement of speech as easy disartria, adiadochokinesia, dysmetria occur. Then mental disorder comes. In the culmination stage of the acute poisoning there are observed toxic delirium, hyperthermia, sometimes convulsive syndrome and meningeal phenomena. In persons who had TEL psychosis, residual signs are keeping for long period: psychasthenic phenomena, intellectual degradation, a stable focal symtomatics.

Chronic intoxication with TEL frequently has an oligosymptomatic character. In its course it is possible to distinguish the initial stage, in which asthenovegetative and asthenoneurotic syndromes prevail. In the subcompensation stage the organic symtomatics occurrence is possible: paresthesias, cerebellar (ataxia, dysartria, nystagm, intention tremor, dysmetria, etc.) and extrapyramidal (muscular dystonia, hypotonia, bradikinesia) symptoms. The displays of encephalopathia are increasing. In the decompensation stage exacerbations and psychotic conditions arise. The displays of toxic hepatitis, peripheral oedemas, myocardiodystrophia, moderately expressed changes in blood (basophilicity of RBC, reticulocytosis, leucopenia) may be observed. Porphyrinuria is marked seldom. Plumburia is insignificant — from 0.02 up to 0.2 mg/L.

**Prevention of Tetraethyl Lead and its Mixes Poisoning.** Now in the majority of the developed countries the ethylic petrol usage is legislatively forbidden. The replacement of ethylic petrol by other kinds of fuel (high-octane petrols) will allow to remove TEL from the technological schemes. It is the best way of preventive maintenance.

The maximal single MAC for TEL — 0.005 mg/m<sup>3</sup>.

The teenagers, pregnants and nursing women, the patients with organic diseases of the CNS, epilepsy, mental and endocrinic diseases, diseases of the liver, chronic otites, arterial hypotonia, hypertension and other diseases are not allowed to work with TEL. The persons working with TEL and its mixes are exposed to regular medical examinations. In contact with pure tetraethyl — or tetramethyllead medical examinations are carried out monthly; the physical surveys of the persons working with ethylic petrol (technicians, workers of mixing stations, etc.) are performed once a half-year. The physician and neurologist participate in the surveys.

Safety measures and personal hygiene observance is obligatory. Washing hands and overalls in ethylic petrol, mouth blowing of hoses are forbidden. After work an emplyee should take a shower. Food should be enriched by protein, fiber and vitamins.

**Mercury** (Hydrargirum (Hg), nuclear weight,  $t_{\text{melt}} = -38.8^{\circ}\text{C}$ ;  $t_{\text{boil}} = -357.25^{\circ}\text{C}$ ) — silver-white liquid metal. Mercury and its compounds are applied in instrument making, electrical engineering, for extraction of metals from ores as amalgams, for needs of a pharmaceutical industry, fungicides, caustic soda obtaining, in production of explosive mercury. The compounds of mercury are widely used.

Steams of mercury penetrate into the organism basically through the respiratory organs (already at 0°C mercury evaporates). Salts of mercury can penetrate through the skin also. Ingestion of metal mercury is not dangerous and has no risk for health.

The mercury circulates in the organism as albuminate, gets into the reaction with thyolic proteins, causing metabolism disturabances and the change of functional conditions of organs and systems. It's possible a material cumulation of the agent in parenchymatous organs. The mercury is a strong protoplasmatic poison. The acute and chronic poisonings with mercury are possible. The acute poisonings arise at incidents, at cleaning of the boiler and furnaces at mercury factories. The displays of the toxic hepatitis, ulcerous stomatitis, phenomena of hemorrhagic colitis and acute renal falure are typical.

Chronic intoxication (micromercurialism) arise at working in conditions of long contact with mercury. There are characteristic asthenovegetative and asthenoneurotic syndromes, tremor of the extremities, excretoric stomatitis with occurrence of characteristic grey line on the gums. A part of the patients has original disorder of mental functions known as mercury erethism, which is characterised by emotional lability, unadequacy and instability of affect. In complicated cases the picture of mercury encephalopathy develops, mercury polyneurites are met rather seldom.

**Prevention of Mercury Poisoning.** MAC of the steams of metal mercury in the air of a working zone is 0.01 mg/m<sup>3</sup>, and average workdaily MAC — 0.005 mg/m<sup>3</sup>. MAC for sulema production 0.2 mg/m.

The best prevention of mercury poisoning is a replacement of mercury by nontoxic or less harmful substances. If it is impossible we use other methods. All works with mercury should be carried out in specially equipped separate premises. The walls and ceilings of the premises should be covered with special mercury-unpenetrative paints.

The determination of mercury steam is carried out by colorimetric methods by pink colouring on a background of a white copper iodide suspension. Sensitivity of the method is 0.01 mg/m<sup>3</sup>. For selection of tests two Polezhaev's devices connected in a succesive order, containing by 2 ml of absorptive solution can be used. More exact data may be received at using of the atomic-adsorptive method, and also atomic-emission spectrometry, X-rays-fluorescent spectrometry, mass-spectrometry, straight line potentiometry, pulsing polarography and inversive voltampermetry.

**Benzene** (C<sub>6</sub>H<sub>6</sub>, molecular weight 78.12 Da; density — 0.879 g/cm<sup>3</sup>; t<sub>boil</sub> = 80.5°C, t<sub>melt</sub> = 5.5°C; elasticity of the steams at 20°C — 9.97 kPa; a parameter of refraction — 1.5, colourless liquid with a characteristic smell. It mixes up in all parities with the nonpolymeric solvents (turpentine, ethers, carbohydrates), dissolves fats, rubber, synthetic pitches. The technical grades of benzene contain significant quantities of other aromatic carbohydrates admixtures.

Benzene is used for organic synthesis (phenol production, stirol, cyclohexane, caprolactam, artificial fibers, artificial rubber, plastic mass, detergents and medicins), at work with laser installations, for extracting protein, degreasing bones and fat-containing substances. Benzene is allocated in the air of a working zone at the enterprises of petroleum and chemical industry as an intermediate product. Benzene is a component of crude petroleum.

In conditions of manufacture the poisoning with benzene is observed owing to inhalation of its evaporings. Exposure through the skin is possible too. Benzene sorption from the air in the lungs makes 40–65%. Benzene contacts convertibly with proteins of blood and exposed to intensive biotransformation by oxidation (phenol is formed, hydrochinon, pirocatechin, oxihydrichinon and muconic acid), conjugations (phenylmercapturic acid). Phenol and polyphenols are bound and are taken out from the organism by sulfuric and glucuronic acids. A part of the poison is taken out through the lungs.

Benzene is a polytropic poison, causing acute and chronic poisoning. At acute poisoning benzene works as a narcotic. In modern conditions the benzene acute poisonings arise only in exclusive cases (emergencies, etc.). The chronic poisoning with ben-

zene (concentration about several tens and hundreds milligrams on cubic meter) proceeds with a prevailing defeat of system of hemopoietic and nervous systems. Hematological changes have a hypoplastic character. The quantity of cellular elements of the peripheral circulating pool and trunclal cells of red medulla decreases. The pathognomic attribute for chronic intoxication with benzene is neutropenia with decrease of activity of cytochromoxydase, alkaline phosphatase and increase of sour phoshatase activity in neutrophilic granulocites. The clinic signs of hemorrhagic syndrome is determined by a level of thrombocytopenia. Bleedings can be marked at the normal contents of blood platelets too, that is connected to infringements of their adhesive and agregation activity and defects of blood clot formation. Anemic syndrome is notable by tendency to progression. The incidences of hemoglobinoses in workers with benzene are described. Dysproteinaemia is characteristic for those who had benzene poisoning. The level of general protein of the blood serum is increased, there are changes of albuminic/globulinic index, the contents of β- and γ-globulines is increased.

The chronic poisoning with benzene results in infringement of the cardiovascular system function: increase of minute volume of blood, decrease of peripheral resistance of vessels and blood pressure. The locomotor apparatus is damaged also. On rentgenograms the centers of osteoporosis, little foci of osteosclerosis, destructurization of cortical substance of long tubular bones are defined.

Main gasintestinal syndromes are the changes of secretoric function of the stomach, hypoaciditas, decrease of activity of pancreatic enzymes, signs of malabsorption.

Against a background of immunity depression and infringements of barrier functions of the organism tissues the various infections getting a generalized character occur rather often.

In experiment on laboratory animals mutagenic and cancerogenic activity of benzene (group 1 of IARC) is proved, the opportunity sensitizing, irritating action of the poison and its influence on reproduction function is shown.

**Prevention of Benzene Poisoning.** The preventive maintenance is carried out by introduction of multiplane healthy measures. According to the GOST 12.1.005-88 it is established that an average work-shift MAC of benzene in the air of a working zone is 1.5 mg/m<sup>3</sup>, maximal single MAC — 5 mg/m<sup>3</sup>, MAL of pollution of the hands' skin is 0.05 mg/cm<sup>2</sup>. Using benzene as solvent for clearing details, washing of hands is forbidden.

The replacement of benzene by less toxic compounds is provided. At benzene using in technological process, installations and units of the equipment are being hermetized. So, a maximal hermetic sealing of the process equipment and transport com-

munications, observance of a mode of operation of locking fixture have an important meaning. The workplaces are equipped with rational ventilation.

The teenagers, pregnants and nursing women are not allowed to work with benzene. The periodic medical surveys are carried out annually. The persons with signs of poisoning should be transferred to another post. With the preventive purpose at the enterprises with high risk of intoxication there are applied treatment-preventive diets (enriched by products containing many sulfurcontaining aminoacids — cheese, curd), as well as large doses of ascorbic acid (150 mg/day).

**Methyl spirit** (methanol,  $\text{CN}_3\text{COOH}$ , 32.04 Da,  $t_{\text{boil}} = 64.7^\circ\text{C}$ ) — colourless liquid. It is obtained by way of dry distillation of wood or by synthesis. It is applied as solvent of fats, oils, rubber; enters the structure of the solvents. It is used in chemical industry, as raw material for synthesis; can enter antifreeze structure.

Toxicity of methyl spirit is connected with action of the whole molecule of methanol, and also in compound with formation of formaldehyde and formic acid at its biotransformation. Intoxication with methanol is accompanied by infringements of perfusion of brain tissue, as a consequence of influence on suprasegmentar structure of the vegetative nervous system and, simultaneously, degeneration of ganglionar elements. In particular, the neurotoxic action is shown as toxic retrobulbar neuritis of the optic nerve, in severe cases it is possible the atrophy of n. opticus. Some quantity of methyl spirit at poisonings collects in the cerebrospinal liquid, and also in aqua moisture and vitreous body of the eye apple.

Under conditions of production the acute and chronic intoxications owing to steams inspiration or methyl spirit absorption through the skin is rather limited. The risk of poisoning is great at cleaning closed tanks. The methyl spirit poisonings basically are observed in ingestion (instead of ethyl spirit).

The acute poisoning with methanol in mild cases manifests itself in temporary cerebral disorders. Some days after the ingestion there are observed general cerebral symptoms, focal symptomatics, later on disappearing.

At serious poisonings the clinical symptoms are the vision disorders. It may be combined with cerebral signs. Vision disorders appear not at once, sometimes in 2–3 days of apparent well-being. In the beginning patients complain of a net and fog before eyes. In some h (sometimes in 1–2 days) visual acuity begins to decrease up to complete loss of sight. In a number of cases the blindness comes suddenly.

In severe cases the cerebral phenomena are prevalent, which can result in development of a comatous condition and lethal outcome.

The chronic poisoning with methyl spirit steams develops gradually, expressed in irritation of mucous environments, general weakness, headaches, noise in the head, tremor, dispeptic phenomena.

**Prevention of Methyl Spirit Poisoning.** Maximal single permissible concentration (MAC) of methyl spirit in the air of a working zone makes  $50 \text{ mg/m}^3$ . For prevention of an opportunity of methyl alcohol intake, it's necessary to keep strictly the orders of expenditure and storage, transportation, as well as an appropriate sanitary-educational work should be carried out among the persons contacting with it.

**Petrol (gasoline)** is a mix of methan, naphten, aromatic and unsaturated hydrocarbons — transparent, colourless or yellow, flying, inflammable liquid with a characteristic smell.

Gasolines are applied basically as fuel to the internal combustion engines, and also as the solvent and diluter in rubber and paint industry, for extraction of vegetable oils from seeds, fat from bones, etc.

Steams of petrol get in to the organism and are taken out through lungs. They have percutaneous and peroral route of exposure.

The acute poisonings can take place at cleaning tanks, bulk-oil courts, transfusion of petrol in small premises, pneumatic colouring, at breakage of oligoextractive and other equipment. The clinical picture of the acute intoxication depends on inhaled petrol steams concentration. At concentration of  $5,000\text{--}10,000 \text{ mg/m}^3$  a headache, cough, lacrimation, facial hyperemia occur in some minutes. At concentration of  $15,000\text{--}20,000 \text{ mg/m}^3$  the loss of consciousness is possible, and very high concentration ( $35\text{--}40 \text{ g/m}^3$  and more) is fatal.

The ingestion is observed at aspiration of petrol with the mouth through a hose. Painful cough up to nausea begins at once. At getting into the stomach the signs of gastroenteritis prevail, at aspiration — toxic pneumonia.

The chronic petrol poisoning manifests as astheno-vegetative and astheno-neurotic syndromes, digestion disorders. At the high contents of aromatic hydrocarbons the changes of the hemogram are possible. At regular contact of the hands skin with petrol the development of sharp and chronic skin diseases (dermatites, exema, etc.) is possible.

**Prevention of Gasoline Poisoning.** MAC for cracking-petrols is  $100 \text{ mg/m}^3$ , for the petrol-solvent —  $300 \text{ mg/m}^3$ .

At danger of acute poisoning it is necessary to use hose gas masks, overalls. On workplaces with high contents of petrol steams in the air it is forbidden to work alone. For protection of the hands skin it is applied pastes such as “of biological gloves“, other protective ointments, greasing of the skin by greasy creams and ointments after work. It is strictly forbidden aspiration of petrol by the mouth.

**Pesticides** (chemical weed-killers and pest-killers) is an extensive group of compounds intended

for struggle with the wreckers of the agriculture, with a series of synantropic organisms and for plants growth regulation.

Depending on the purpose there are distinguished:

- acaricides — preparations for struggle with ticks;
- algicides — preparations for destruction of seaweed and other water vegetation;
- antiseptics — preparations for disinfection of needs (mainly for processing surfaces);
- arboricides — preparations for destruction of undesirable wood and bush of vegetation;
- aphicides — preparations for struggle with aphicides;
- bactericides — preparations for struggle with pathogenic bacteria in external environment (in various objects);
- herbicides — preparations for struggle with weed plants;
- zoocides (rodenticides, raticides) — preparations for struggle with rodents;
- insecticides — compounds for struggle with harmful insects;
- limacides (molluscocides) — preparations for struggle with molluscs;
- nematocides — preparations for struggle with round vermes;
- fungicides — preparations for struggle with fungi;
- retardants — preparations which are slowing down development of plants;
- defoliantes — preparations causing falling of leaves;
- deflorants — preparations for removal of superfluous flowers;
- desiccants — preparations for desiccation of plants;
- repellents — means which are frightening off insects;
- attractants — substances for attraction of insects;
- infertilizers of insects — preparations for sterilization of insects;
- antifidings (antifidants) — means which are frightening off insects from food.

The most spread agents are herbicides, insecticides, fungicides, as well as regulators of growth of plants. By character of action it can be herbicides of continuous and selective action, by features of application — contact, system and acting on root system of plants or on sprouting seeds. In its turn insecticides can be contact, intestinal, system or fumigants. The last ones penetrate in the organism of the insect through the respiratory organs. Fungicides are usually divided into fungicides for seeds and for plants, which in their turn are subdivided into preparations of preventive and treatment action.

The hygienic classifications of pesticides are based on allocation of various groups by their toxic-

ty: high toxic ( $DL_{50}$  up to 50 mg/kg, high toxic —  $DL_{50}$  more than 1 g/kg), by the degree of skin resorption (acute, middle — and light expressed); by the degree of evaporation, by the degree of cumulation (superhigh factor of cumulation less than 1, expressed — 1–3, moderate — 3–5, weak — more than 5) and by stability (very stable — time of decomposition 1–2 years, stable — 6–12 months, moderately stable — 1–6 months and unstable — up to 1 month).

I. According to toxicity in stomach introduction (up to  $LD_{50}$  mg/kg):

1. Strong poisonous substances — up to 50.
2. High toxic — 50–200.
3. Middle toxic — 200–1,000.
4. Low toxic — more than 4,000.

II. According to skin-resorbed toxicity (up to  $LD_{50}$ ):

1. Sharply expressed — it is less than 300 (the skin-oral factor is less than 1)
2. Expressed — 30–1,000 (skin-oral factor).
3. Poorly expressed — more than 1,000 (the skin-oral factor is more than 3).

III. According to the degree of evaporation:

1. Very dangerous substance is equal toxicity.
2. Dangerous — satiating.
3. Not very dangerous — satiating actions.

IV. According to cumulation:

1. Supercumulation — coefficient of cumulation is less than 1.
2. Expressed — 1–3.
3. Moderate — 3–5.
4. Poorly expressed — more than 5.

V. According to cancerogenic ability:

1. The obviously cancerogenic ability cause separate cases of cancer in people; strongly cancerogenic ability — in experiences on animals.
2. Cancerogenic — cancerogenicity is proved in experiences on animals, but is not proved in humans.
3. Low cancerogenic — light cancerogenes in experiences on animals.

4. Suspicious on oncogenicity.

VI. According to mutagenicity:

1. Supermutagens — cause 100% and more of mutation in plants and animals (i.e. 100 mutations by 100 chromosomes).
2. Strong mutagens — 5–100% of mutagenicity.
3. Middle mutagens — 2–5%.
4. Light mutagens — 1–2%.
5. Very light mutagens — 0.5–1.0%.

VII. On teratogenicity:

1. The obvious teratogenes.
2. Suspicious on teratogenicity.

VIII. According to embriotoxicity:

1. Selective embriotoxic.
2. Moderate embriotoxicity.

IX. According to allergic peculiarities:

1. Strong allergens.
2. Light allergens.



a treatment-preventive meal (diet enriched by protein and vitamins), vitamin preparations.

The pesticides application is carried out according to the technological requirements to a given agriculture, the preparations with low stability in external environment, minimally toxic for warm-blooded organisms and humans under conditions of high pesticides activity have an advantage. The air way of pesticides application is more preferable in comparison with the overland one.

At pesticides production and packing it is widely used the automatisation, remote control of technological units and operations. The industrial premises are equipped with balanced ventilation, both general and local. In corridors of management only incoming air moves, ventilation is organized from reagent and dosage cabins. The removed air and waste waters are detoxicated by burning in fire or filtration through sorbents (with their subsequent burning). Degazation of the polluted overalls and equipment is made under the authorized instructions with application of oxidizers and superficial-active compounds.

### PHYSICAL HAZARDS

At present the occupational environment in industry and agriculture has about 20 physical factors. There are occupational microclimate, ionizing radiation, electromagnetic waves (IR, UV, visible light, laser, microwaves), ultrasound, noise, vibration, decreased and increased barometric pressure, etc.

### Occupational Microclimate

It is the complex of physical factors (convection and radiation temperature, air humidity and the velocity of air movement) determining the thermal status of the worker's organism.

A Ukrainian scientist G. Shahbazyan proposed the classification of microclimate which is widely used now (Fig. 42):

1. Microclimate of hot workshops:
  - with radiation prevalence;
  - with convection prevalence.
2. Microclimate of cold workshops:
  - manmade;
  - microclimate of non-heating premises.
3. Microclimate with expressed amplitude of factors.
4. Microclimate made by HVAC systems.

You see, we can classify the occupational microclimate by its action on the human's organism and the conditions of its forming. Hygienists use as the standard of thermal comfort a man dressed the light clothes (thermal resistance = 1 clo (0.155 W/m<sup>2</sup>·K) in piece. The best thermal feeling of a man is characterized by these parameters (Table 39):

For complex evaluation of occupational microclimate WHO experts offered WBGT-index — the empirical index calculating from data of psychrometry and Vernon's termometry by the formula:

For out-door conditions:

$$WBGT = 0.7 t_{wet} + 0.1 t_{dry} + 0.2 t_{Vern}$$

For indoor conditions:

$$WBGT = 0.7 t_{wet} + 0.3 t_{Vern}$$

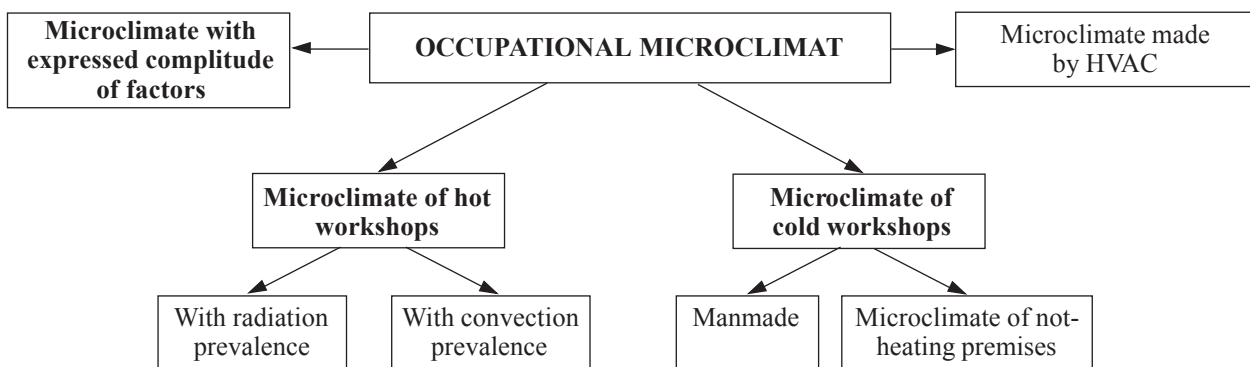


Fig. 42. Classification of Occupational Microclimate

Table 39. Occupational Microclimate and its Impact on Health

Occupational environment		Physiological indices of thermal comfort
Air temperature	20–22°C	Heat production = heat loosing (93.0–116.3W) Body (oral) temperature: 37.2°C Skin temperature: 33.6°C
Relative air humidity	30–70%	
Velocity of air movement	0.3–0.5 m/s	
Radiation temperature	15–17°C	
The temperature of industrial objects	15–35°C	
Temperature diapason "head-feet"	3–6°C	

Table 40. **Classes of Work Conditions**

Heaviness of work	Energy losses, W	Class of work conditions					
		Optimal	Admissible	Harmful			
				1 level	2 level	3 level	4 level
1a	Up to 139	21.0–23.4	23.5–25.4	25.5–26.6	26.7–27.4	27.5–28.6	28.7–31.0
1b	140–174	20.2–22.8	22.9–25.8	25.9–26.1	26.2–26.9	27.0–27.9	28.0–30.3
2a	175–232	19.2–21.9	22.0–25.1	25.2–25.5	25.6–26.3	26.3–27.3	27.4–29.9
2b	233–290	18.2–20.9	21.0–23.9	24.0–24.2	24.3–25.0	25.1–26.4	26.5–29.1
3	> 290	17.0–18.9	19.0–21.8	21.9–22.2	22.3–23.4	23.5–25.7	25.8–27.9

\* — for warm seasons in the moderate climate.

$$WBGT = \frac{WBGT_{\text{head}} + WBGT_{\text{abd}} + WBGT_{\text{anc}}}{4}$$

By the WBGT-index in Ukraine they divide all occupations into 3 classes of work conditions (Table 40).

In USA under conditions of high temperature and heavy workload, the CSHO should determine the work-load category of each job. Work-load category is determined by averaging metabolic rates for the tasks and then ranking them:

Light work: up to 200 kcal/hour

Medium work: 200–350 kcal/hour

Heavy work: 350–500 kcal/hour

The acute action of overheating microclimate can cause heat stroke, heat edema, cramps. Prolonged action of these factors can be risky for the diseases as vegetative dystonia, myocardiodystrophy, hyperacid gastritis, urolithiasis (urine stones), so on.

Chronic overcooling causes the neuralgia, neuritis, radiculitis, myositis, tonsillitis and other inflammatory processes. This factor takes part in the pathogenesis of bronchial asthma, paroxysmal tachycardia with allergic genesis.

By the data of literature the adaptation to the discomfortable occupational microclimate takes about some months.

**Prevention:** There are several preventive directions in the prophylaxis of diseases caused by occupational microclimate:

1. *Hygienic standardization:* To define an optimal and admissible parameters for working zone with taking in account the heaviness of labor and the season.

In hot countries there are used the following work standards:

The air temperature: up to 31–32°C — for light labor (“white-collars”); 30–31°C — for average labor; 29–30°C — for hard work.

It’s recommended to increase the air movement velocity by 0.1 m/s and relative humidity by 5% for every 1°C over defined limits.

Infrared radiation is one of the factors of occupational microclimate. Long-wave IR radiation

(>100 μ) is being absorbed by skin surface, short waves (0.76–15 μ) penetrate in the depth about 2 cm.

For limitation of infrared irradiation it’s using these standards:

1) Temperature of the working surfaces less than 45°C.

2) Radiation density should be less than 35 W/m<sup>2</sup> if 50% and more of body surface is under irradiating:

— up to 70 W/m<sup>2</sup> if it’s 25–50%;

— up to 100 W/m<sup>2</sup> if less than 25%.

For open sources of IR radiation: its power should be less than 140 W/m<sup>2</sup> if irradiated skin surfaces less than 25% with using of special clothes

2. *Technological measures:* Changing of technology (for example in foundry to change combusting of solid and liquid fuel for inductive heating with high frequency current; automatization; distant operating, so on).

3. *Architectural-planning measures:* To project for building and reconstruction rational architectural decisions (optimal sizes of premises, localization of heat producing sources, shielding).

4. *Sanitary-technical measures:* Local conditioning of the air, rational ventilation, air showering, heating, etc. Circulating air is the most highly effective, as well as the most complicated, personal cooling system. By directing compressed air around the body from a supplied air system, both evaporative and convective cooling are improved. The greatest advantage occurs when circulating air is used with impermeable garments or double cotton overalls.

5. *Policy and plan:* Science based regimen of the labor and the rest (for example, if density of IR radiation is less than 700 W/m<sup>2</sup> the duration of non-stop working (operating) should be no more than 15 minutes and percentage of work operations should be less than 70%).

Every worker who works in extraordinary conditions that increase the risk of heat stress should be personally monitored. These conditions include wearing semipermeable or impermeable clothing when the temperature exceeds 21°C, working at extreme metabolic loads (greater than 500 kcal/hour), etc. (Table 41).

Table 41. Regulation of Work in IR-related Heat

Density of IR radiation, W/m <sup>2</sup>	Duration of non-stop operating	Percentage of work operation
700	15	70
700–2,100	10	50
>2,100	5	30–40

Personal monitoring can be done by checking the heart rate, recovery heart rate, oral temperature, or extent of body water loss. To check the heart rate, count the radial pulse for 30 seconds at the beginning of the rest period. If the heart rate exceeds 110 beats per minute, shorten the next work period by one third and maintain the same rest period.

The recovery heart rate can be checked by comparing the pulse rate taken at 30 seconds ( $P_1$ ) with the pulse rate taken at 2.5 minutes ( $P_3$ ) after the rest break starts.

Oral temperature can be checked with a clinical thermometer after work but before the employee drinks water. If the oral temperature taken under the tongue exceeds 37.6°C, shorten the next work cycle by one third.

Body water loss can be measured by weighing the worker on a scale at the beginning and the end of each working day. The worker's weight loss should not exceed 1.5% of total body weight during the working day. If a weight loss exceeding this amount is observed, fluid intake should increase.

The following administrative controls can be used to reduce heat stress:

- reducing of the physical demands of work, e.g. excessive lifting or digging with heavy objects;
- providing of recovery areas, e.g. air-conditioned enclosures and rooms;
- using of shifts, e.g. early morning, cool part of the day, or night work;
- using of intermittent rest periods with water breaks;
- assigning of extra workers and limiting of worker occupancy, or the number of workers present, especially in confined or enclosed spaces.

6. *Individual protection*: Reflective clothing which can vary from aprons and jackets to suits that completely enclose the worker from neck to feet, can stop the skin from absorbing radiant heat. However, since most reflective clothing does not allow air exchange through the garment, the reduction of radiant heat must more than offset the corresponding loss in evaporative cooling. For this reason, reflective clothing should be worn as loosely as possible. In situations where radiant heat is high, auxiliary cooling systems can be used under the reflective clothing. Commercially available *ice vests*, though heavy, may accommodate as many as 72 ice

packets, which are usually filled with water. Carbon dioxide (dry ice) can also be used as a coolant. The cooling offered by ice packets lasts only 2 to 4 h at moderate to heavy heat loads, and frequent replacement is necessary. However, ice vests do not encumber the worker and thus permit maximum mobility. Cooling with ice is also relatively inexpensive. *Wetted clothing* is another simple and inexpensive personal cooling technique. It is effective when reflective or other impermeable protective clothing is worn. The clothing may be wetted cloth overalls or wetted two-piece, whole-body cotton suits. This approach to auxiliary cooling can be quite effective under conditions of high temperature and low humidity, where evaporation from the wetted garment is not restricted.

*Water-cooled garments* range from a hood, which cools only the head, to vests and "long johns", which offer partial or complete body cooling. Use of this equipment requires a battery-driven circulating pump, liquid-ice coolant, and a container. Although this system has the advantage of allowing wearer mobility, the weight of the components limits the amount of ice that can be carried and thus reduces the effective use time. The heat transfer rate in liquid cooling systems may limit their use to low-activity jobs; even in such jobs, their service time is only about 20 minutes per pound of cooling ice. To keep outside heat from melting the ice, an outer insulating jacket should be an integral part of these systems.

#### 7. Medical benefits:

- water regimen: to drink enough quantity of aerated water with sodium chloride, tea, buttermilk, skim milk, stewed dry fruit, juices, etc. It's forbidden to use light alcohol beverages (dry wine, beer);
  - special diet enriched with protein;
  - dispensarization — the system of active medical survey (previous and periodical medical examinations);
  - tempering.
- Individual protection includes special overalls, etc.

#### Electromagnetic Waves

Microwave radiation is used for radar, in physiotherapy, so on. This factors can cause deep tissue burns. Prolonged exposure to microwaves may be associated with impaired fertility. Some authors described intellectual and emotional disturbance associated with prolonged exposure to microwave radiation.

#### Prevention:

1. *Hygienic standardization* (Table 42).

*Policy and plan*: The maintenances are protection by time and distance. They use optimal placing of the equipment; optimize labor and rest regimen, mark the dangerous zones, use special building constructions and optimize internal planning.



Table 42. Standards for Isolated Action of Microwaves

Diapazone	MAL for electrical field	MAL for magnetic field	Diapazone	MAL for electrical field	MAL for magnetic field
60 kHz–3 MHz	500 W/m	50 A/m	Constant	10 W·m <sup>2</sup>	
3–50 MHz	300 W/m	–	Periodical	10 W·m <sup>2</sup>	
30–300 MHz	80 W/m	3 A/m	Local irradiation of hands	50 W·m <sup>2</sup>	
300 MHz–300 GHz					

Table 43. Use of UV Radiation and its Impact on Health

		$\lambda$ , nm	Usage	Biological effects
A	Proximal	400–315	–	Mild biological effect
B	Medical	315–280	–	Erythema, dermatitis
C	Distal	200–280	Welding, mercury lamps, etc.	Cataract, keratitis, cancerogenic effect, bactericidal action
Vacuum UV		< 200	–	Cancerogenic effect

*Technological measures:* Mechanization and automatization, using distant operating, minimizing microwave radiation source power.

*Sanitary-technical measures:* Shielding for reflecting (metallic construction) or absorbing (dielectrics) electromagnetic energy.

*Individual protection:* Using of overalls shielded with metallic content fabric. They use radiation protected glasses also.

*Medical benefits for prevention:*

— dispensarization — the system of active medical survey (previous and periodical medical examinations);

— special diet enriched with protein and vitamins;

— tempering.

**Ultraviolet (UV) radiation** is the part of electromagnetic field with wavelength less than 400 nm. They divide all UV spectrum into some regions (Table 43).

UV radiation has several biological effects. It causes tanning by its effect on melanocytes and causes skin cancer, especially among fair-skinned people.

The main natural source of UV radiation is Sun (3–4% of all solar radiation energy). Manmade sources of UV rays are gas-dischargeable lamps, welding, melted metal, etc.

**Prevention:**

*Hygienic standardization* (Table 44):

*Individual protection:*

— sun protective creams (pasts, unguents) containing PABA or benzopyrenes;

— shielding glasses;

— special clothes.

*Medical benefits for prevention:*

— dispensarization — the system of active medical surveillance (previous and periodical medical examinations);

— special diet enriched with protein and vitamins;

— tempering.

**Laser** (light amplification by stimulated emission of radiation) — are pulsed coherent electromagnetic waves i.e. light waves in which all waves are in the same phase. They have several important scientific and industrial uses. Lasers can cause irreparable retinal damage and severe burns. In Ukraine all lasers are divided into 4 classes:

I — safe devices;

II — dangerous for eyes;

III — very dangerous for eyes (include diffuse reflected light);

IV — very dangerous for eyes and skin.

Table 44. Prevention of Over-Exposure to UV Radiation

Categories	Skin surface**	Irradiation in 50% of duty time***
A*	50 W	10 W
B	0.05 W	0.01 W
C	0.001 W	–

\* — for local irradiation: permissible surface density is up to 1 W·m<sup>2</sup>; \*\* — less than 0.2 m<sup>2</sup> including face and neck with exposure to UV less than 5 min, pauses between irradiation more than 30 min and total duration of exposure less than an h; \*\*\* — exposure more than 5 min.

**Prevention:**

1. *Hygienic standardization.*
2. *Policy and plan:*

For IV class devices they use placing in the isolated premises. Walls should be covered with lusterless materials.

For III–IV class devices it's necessary to have door locks with block system, inner locks and mark "No admittance". Laser devices should be isolated as maximum.

It's possible to use:

- conductors for laser to the target;
- all lenses, prisms should be equipped with blinds;
- diaphragm.

3. *Individual protection:* Using of cotton clothes, gloves, spectacles with special glass.

4. *Medical benefits* include dispensarization and healthy diet.

**Pressure**

Extreme variations of atmospheric pressure are tolerable if the oxygen supply is maintained.

**High pressure.** Under high pressure more oxygen and nitrogen are dissolved in blood and body tissues. Under extremely high pressure, e.g. scuba diving below 100 meters, so much nitrogen is dissolved that nitrogen narcosis results, with disorientation and loss of consciousness. This is preventable by replacing nitrogen with helium.

Some technological processes carried in water (bridge, dumb, tunnel building) use the caissons. In these chambers the air pressure is increased because for water replacing they use compressed air.

Sudden reduction of pressure (decompression) leads to release of dissolved gases from blood and tissues, with formation of bubbles (aeroembolism) – "the bend", so-called because of the accurately painful effects of joints. There are the caisson disease forms:

- mild: artralgia, ostalgia, mialgia, neuralgia occurs in bends;
- middle severity: labyrinths damage, digestive tract and vision problems;
- severe: medullar, cerebral, coronary and respiratory signs;

— lethal: emboli of lung vessels, heart stroke, insults.

**Prevention:**

1. *Technological measures* include using of helium-oxygen mixture.

2. *Hygienic standardization:* MAL of air pressure in the caisson is 3.9 Atm.

3. *Policy and plan:* Duration of the working day is limited. (Table 45).

Decompression regimen should be applied at each shift' end.

4. *Individual protection:* Prevention of overcooling (warm clothes and shoes for workers, taking shower after work at 37–38°C, hot drinks)

5. *Medical benefits:*

- dispensarization;
- using medical lock (chamber on 1–2 beds);
- placing isolators in every medical unit (1 bed by 24 caisson workers);
- oxygen inhalation.

**Low pressure.** Under low pressure, vital processes are oxygen-starved. Brief exposure to high altitude of people, acclimatization attributable to oxygen starvation with cardiovascular, respiratory and other systemic effects. Low atmospheric pressure results in the degermetization of air crafts (explosive decompression). In this case all gases content in the internal cavities (lung, gastrointestinal tract, medium ear, paranasal sinuses) dilate. It can cause the body rupture, shock, aeroembolism.

In clinic they use classification of altitude disease into two forms: toxic (weakness, cold sweat, nausea, vomiting, anuria) and asphyctic (short wind, cyanosis, mental disorders). Zone of adaptation for work in highlands rich to 4,000–5,000 m. At 5,000–6,000 m the altitude disease results, climbing to the altitude more than 8,000 m without special equipment is dangerous for life.

**Prevention:**

1. *Individual protection:* using special equipment (climbing above 4,500 m with oxygen apparatus, flights at the altitude of 12,000 m and more carried out in special suits only).

2. *Medical benefits:*

- dispensarization;
- training for adaptation to oxygen starvation
- personal hygiene;

Table 45. **Duration of Shifts in Caissons**

Pressure, atm	Duration of work, h	Locking, min	Relocking	All time, h	Daily number of duties
0.1–1.3	5.28	12	20 min	6	8
1.31–1.7	5.06	14	40 min	6	8
1.71–2.5	4.14	18	1 h 28 min	6	8
2.51–2.9	3.48	20	1 h 52 min	6	8
2.91–3.2	2.48	20	2 h 12 min	5.2	9
3.21–3.5	2.26	22	2 h 32 min	5.2	9
3.51–3.9	1.03	12	1 h 25 min	2.4	9

- healthy life style, health promotion;
- high-grade nutrition.

### Vibration

Vibration is the oscillation of elastic bodies. They classify vibration into general and local. General (whole body) vibration is conducted through base surfaces on human body, spreads through tissues and bodies and makes movement of the body in a space with vibrating object. It can be transport, transport-technological and technological vibration. By frequency composition general vibration is subdivided into the following classes: low-frequency (1–4 Hz), average frequency (8–16 Hz) and high-frequency (32–64 Hz).

Local (hand-arm) vibration is conducted through worker's hands. It can be subdivided as: low-frequency (8–16 Hz), average frequency (32–64 Hz) and high-frequency (125–1,000 Hz).

All kinds of vibration are subdivided into permanent vibration (vibration velocity is constant, it doesn't change significantly (less than 6 dB per 1 min) and non-permanent (changeable and periodical (regular and irregular).

*Hand-arm vibration* affects operators of chain saws, chipping tools, jackhammers, jack leg drills, grinders and many other workers who operate hand-

held vibrating tools.

*Whole body vibration* energy enters the body through a seat or the floor, it affects the entire body or a number of organs in the body. Exposed groups include operators of trucks, buses, tractors and those who work on vibrating floors. Table 1 lists examples of vibration exposure in various industries (Table 46).

Both general and local vibrations cause vibration disease. It results usually among highly skilled specialists with high experience (and prolonged exposure to the factor). In clinics they classify vibration disease into 2 nosological forms: vibration disease caused by local and general vibration. The most dangerous one for health is local vibration with frequency of 16–250 Hz. Pathogenesis of the disease results reflector action of the vibration on the tissue receptors, changes in functions of the CNS, suprasegmental part of the vegetative nervous system. Low-frequency vibration cause infringement of muscular and bones tissues, peripheral nerves, vestibule-somatic reactions (nistagmus, dysmetria, etc). High frequency vibration changes vegetative regulation of the vessels.

#### Prevention:

1. *Hygienic standardization*: With exposure during 480 minutes daily — 109 dB (vibration velocity).

Table 46. Examples of Occupational Vibration Exposure

Industry	Type of Vibration	Common Source of Vibration
Agriculture	Whole body	Tractors
Boiler making	Hand-arm	Pneumatic tools
Construction	Whole body	Heavy equipment vehicles
	Hand-arm	Pneumatic tools, Jackhammers
Diamond cutting	Hand-arm	Vibrating hand tools
Forestry	Whole body	Tractor
	Hand-arm	Chain saws
Foundries	Hand-arm	Vibrating cleavers
Furniture manufacture	Hand-arm	Pneumatic chisels
Iron and steel	Hand-arm	Vibrating hand tools
Lumber	Hand-arm	Chain saws
Machine tools	Hand-arm	Vibrating hand tools
Mining	Whole body	Vehicle operation
	Hand-arm	Rock drills
Rivetting	Hand-arm	Hand tools
Rubber	Hand-arm	Pneumatic stripping tools
Sheet Metal	Hand-arm	Stamping equipment
Shipyards	Hand-arm	Pneumatic hand tools
Shoe-making	Hand-arm	Pounding machine
Stone dressing	Hand-arm	Pneumatic hand tools
Textile	Hand-arm	Sewing machines, looms
Transportation	Whole body	Vehicles

2. *Sanitary-technical measures*: Weight of manual tools should be less than 10 kg, equipment repairing in right terms, using of amortization.

3. *Plan and policy*:

- it's forbidden work withing vibration for men under 18 and women;
- rational regimen of work;
- complex teams;
- staff training;
- prevention of overcooling.

4. *Individual protection*: Vibration proof gloves (with elastic inner layer on the palmar surface), knee-guards, special belts, breastplate, shoes with vibration proof sole or insole.

5. *Medical benefits*:

- dispensarization (medical examinations are carried out annually with participation of health providers like neurologist, physician. ENT, by the indications — other specialists. They use functional tests;
- sanitary education;
- healthy diet enriched with vitamins (especially B1, C and PP);
- physical exercises and massage;
- water procedures: warm hand-baths, shower;
- UV radiation.

### Occupational Noise

Noise — a complex of sounds with various intensity and frequency — has irregular character and causes unpleasant feeling.

Sound waves are enable for diffraction and interferention. In closed premises sound can reverberate. In various workshops the noise level can be variable (Table 47).

The noise is divided into some groups:

1) by the spectrum:

- wide-frame (the spectrum is more than an octave);
- tonal (having discrete tones);

2) by the time characteristics:

- constant (level overfalls in 8-hour duty up to 5 dBA);
- non-constant (level overfalls in 8-hour duty more than 5 dBA):

Table 47. Level of Occupational Noise at Some Industrial Processes

Workshop	Noise level, dB
Cold punching	101–105
Nail manufacturing	104–110
Polishing of welded joints	115–117
Capstan lathe	84–88
Milling shop	93–95
Forger shop	110–115
Pneumatic chipper	114–127
Pneumatic pick (mine)	92–109
Textile loom	94–104

a) discrete (has stable intervals with constant noise level);

b) impulse (consist of some sound signals);

3) by the frequency:

- low frequency: up to 350 Hz;
- average-frequency: up to 800 Hz;
- high frequency: more than 1,000 Hz.

Very loud noise (above 115–120 dB) can damage the cochlea and permanent impair hearing. The damage to the cochlea depends on the duration and intensity of noise: it may lead to generalizing hearing loss or impaired hearing over specific sound references. Noise-induced hearing loss typically begins with loss at the 4,000 Hz frequency. In an occupational setting loud noise is also a hazard because it limits ability to hear warning signals.

Poise is a power stress-factor. Noise disease is a result of prolonged action of the noise and contain two main syndromes: cochlear neuritis and vegetative disorders including hypertonia.

### Prevention:

1. *Hygienic standardization*: In the most countries National Health Ministry use a standard of 85 to 90 dB. It's accepted as the upper limit of occupational exposure, above which ear protectors (antiphons) are required. For example, Occupational Safety and Health Administration (OSHA) standard is 90 dB over an 8-hour time-weight average. In the Ukraine, the maximal admissible level of the noise is 80 dB.

2. *Individual protection*:

- using of antiphons;
- antiphons are subdivided into external (helmet, ear-flaps) and internal (tampons, bush);
- complex team;
- rational regimen of work and rest;
- for working with impulse noise to use “background” sound and light warning signals.

3. *Medical benefits*:

- dispensarization, medical examination includes audiometry;
- sanitary education.

**Ultrasound** is mechanical oscillations of elastic medium with frequency more than 20,000 Hz. A man can't hear it. Ultrasound is used in chemical synthesis for purification and emulgation, for dispersing of solid matter, for welding, in ultrasonic medical imaging, treatment, so on. The biological action of ultrasound depends on its intensity. Ultrasound with low intensity (up to 1.5 W/cm<sup>2</sup>) acts as a physical catalytor. Ultrasound with average intensity (1.5–3 W/cm<sup>2</sup>) leads to the nervous system inhibition. Higher intensity is dangerous because can destroy the tissues.

In decursus morbi the vegetable signs are prevalent. Absorption of ultrasound is not the same for various tissues, it rises with ultrasound frequency rising.

**Prevention:**

1. *Standardization:* Ukrainian standards limit the ultrasound pressure level at the work place by their frequency (Table 48).

For constant ultrasound MAL is 110 dB.

2. *Sanitary-technical measures:* They use shielding of ultrasound equipment, distant operating, etc.

3. *Policy and Plan:* Labor regimen.

4. *Individual protection:* antiphones and protective gloves.

5. *Medical benefits:*

— dispensarization;

— diet enriched with vitamins.

**Infrasound** is the acoustical oscillations with frequency up to 16 Hz. Infrasound has very high threshold of hearing reception so usually we can't hear it. The sources of infrasound can be either natural (wind, storm, sea waves, tectonic processes) or manmade origin.

Infrasound is usually a part of any noise spectrum. It influences the hearing, vestibular and skin reception. Vegetative disorders come from this action. Infrasound level more than 180 dB is lethal for a man.

**Prevention:**

1. *Standardization:* MAL for non-constant infrasound is 110 dB and for different zones of constant infrasound — 102–105 dB.

2. *Policy and plan:* Labor regimen.

3. *Sanitary-technical:*

— isolating;

— shielding.

4. *Medical benefits:*

— dispensarization;

— diet enriched with vitamins.

**Industrial Dust**

Dust is the gas-dispersed system with solid phase. It consists of little particles.

According to the origin it can be subdivided into:

1) aerosols of condensation: condensed steams of metals, etc.;

2) aerosols of disintegration: organic, mineral (non-organic), mixed dust.

By the particle size the dust is classified according to the scheme:

1) high dispersed;

2) average dispersed;

3) low dispersed.

The most dangerous are particles with size of 1–2 μ.

Physical factors of the dust are:

1. Dispersity.

2. Form and consistension.

3. Solubility.

4. Electrical charge.

5. Radioactivity.

The highest concentration of the dust characterizes mining, grinding, work with friable goods (sand, cement). The dust can influence as follows:

1. Direct influence:

— irritative: mechanical irritation of mucous leading to inflammative processes;

— toxic: toxic dust results chronic and acute poisoning;

— mutagenic;

— teratogenic;

— cancerogenic;

— specific (fibrogenic) — it's typical for silica dust;

— photodinamical: dust can sensibilize skin cells to solar UV radiation exposure and lead to photo-dermatites;

— biological — aerogenic transport of disease agents (TB, anthrax);

— allergic;

— radioactive.

2. Indirect influence:

— decreasing of the negative-charged ions in the air;

— forming of fogs in humid air;

— lead to overheating microclimate.

You should understand that different kinds of the industrial dust cause different diseases. For example, high dispersed dust is captured in the proximal part of the upper respiratory tracts (nasal cavity and nasopharynx). It occurs because anatomical structure and functional properties of the upper respiratory tract provide for gravitation and inertion sedimentation of dust particles. In generally, about 30–50% of all dust particles are captured in the nasal cavity and nasopharynx, 40–60% — by trachea and bronchi mucoses and only about 10% of particles can penetrate with the air into terminal bronchioli and alveoli.

The human's organism has a very effective mechanism of dust particles elimination. It's phagocytosis and excretion with sputa. Mucociliar transport helps excretion also. Some particles can pass to the pulmonary lymphatic system and interstitial tissue and cause pathological processes. The acute and chronic inflammation of the mucoses can be caused by long action of the dust. In this case the protective abilities of respiratory tract are decreasing, dust loading on the lungs is increasing.

There are some diseases caused by the industrial dust:

Table 48. MAL of Ultrasound Pressure

Average frequency, kHz	Level of ultrasound pressure
12.5	80
16	90
20	100
25	105
31.5–100	110

- dust conjunctivitis;
- professional bronchitis;
- pneumoconiosis;
- chronic industrial poisoning;
- professional bronchial asthma.

Dust conjunctivitis is observed in the workers who don't use individual protection in dust polluted air.

Occupational bronchitis is a polyetiological disease. It's provoked by not only dust pollution factor but also by overcooling or overheating occupational microclimate, tobacco smoking, air pollution with chemical agents, germ pollution. Clinical and morphological signs of bronchitis depend on physical-chemical peculiarities of the dust particles and attended occupational factors. For example, action of quartz-containing dust leads to atrophic sclerotic bronchitis. Organic dust (for example: cotton, wool, linen) leads to catarrh inflammation of trachea and bronchi.

At present there is used the classification of pneumoconiosis — a group of diseases caused by prolonged exposure (10–20 years) to dust polluted air at the work place. Pneumoconioses are subdivided into some groups:

- silicosis (caused by dust containing SiO<sub>2</sub>);
- silicatosis (caused by dust containing other silicon compounds);
- carboconiosis (caused by coal dust);
- metalloconiosis (caused by metallic dust);
- pneumoconiosis (caused by organic dust);
- pneumoconiosis (caused by mixed dust).

*Silicosis* is characterized by a nodular form of pneumosclerosis, restrictive respiratory insufficiency, tendency to progress and be complicated with tuberculosis (coniotuberculosis). Silicosis (derived from “silicium” — silicon) is the most common and severe pneumoconiosis. The term “silicosis” was proposed by Wiscount in 1870.

Silica or silicon dioxide constitutes much of the Earth's crust. Natural forces and manmade processes such as mining convert silica particles to a fine dust that, when inhaled, produces progressive pulmonary fibrosis and respiratory failure. It has been a common industrial disease since explosives have been used in underground mining. It's a serious risk for other occupationally exposed to the silica dust, e.g. sandblasters, knife grinders etc. Exposure also occurs in the manufacture of abrasive soaps and in many other occupations (ceramists, foundry workers, stone mason, etc). Concrete and masonry products contain silica sand and rock containing silica. Even materials containing small amounts of crystalline silica may be hazardous if they are used in ways that produce high dust concentrations. They are:

1. Chipping, hammering, and drilling of rock.
2. Crushing, loading, hauling, and dumping of rock.

3. Abrasive blasting using silica sand as the abrasive.

4. Abrasive blasting of concrete (regardless of abrasive used).

5. Sawing, hammering, drilling, grinding, and chipping of concrete or masonry.

6. Demolition of concrete and masonry structures.

7. Dry sweeping or pressurized air blowing of concrete, rock, or sand dust.

Silicosis, caused by inhaling silica dust, affects mainly the upper parts of the lungs.

*Silicatosis* (asbestosis, talcosis, nephelinos, olivinos, etc.) is usually characterized with diffuse or mixed pneumosclerosis; a pathological process progresses slowly (exclude asbestosis), TB is a rare complication.

Asbestos is a fibrous material, formerly widely used as insulation and for many other purposes because of its fire-resistant and seeming inert nature. The fibers of asbestos consist of microscopic fibrils, which under the electron microscope are seen to consist of very small fibers in the Angstrom units range. These ultramicroscopic fibers make damage, probably at the intracellular level. The exact pathogenesis is not known. Asbestos produces three distinct pathological conditions: asbestosis, cancer (especially of the lung but also the larynx and gastrointestinal tract) and mesothelioma.

Asbestosis is a chronic progressive pulmonary fibrosis that causes impaired respiratory function, cor pulmonale and death from respiratory are right-sided heart failure or from secondary bronchopneumonia. It's caused by heavy exposure to asbestos dust and has a short latent period, often less than 10 years.

Lung cancer occurs often among asbestos workers since working conditions have improved enough to lead to reduce incidence of asbestosis. Histologically it resembles tobacco-related lung cancer but is more often seen in the periphery of the lung that is close to hilus and in the lower lobes. This fact made some employers to establish a policy of hiring non-smokers only. The latency period for asbestos-related lung cancer is usually in the range of 20 to 35 years but can be as short as 10 years.

Mesothelioma is a malignant tumor of pleural or peritoneal membrane. It's unique associated with exposure to asbestos.

Carboconiosis (anthracosis and graphit-coniosis) is a disease with a benign course. Metalloconiosis (siderosis, aluminosis, berilliosis, etc.) has no grave consequences also.

For exposure to organic dust allergic, bronchospastic and inflammatory signs are very typical. This group of diseases includes bissinosis (exposure to cotton dust), bagassosis (exposure to sugar cane dust), lung of miller (exposure to flour and grain dust), amylosis (exposure to starch), etc. Patients

suffering from organic dust disease generally manifest one out of two acute syndromes: a diffuse pneumonia accompanied by shortness of breath and fever (so-called hypersensitivity pneumonia) or an acute asthma bronchitis problem. With chronic exposure the patient may end up with chronic obstructive or restrictive lung disease. When patients present with an asthmatic bronchitis picture, the chest X-ray is usually clear and the patient complaints are coughing, wheezing, and shortness of breath. This is also known as occupational asthma. Classically, the symptoms are worse on returning to work after a weekend off and abate after stopping work at the end of the week. One of the best studied of such diseases is found in cotton workers; it is called byssinosis or brown lung. The second major manifestation of organic dust exposure is called hypersensitivity pneumonia (HP). In HP the patients are clinically sick with pneumonia and the X-ray shows an infiltrate. In contrast to infectious pneumonia, HP is not an infection and is not treated with antibiotics. HP is caused by an allergic reaction to the inhaled dust. One of the best studied examples of HP is farmer's lung. Farmers who work around moldy hay may inhale the fungal spores that make the hay moldy. They may become sick within a few h of inhaling the fungal dust and develop fever, cough, and shortness of breath. The chest X-ray shows a stringy infiltrate (Table 49).

**Prevention:**

*Hygienic standardization:*

There is used for non-toxic dust one-time MAC = 10 mg/m<sup>3</sup>. For silica-content dust these standards are presented in Table 50.

If concentration in the working zone is over the norm, the workers should use protective equipment (masks).

*Sanitary-technological measures:* Automatization, hydrotechnology of mining, pneumatic transportation, distant operating, etc.

*Architectural-planning measures:* Isolation of dust productive processes. They place all devices close to external walls.

*Sanitary-technical measures:* Ventilation (general and local); moisturizing of dusting materials; using detergents, vacuum and wet cleaning.

*Policy and plan:* Complex team; labor and rest mode.

*Individual protection:* Protective clothing and respiratory protection.

*Medical-biological benefits:*

1) Dispensarization. The contraindications to the work in the industrial dust pollution are TB, respiratory disease, cardio-vascular disease, etc.

- 2) Preventive UV radiation.
- 3) Alkalic inhalations.
- 4) Diet enriched with protein and vitamins.
- 5) Health promotion.
- 6) Therapeutical recreation, etc.

**Table 49. Occupational Lung Disorders Caused by Exposure to Organic Dust**

Disease	Inhaled Material
Bagassosis	Moldy bagasse (sugar cane)
Bird fancier's, breeder's, or handler's lung	Avian droppings or feathers (including parakeets, chickens, turkeys, and pigeons)
Byssinosis	Cotton dust
Cheese washer's lung	Moldy cheese
Coffee worker's lung	Coffee beans
Farmer's lung	Moldy hay, grain, silage
Fish meal worker's lung	Fish meal
Furrier's lung	Animal pelts and hair
Humidifier or airconditioner lung	Contaminated water in humidification and air-conditioning systems
Malt worker's lung	Moldy barley
Maple bark disease	Maple bark
Maple bark stripper's disease	Maple tree logs or bark
Mummy disease	Cloth wrappings or mummies
Mushroom worker's lung	Mushroom compost
Paper mill worker's and pulpwood handler's disease	Moldy wood pulp
Paprika slicer's disease	Moldy paprika pods
Sauna taker's disease	Contaminated sauna bath water
Sequoiosis	Redwood sawdust
Suberosis	Moldy cork dust
Wheat thresher's lung	Wheat flour containing weevils
Woodworker's lung	Oak, cedar, and mahogany

**Table 50. MAC for Silica-Content Dust**

Content of silicon dioxide	MAC, mg/m <sup>3</sup>
< 10%	4
10–70%	2
> 70%	1

**BIOLOGICAL HAZARDS**

Biological hazards include bacteria, viruses, fungi, and other living organisms that can cause acute and chronic infections by entering the body either directly or through breaks in the skin. Occupations that deal with plants or animals or their products or with food and food processing may expose workers to biological hazards. Laboratory and medical personnel also can be exposed to biological hazards.

Any occupations that result in contact with bodily fluids pose a risk to workers from biological hazards.

In occupations where animals are involved, biological hazards are dealt with by preventing and controlling diseases in the animal population as well as proper care and handling of infected animals. Also, effective personal hygiene, particularly proper attention to minor cuts and scratches, especially those on the hands and forearms, helps keep worker risks to a minimum.

In occupations where there is potential exposure to biological hazards, workers should practice proper personal hygiene, particularly hand washing. Hospitals should provide proper ventilation, proper personal protective equipment such as gloves and respirators, adequate infectious waste disposal systems, and appropriate controls including isolation in instances of particularly contagious diseases such as tuberculosis.

## PHYSIOLOGY OF WORK

Physiology of work is a component of hygiene of work and a section of general physiology, which is devoted to study of changes of a functional condition of the human organism under influence of labour activity and industrial environment, development of physiological bases of scientific organisation of labour process with the purpose of long-term support on a high level of work capacity of the man and his health.

The researches in the field of physiology of work will be carried out basically in two directions: (1) study of general physiological laws describing an active condition of the organism; (2) development of the scientifically proved rational ways of organisation of concrete kinds of labour activity assisting improvement of a physiological condition of the workers.

The work physiology study object is the following: the forms of organisation of labour process, equipment of a workplace, physiological changes in the organism of the worker, his health.

The basic purpose of physiology of work — scientific substantiation of the recommendations for optimization of labour process in system of scientific organisation of labour activity.

The general objectives of work physiology consist in study of the forms of revealing working activity, condition arising in the human organism, physiological laws and mechanisms describing change in the organism in an operating time. Together with general objectives there are allocated tasks caused by the basic directions of economic and social changes, describing a stage of the state development. So, for example, the service of the new

equipment on modern manufactures requires not only high qualification of the personnel, but also observance of the appropriate hygienic and physiological requirements to conditions of work. Objectives of labor physiology are following:

1. Physiological estimation of new kinds of new technologies, modern equipment used in industry and agriculture.

2. Study of physiological-hygienic features of labour activity of the workers of new trades.

3. Establishment of physiological laws of occurrence and mechanisms of formation of such negative condition, as weariness, monotony, hypodynamia, nervous-emotional pressure, overfatigue.

4. Study of character and mechanism of action of such factors, as ultra-, infrasound, ionizing and laser radiation, electromagnetic field and so on.

5. Study of features of physiological functions in labour activity of different groups of the workers: women, teenagers, seniors.

6. Scientific substantiation of methods of industrial training, professional choice and professional orientation

7. Development of the modern scientifically proved recommendations of construction of optimum modes of work and rest, equipment of workplaces, organisation of technologies, preventive maintenance of undesirable influences of stress, hypodynamia, monotonia.

8. Improvement of a methodical level of conducted researches on modernization of the equipment, expansion of methods of researches, application of program ways of the tax and analysis of the received data.

The methods of research in physiology of work in each separate case are determined by the character of its tasks. One of the main tasks of physiology of work is the study of physiological processes in the worker's organism, the important place has physiological and biochemical methods of research of CNS functions, analyzers, CVS, the respiratory and muscular systems, the system of blood.

*Heavy work* needs great muscular efforts. 17–25 MJ (4,000–6,000 kcal) and more per day. Usually this job is socially inefficient, has low productivity, needs long rest — up to 50% of working h.

*Conveyor* is the form of work which is determined by splitting the process into operation given rhythm, strict sequence of performance of operations, automatic submission of details to each workplace with the help of a driven tape of the conveyor. The conveyor requires the synchronized work of its participants according to the given rate and rhythm. Thus the less interval of time spent by the worker on operation, the more monotonously the work, the more simplified its contents. Monotony is one of conducting negative features of conveyor work resulting in premature weariness and fast nervous exhaustion. In a basis of this specific phenomenon the preva-



lence of process of breaking in cortical activity developing under the influence of monotonous repeated irritants. Hence it is reduced irritability of analyzers, the attention dissipates, the speed of reactions is reduced and quickly there comes exhaustion.

*Mechanized Forms of Work.* At these forms of work the power expenses of the workers are within the limits of 12.5–17 MJ (3,000–4,000 kcal) per day.

Professions of *the mechanized work* quite often require special knowledge and impellent skills

*Partially Automated Work.* Characteristic features of this kind of works — monotony raised rate and rhythm of work, loss of a creative beginning.

*Control on the Production and Mechanisms.* At these forms of work the man is included in a control system as a necessary operative part.

*Intellectual Work.* This work is submitted as trades concerning sphere of material manufacture (the designers, engineers, engineering, dispatchers, operators, etc.), and outside (doctors, teacher, writers, actors, artists, etc.). The intellectual work is characterized, as a rule, by necessity of processing of large volume of the diverse information with mobilization of memory, attention, frequency of stressful situations. At the same time muscular efforts are insignificant, the daily allowance energy lost makes 10–11.7 MJ (2,000–2,400 kcal per day).

*Static Work.* Static work is a process of reduction of muscles necessary for keeping body or its parts in space.

*Dynamic Work.* Dynamic work is a process of muscles contraction resulting in moving of a human's body or its parts in space. The dynamic work is subdivided into general, regional and local. General muscular dynamic work is carried out more than two thirds of weight skeletal muscles including legs and trunk. Regional muscular work is carried out mainly with shoulder girdle or pelvic girdle (from one up to two thirds of weight of skeletal muscles. Local muscular work is carried out with participation less than one third of skeletal muscles.

*Heaviness* of the labour is the characteristic of energy loss in the work process.

*Intensity* of the labour is the psychophysiological characteristic of the work process (Table 51).

### **Ergonomic Hazards**

The science of ergonomics studies and evaluates a full range of tasks including, but not limited to, lifting, holding, pushing, walking, and reaching. Many ergonomic problems result from technological changes such as increased assembly line speeds, adding specialized tasks, and increased repetition; some problems arise from poorly designed job tasks. Any of those conditions can cause ergonomic hazards such as excessive vibration and noise, eye strain, repetitive motion, and heavy lifting problems. Improperly designed tools or work areas also can

be ergonomic hazards. Repetitive motions or repeated shocks over prolonged periods of time as in jobs involving sorting, assembling, and data entry can often cause irritation and inflammation of the tendon sheath of the hands and arms, a condition known as carpal tunnel syndrome.

Ergonomic hazards are avoided primarily by the effective design of a job or jobsite and better designed tools or equipment that meet workers' needs in terms of physical environment and job tasks. Through thorough worksite analyses, employers can set up procedures to correct or control ergonomic hazards by using the appropriate engineering controls (e.g. designing or redesigning work stations, lighting, tools, and equipment); teaching correct work practices (e.g. proper lifting methods); employing proper administrative controls (e.g. shifting workers among several different tasks, reducing production demand, and increasing rest breaks); and, if necessary, providing and mandating personal protective equipment. Evaluating working conditions from an ergonomics standpoint involves looking at the total physiological and psychological demands of the job on the worker.

Overall, industrial hygienists point out that the benefits of a well-designed, ergonomic work environment can include increased efficiency, fewer accidents, lower operating costs, and more effective use of personnel.

**Occupational Stress.** Anyone can suffer from burnout—feeling seriously stressed and unable to cope. But burnout can be avoided when you learn about its causes and symptoms, how to recognize the problem, and ways that you can change your environment to reduce stressful situations. Burnout is most likely in people who feel overworked and unappreciated. They become disappointed, and sometimes cynical. They may also feel guilty and ashamed. The symptoms of burnout can include exhaustion, both mental and physical; hopelessness and helplessness; low spirit and self-esteem; frequent illness. Burnout happens often in helping professions such as nursing, but anyone doing very pressured, (or even very boring) work can suffer burnout.

58% of cases of occupational stress involving spare time were in the service industries. For comparison, 23% of all nonfatal occupational injuries and illnesses occurred in service sphere in 1997. Manufacturing accounted for 21% of occupational stress cases and retail trade for 14%. These proportions were lower for these industries than the comparable proportions for all injuries and illnesses.

Like the service industry, finance, insurance, and real estate had a higher proportion of occupational stress cases than of all nonfatal injury and illness cases. 20% of cases of occupational stress were in finance, insurance, and real estate, while only 2% of all injuries and illnesses were recorded in the industry.

Table 51. **Criteria of Classification of the Work by Level of Heaviness and Intensity**

Criteria	Categories of the labour			
	I. Light, low intensive	II. Middle, intensive	III. Hard, intensive	IV. Very hard, very intensive
<b>Physical work</b>				
<i>Dynamic loading</i>				
Power of the work with general loading (of shoulder and pelvic girdle muscles, trunk muscles)	< 20 W	< 45 W	< 90 W	> 90 W
Regional loading (shoulder girdle)	< 10 W	< 22 W	< 45 W	>45 W
Local loading (hands and forearms)	< 2 W	< 4,5 W	< 9 W	> 9 W
Maximal weight	< 5 kg	6–15 kg	16–40 kg	> 40 kg
Walking:				
By the horizontal	< 15 steps/min	< 30 steps/min	< 40 steps/min	> 40 steps/min
By the stairs	< 5 steps/min	< 15 steps/min	< 30 steps/min	> 30 steps/min
Inclinations of the trunk >30°	< 0.5/min	< 1.0/min	< 2.0/min	> 2.0/min
<i>Static loading</i>				
–holding by a hand	< 18,000 kg/s	< 43,200 kg/s	< 97,200 kg/s	> 97,200 kg/s
–holding by hands	< 43,200 kg/s	< 97,200 kg/s	< 208,400 kg/s	> 208,800 kg/s
–holding with participation of trunk and legs muscles	< 61,200 kg/s	< 129,600 kg/s	< 266,400 kg/s	>2 66,400 kg/s
Compelled pose	free pose	10–25% of work time	< 50% of work time	> 50% of work time
<i>Mental loading:</i>				
Intensity of the attention*				
Number of the supervision objects	< 5	< 10	< 25	> 25
Duration of the supervision	< 25% of work time	< 50% of work time	< 75% of work time	> 75% of work time
Density of the signals	< 15/hours	< 35/hours	< 60/hours	> 60/hours
Emotional pressure	no	work by strict time-list	deficit of the time, high responsibility	personnel risk, responsibility for safety of other persons
Time of work	morning 7–8 h	afternoon 7–8 h	night	irregular with work in the night
Intensity of visual work:				
Category of the visual work	inexact	low exact, middle exact	high exact	very high exact and extraexact
Volume of the operative memory	–	< 2 elements	< 5 elements	> 5 elements
Intellectual loading	no	work by exact instruction	deciding complicate tasks by known algorithm	evristic activity
Monotony:				
– quantity elements of operation	> 10	6–10	3–5	1–2
– number of repeating (per h)	< 40	< 90	< 180	> 180
– time of the passive supervision	80% of work time	90% of work time	95% of work time	98% of work time

\* — for women and boys-teenagers — by 40% less, for girls-teenagers — by 60% less.

## OCCUPATIONAL HEALTH OF WOMEN AND ADOLESCENTS

Women have been joining the labour force in increasing numbers, in sectors that include agriculture, industry and services, making up about 42% of the estimated global working population. Although they contribute appreciably to national economies, their special needs are seldom adequately met, even when they have access to some occupational health service.

When exposed to occupational hazards, women of fertile age are susceptible to specific adverse effects on reproduction, including abortions (embryotoxic agents) or malformations of the foetus (teratogenic agents).

Female workers often suffer from musculoskeletal disorders because neither the tasks nor the equipment they use, which is normally designed for men, are adapted to their structure and physiology.

In addition, female workers have specific stress-related disorders, resulting from job discrimination (such as lower salaries and less decision-making), a double burden of work (workplace and home) and sexual harassment.

*Child Labour:* According to the ILO, of the 250 million children between the ages of 5 and 14 working in developing countries today, nearly 70% work under hazardous conditions. Asia has the most child workers with 61% of the global total, Africa has 32%, and Latin America — 7%. Africa, however, leads in the proportion of working children, with about 41% of all children aged between 5 and 14; the proportion in Asia is 22%, and in Latin America — 17%.

Women, migrants, minorities and children are particularly vulnerable to occupational hazards. This is especially true in the informal sector, where workers are not necessarily protected and are often subjected to highly unsafe conditions in makeshift factories. Entire families may be exposed to hazards associated with industrial processes in the home, or entire communities may be affected by uncontrolled hazardous emissions from factories located adjacent to their homes.

## INTERNATIONAL PROGRAMME IN OCCUPATIONAL HEALTH

**WHO's Response.** Since its inception in 1948, WHO has recognized the utmost importance of improving the health status of working populations and has been developing international collaboration in this area. Today, WHO Collaborating Centres carry out research, analyse data, identify trends, prepare and disseminate reports and make recommendations for national public health services and decision-making.

However, developing countries are yet to be fully involved in this work.

In order to arrive at more accurate estimates of the global burden of occupational disease and injuries, there is a need for further improvements and standardization of occupational health reporting in all countries, most particularly in developing countries. Another area, which needs particular attention, is the development of methods to estimate the economic impact of occupational injuries and diseases, as well as the cost-effectiveness of early occupational health interventions.

At present, the emphasis of WHO's Occupational Health Programme is on data collection and analysis, research, formulation of strategies and recommendations for hazard prevention and control, human resource development with special emphasis on developing countries, as well as rational development of the international network of collaborating centres.

WHO's Occupational Health Program also addresses groups of workers with special needs. These include women and workers in small enterprises or in the informal sector, who are usually not covered by legislation and do not have access to occupational health services.

Strengthening international partnerships in the field of occupational health is one more area of importance. WHO has paid special attention to cooperation and coordination of its work with the ILO, which works hand in hand with WHO to protect the labour force and to ensure safety and health at work. The Joint ILO/WHO Committee on Occupational Health meets periodically to review occupational health priorities and to make appropriate recommendations for international action.

WHO collaborates actively with the International Commission of Occupational Health (ICOH), the International Occupational Hygiene Association (IOHA), the International Ergonomic Association (IEA), the European Commission (EC) and other nongovernmental and intergovernmental organisations striving to protect the health of workers.

WHO has also launched the Prevention and Control Exchange (PACE) initiative, which aims at the development of national capabilities in the field of primary prevention of occupational hazards. This is achieved through the promotion of awareness and political will, transfer of appropriate technologies, development of human resources, promotion of applied research and information dissemination. On-going activities include the preparation of documents on the prevention and control of specific hazards, such as noise and dust. The publication on dust is also relevant to the Joint ILO/WHO International Programme on the Global Elimination of Silicosis.

Each year, WHO and its Collaborating Centres and NGOs plan joint activities to implement the Global Strategy on Occupational Health for All.

The 10 priority WHO objectives proposed by Global Strategy on Occupational Health for All are as follows:

1. Strengthening of international and national policies for health at work and developing the necessary policy tools.

2. Development of healthy work environment.

3. Development of healthy work practices and promotion of health at work.

4. Strengthening of occupational health services (OHS).

5. Establishment of support services for occupational health.

6. Development of occupational health standards based on scientific risk assessment.

7. Development of human resources for occupational health.

8. Establishment of registration and data systems, development of information services for experts, effective transmission of data and raising of public awareness through public information.

9. Strengthening of research.

10. Development of collaboration in occupational health and with other activities and services.

## Chapter 8

# HOSPITAL HYGIENE

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### BASIC CONCEPTS

Functioning of medical-preventive institutions represents a complex of technological, scientific-practical, economic and social-psychological problems, which decision impossible without the hygienic requirements and recommendations.

#### *Tasks of Hospital Hygiene:*

1. Preference to acceleration of recovery the patient, medical and psychological rehabilitation.
2. Achievement for psychological and somatic comfort for the patients during stay in hospital institutions.
3. Prevention of nosocomial infection.
4. Maintenance of epidemic and radiologic safety.
5. Maintenance of healthy occupational environment for the medical personnel.
6. A regulation of use of new disinfectants, detergents, polymeric materials, newest equipment and technologies in medical institutions.
7. Formation of bases of a healthy life style in the personnel and patients MPI.
8. Minimization of influence on an environment of constructing and operating medical institutions.

The main characteristic of all medical-preventive institutions is existing of hospital environment. Hospital environment is a set of all factors of physical, chemical, biological and information nature, which carries out influence on the organism of the patient during treatment. There are microclimate of hospital premises, various radiation and wave influences, medicines, antiseptics and polymer material, special hospital strains of bacteria. These factors define dynamics of medical rehabilitation and health of the patient and the staff.

### HYGIENIC REQUIREMENTS TO THE HOSPITAL AREA

Before to build any health facilities it's recommended to arrange their planning with the authorized general plans and projects on the basis of the

circuits of area development. When developing the general plans of medical-preventive institutions it is necessary to take into account local climatic conditions and to provide measures on protection of building and nearby area from the adverse external factors. A choice of the ground area for an arrangement of houses of hospitals, maternity houses and others in-patient institutions should be agreed with local authorities and institutions of environmental health service.

The medical institutions have to settle down in residential or suburb zones in conformity with the authorized plan and projects of detailed planning of the residential area in view of its functional application. General hospitals and maternity houses should be placed outside of the centre of cities and settlements, the hospitals of emergency care have to be under construction in view of the maximal approximation to groups of the population, which they are served. The specialized hospitals or complexes with capacity for over than by 1,000 beds for the patient stay during long time, and also special hospitals (psychiatric, tuberculosis and others) is necessary to place in a suburb zone, with 1,000 m sanitary space from residential territories. In a choice of a site for health facility it is necessary to remember an environmental sanitary situation and prevailing direction of winds (a "wind rose").

The ground in hospital area must be clean, dry, without sharp differences of a relief. The hospital area should be placed in aerodynamic shadow, so that the velocity of air movement doesn't exceed 5 m/s. They electrify the area, supply it with water-pipes and water drain, border on perimeter and protect by a strip of green plantings with width no less than 15 meters (2-3 lines of trees with low root and rich crone). It is forbidden to construct hospital institutions in places which were earlier used for landfills, field of assenization (irrigation, filtration), cemetery, etc., and also that have polluted soil.

Hospitals and maternity houses should be removed from the railways, airports, high-speed highways and other powerful sources of pollution (Table 52).

Table 52. Standards for Area of Health Facility in Ukraine

Health facilities	Units of operational structure		Land area, m <sup>2</sup> per unit	
			Children	Adults
Hospitals	beds	35	—	350
		50	—	300
		150	250	150
		300	125	200
		400	125	200
		500	135	100
		600	135	100
		800	—	80
Sanatoria	1 place	Up to 500	150	
		Up to 1,000	125	
		More than 1,000	120	
Out-patient institutions	Daily visits per 1,000 persons		0.5 ha per one object	
Dispensaries	Daily visits per 1,000 persons		0.4 ha per one object	
Ambulance stations	1 ambulance van per 1,000 persons		0.07 ha per 1 van	

At an arrangement medical and maternity institutions in residential zone it is necessary to place them not closer than 30 m from a red line of building and 30–50 m from apartment houses, depending on the number of floors in houses of medical-preventive institutions.

The hospital area should be gardened and comfortable. The area of green plantings and lawns has to make no less than 60% of the general area and area of a garden zone — 25 m<sup>3</sup> on a bed.

Bushes are necessary to place not closer than 5 m from a hospital house, trees — not closer than 10 m. Trees and the bushes with poisonous fruit, sharp hooks, allergic-dangerous (give a lot of pollen) plants are not used for gardening.

#### **Hygienic meaning of vegetations:**

##### *Positive:*

1. Protection against wind, dust and noise.
2. Optimization of microclimatic conditions: they give a shadow, normalize a humidity of the air and make an aerodynamic shadow.
3. Bactericidal influence of phytoncides on bacterial pollution of air.
4. Oxygenation of the air.
5. Fixing of dust by a grassy lawn.
6. Architectural-planning meaning.
7. Aesthetic and psychohygienic meaning.

##### *Negative:*

1. They can be a potential source of allergens.
2. Some plants are poisonous.
3. Danger of traumatization with sharp and rigid stalks of plants, with heavy fruit, etc.
4. Adsorption of dust particles by plants surface.

Hospital area located in territory of settlements should have a strip of green plantings with width no less than 15 m with two-line planting of high-root trees and a line of bushes. Behind perimeter of

a site of polyclinics, woman wealness centers and dispensary without IPD, and also ambulance stations they use a strip of green plantings.

The bushes should be in width no less than 5 m around radiologic and infectious departments, and also along the X-ray studies if they are on the ground floor.

### **THE SYSTEM OF HOSPITAL BUILDING**

Now they use three basic systems of building of medical institutions. They are distinguished by a various degree of centralization and isolation of functional departments.

The centralized system of building of hospitals is characterized by the maximal concentration of medical service. Usually the hospital house represents a multi-storeyed structure the separate departments and services situated at various levels in general architectural space. In Ukraine the hospital could not have more than 9 floors.

The basic advantages of the centralized system are following:

1. Economy. At the expense of the small area and absence of duplication of the basic building volumes, functional departments, and engineering networks, the charges on construction and technical equipment of hospital decrease.

2. The reduction of the vertical and horizontal ways of movement of the personnel and patients allows to raise efficiency of medical process.

3. The large concentration of scientific and technical resources allows to develop departments on the basis of this centralized type hospitals, which give the qualified and specialized medical care.

Sometimes this system has some drawbacks:

1. The raised risk of nosocomial infections. Difficulty of isolation of departments with a various structure, presence of ascending flows of bacterial aerosols, intensification of loading on hospital environment lead to increased risk of disease.

2. Deterioration of conditions of hospital environment. High concentration of technical equipment makes excessive noise level. The microclimate of the top floors could be overcooling because of power wind drafts.

3. The architectural flexibility of the centralized system is usually low.

The decentralized system is characterized by organisation of various functional departments in separate houses.

The essence of pavilion system is the arrangement of separate functional departments in 2–3 floor-houses. The basic advantages of this system are: good isolation of various departments, that allows to prevent occurrence of nosocomial infections, and good conditions for observance medical care regimen.

However, nowadays they were compelled to refuse decentralized system. It is connected with the large expenses on building works and technical equipment, reduction of a garden zone, increase of the length of movement for the personnel and patients. There are some technical decisions for reduction of the routes of the personnel, in particular underground type of communication, but it does not solve a problem.

Presently most perspective is the mixed system of construction. It unites features of centralized and decentralized system. It has the most flexible architectural planning.

### FUNCTIONAL ZONES AT THE HOSPITAL AREA

The territory of hospitals, maternity houses and other in-patient institutions should have convenient access roads with a firm covering. Internal roads and foot

paths should be covered by the concrete or asphalt.

The optimum capacity of multiprofile hospitals is accepted for 600–800 beds (allowable — 1,000 beds) (Table 53).

At the territory of hospitals there should be the following zones:

1. A zone of medical departments: for the infectious patients, non-infectious patient, for pediatric departments, for patrimonial houses and maternity departments, psychosomatic departments, dermatovenerological departments, radiologic departments
2. OPD and administrative zones.
3. A garden zone.
4. A zone of court yard.

Separate entrances to the various hospital zones should be provided. For emergencies they provide “Ambulance Road” — the entrance and exit for ambulance should create one-flow driving in and out of the hospital department area.

The pathologoanatomic departments with a funeral zone should be isolated from ward departments and they should not be looked through windows of the departments, from the hospital garden, and also through windows of inhabited and public houses.

The distance between houses with windows of chambers has to make up 2.5 of the opposite house height, but no less than 24 m.

Infectious, maternity, psychosomatic, dermatovenerologic and the children’s departments of hospitals should be placed in the separate houses. If hospital has the out-patient department, the last should situate close to periphery of a site.

Before front entrances to the hospitals, polyclinics, SES, dispensaries and the maternity houses there are provided grounds for the visitors at a rate of 0.2 m<sup>2</sup> per one bed or per one visit during a shift, but no less than 50 m<sup>2</sup>. Parking area for vehicle, employees and visitors should be placed not closer than 100 m from ward departments. The temporary parking of vehicle of individual usage should be placed at a distance not closer than 40 m from the entrance to the hospital.

Table 53. Zones of Sanitary Space Between Hospital Objects

Departments		Size
Radiological department	Other departments	More than 25 m
Vivarium	Hospital departments	More than 100 m
	Residential Houses	50 m
Furnace for waste incineration (< 100 kg) in economic yard	Hospital departments	
separate building (> 100 kg)	Residential Houses	More than 30 m
Central medical gases station		100 m
(more than 10 tanks, volume is no less than 50 m)	Hospital departments	25 m
Warehouse for X-ray films (< 1,000 kg)	Residential Houses	
Hospitals and maternity houses	Others	> 20 m
OPD and WWC	Residential buildings	> 30 m
	Residential buildings	> 15 m

At the territory of infectious hospital (department) a “clean” and “dirty” zone should be allocated isolated one from another by a strip of green plantings. At exit from a “dirty” zone there should be stipulated platforms for disinfection of transport.

Buildings of out-patient institution as a rule do not have more than 5 floors.

The departments of children’s hospitals for children till 3 years with the mothers should not be placed above the fifth floor, the chambers for infants and children’s psychiatric departments — are not higher than the second floor.

Cleaning of territory has to be carried out daily. For collecting of waste and household dust they establish containers with covers. These containers should be disinfected and washed properly. Distance between a ground for dust container and ward and medical-diagnostic departments should be no less than 25 m. They should dispose waste from containers every day. Specific (postoperation, pathologicoanatomic and other) medical waste should be incinerated in special furnaces.

## INTERNAL LAY-OUT OF HOSPITALS

Planning of medical and maternity hospitals have to provide optimum sanitary — hygienic and antiepidemic modes and conditions of patient stay, work and rest of the personnel.

Structure of institutions and planning of its premises have to exclude an opportunity of crossing or another contact of “clean” and “dirty” flows.

Hospitals — medical-preventive institutions are intended for granting stationary medical care to the population.

Maternity houses — specialized stationary institutions, which provide health care for pregnant women in childbirth, recently delivered women, newborns, to the gynecologic patients (at presence of gynecological department).

It’s offered to place in basement of medical-diagnostic departments warehouses, sanitary — household premises for the personnel (wardrobes, shower-room), sanitary care unit, buffets and restaurants

for the personnel, central laundry, premises for collecting and sorting of a dirty linen, premises for disinfecting of bad pans, oil-clothes and beds, premises of preservation, regeneration and heating of medical muds; storehouse of radioactive dross and linen polluted with radioactive substances.

It’s forbidden to place medical-diagnostic departments, workshops using hazardous materials and reception wards in basement of hospital.

X-ray rooms and laboratories of radiodiagnostics should not be adjacent on a horizontally or vertically with chambers for the pregnant women and children. It is forbidden to place X-ray studies under premises of shower, lavatories and other possible sources of water.

## SANITARY EQUIPMENT OF HOSPITAL FACILITIES

Premises of hospitals, maternity houses and others should be illuminated by day light. The illumination by the second light or only artificial illumination is used in premises of barns, toilets, bathrooms, enema rooms, rooms of personal hygiene, shower and wardrobe rooms for the personnel, thermostate, microbiological banks, preparation and operational, apparatus, narcosis, photolaboratories and some other premises which do not require natural illumination. Operation room projected with natural illumination, it is necessary to focus to the north (Table 54).

The corridors of ward sections (departments) should have natural illumination. Distance between light pockets should not exceed 24 m, and between the first light pocket and the window in the dead end of the corridor — 30 m.

For protection from blinding actions and overheating in summer time from direct solar rays in medical stationary located in 3 and 4 climatic areas aperture wrapped up on sector of horizon 70–240° of northern latitude they have to use solar protection equipment.

The artificial illumination should answer assignment of premises, be sufficient, regulated and safe, to prevent the dazzling and other adverse influence on the human organism and internal hospital environment.

Table 54. **Window Orienting in the Hospitals**

Premises	Geographic latitudes		
	< 45° N	45–55° N	> 55° N
Operation, IT wards, delivery room	N, NE, NW	N, NE, NW	N, NE, NW, E
Laboratories	N, NE, NW, SE, E	N, NE, NW, SE, E	N, NE, NW, S, SE, E
TB and Infection wards	S, SE, E, NE*, NW*	S, SE, E, NE*, NW*	S, SE, SW, NE*, NW*
Children departments	NE, W		

\* — no more than 10% of all beds.



The general artificial illumination should be stipulated in all the premises. For illumination of separate functional zones and workplaces, they use local illumination.

The artificial illumination of hospital premises is provided with luminescent and bulb lamps.

We use combined lighting (general and local illumination) in the hospital wards. In one-bed chambers the general illumination is provided. In chambers of children's and psychiatric departments, intensive therapy, the reanimation, in postoperation chambers they provide only ceiling fixtures of general illumination. For night shifts they use lamps in niches near doors.

The emergency illumination is provided at dressing, manipulation, procedural, ATS, assistant's, drugstores, reception wards, laboratories of the urgent analysis, X-ray-operation room, and on the nurse stations (Table 55).

All hospitals should be equipped by centralized water supply, sewage system, ventilation (if it's necessary — by systems of air conditioning), rubbish-collector with rubbish chamber, elevators as needed, electrical and telephone networks. If necessary they use centralized vacuum rubbish collectors and other equipment.

The quality of water has to allow State Standard "Drink water". The system of hot water supply is

Table 55. Artificial Lighting of Hospitals

Premises	E, lx	Max. coef. of pulsation, %	Max. admissible discomfort index
Operation room	400	10	25
Delivery room, IT wards	500	10	25
Pre-operation room	300	10	25
Examination rooms of specialists	500	10	25
Other examination rooms	300	10	25
Offices	300	10	40
Telemetry, endoscopy, physiotherapy departments	150	10	40
Spa therapy	150	20	60
HBO ward	150	20	60
X-ray room	50	—	40
Children's departments	150	10	25
Mental hospitals	100	10	25
Other wards	100	10	25
Laboratory	300	10	40

projected with circulation. Recommended volumes of water supply are presented in the Table 56.

For waste treatment from hospital catering service in hospitals they establish fat-catching device. The treatment of waste from hospitals including infectious is carried out by municipal sewer system. At absence of municipal sewage system they use system of local waste treatment.

For all health facilities should be provided reserve (emergency) hot water supply. They could use electrical boilers or second input of hot water supply. For heating it's used water heating system with maximal water temperature in heating devices 85°C. (Using water steam heating in the hospitals is prohibited).

The heating radiating concrete panels can be used in following premises: operation, preoperation, resuscitation wards, narcosis, delivery, premises of electrolight treatment, psychiatric departments of hospitals, therapy rooms, rooms for premature babies, injured children, little children and newborns infection wards, combustiological wards, complete and incomplete boxes, premises of blood bank, storerooms for sterile materials and medications, X-ray rooms, laboratories and experimental-biological clinics (vivaria).

The toilets for the patient should be equipped with cabins, hangers, drying devices for hands, mirrors. In lavatories of female ward sections there should be equipped cabins of women hygiene with ascending shower (bidet).

The quantity of sanitary devices (toilet pans) for the patient in ward departments of hospitals should be accepted at the rate of 1 device per 15 men and 10 women, but no less than 1 device. The quantity of pissuare in male lavatories has to equate to quantity of other sanitary devices. The sizes of lavatory cabins for the patients should be no less than 1.5 (1.1) m with obligatory opening of doors outside.

Table 56. Hygienic Requirements for Water Supply (daily needs)

Health facility	Cold water	Hot water
Out-patient department	15 l per 1 visit	
Hospitals:		
rural	150 l per bed	
city	250 l per bed	150 l per bed
Infection & TB hospitals	250 l per bed	250 l per bed
Spa therapy	500 l per bed OR	
bath	900 l per h	
subaquatic bath	700 per h	
shower	200 per h	
hydrotherapy unit	3000 per h	
hydro massage	500 per h	
vertical extension bath	800 per h	

In sanitary-household premises for the attendants it is necessary to accept:

1. Quantity of sanitary devices for the medical staff — no less than 2 devices for the women and 1 device for the men; but no less than 1 sanitary unit in each department.

2. Quantity of shower cabins — 1 shower cabin per 10 employees in infectious and phthysiatric departments, in other departments — 1 shower cabin per 15 employees in the largest shift. In case of less number of the personnel it is necessary to provide 1 shower cabin in a department.

Lavatory for the patient in ward departments should have special equipment (racks, folding), so that the seriously ill patients can use sanitary devices.

The houses of medical and maternity hospitals should be equipped with systems of balanced ventilation, except for infectious departments. In the last ones it should be established the exhausting ventilation. The exhausting ventilation from chambers has to be carried out through individual channels, which prevents air movement vertically.

The air moves off from operational, narcosis, resuscitation, delivery and X-ray rooms, as a rule, from two zones: 40% — from the upper zone (10 cm from the ceiling), 60% — from the bottom zone (60 cm from the floor) allocation of gases and steams, which can form explosive mixes, or heavy positively charged ions.

Ventilation systems in operation, narcosis, resuscitation, maternity and other wards with severe skin burns should be equipped with bacterial filters (Table 57).

### **Hygienic Requirments to the Various Hospital Facilities**

The reception ward of the hospital has following functional tasks:

- reception, registration and distribution of patients;
- preliminary diagnosis;
- the triage to in-patient or out-patient treatment;
- rendering of necessary medical care;
- conducting measures on prevention of infectious diseases;
- patients transferring to other health facilities;
- discharging of the patient and distribution of the information.

The number of patients entering the reception ward depend on the number of beds in the hospital and its specialization:

- 2% of beds number — in TB, mental and rehab hospitals;
- 15% — in emergency hospitals and maternity houses;
- 10% — in other hospitals.

The number of the patient steams should be accepted according to the ratio:

— 1 steam per 800 beds — TB and rehab hospitals;

— 1 steam per 600 beds — in mental hospitals;

— 1 steam per 150 beds — in emergency care facilities;

— 1 steam per 200 beds — other hospitals.

For each steam in hospitals (excepting infectious, children and obstetric hospitals) they provide one examination room/box and one sanitary inspection room. In infectious hospitals and infectious departments of general hospitals they provide reception wards with examination boxes, their quantity depends on quantity of beds in the department:

— up to 60 beds — 2 boxes;

— 60–100 — 3 boxes;

— more then 100 beds — by the formula  $X = 3 \cdot x$ , where  $x$  — one additional box for every 50 beds of the department.

The similar boxes are organized in children's hospitals.

In obstetric departments the reception premises (examination room, sanitary inspection room) should be provided as combined for physiological department and department of a pathology of pregnancy and separated for observation and gynecologic departments. The movement ways of patients of all departments, including stairs and elevators, should be isolated one from another.

If it's necessary they organize traumatological shifts, their offices should be placed on the ground floors of houses.

For reception of the infectious patient it's provided an isolating room which is connected with examination room of the ward.

**Ward Departments.** The ward department is the basic functional structural element of in-patient medical institutions. The basic types of ward departments are: noninfectious departments (for adults and children), infectious departments, and maternity department.

If children's departments has 60 or more beds they should be placed in separate buildings. Infectious and TB departments are placed only in separate buildings.

The ward department consists of ward sections and general premises located between the sections. The general premises include the medical and diagnostic offices, catering service premises, etc.

The ward section represents an isolated complex of rooms and medical-auxiliary premises providing care for patients with homogeneous diseases. The quantity of beds in a ward section, as a rule, is no less than 20 and no more than 30 (except for a psychiatric one).

The quantity of one-bed rooms in the obstetric, the pregnancy pathology as well as in haematologic, neurosurgical and urologic departments for chil-

Table 57. Hygienic Demands to Hospital Environment

Premises	Air, t°	Air exchange per hour (AEH)		AEH for natural air exchange	Germ pollution				Categori- a of pureness
		inlet	exhaustion		GMN		Str.		
					Before work	After work	Before work	After work	
Adult's and children's wards	20°C	80 m <sup>3</sup> /h per 1 bed 100%		2	3,500*			to 16*	P**
TB wards	20°C	80 m <sup>3</sup> /h per 1 bed 80% 100%		2	»			»	D***
Wards for hypo- thyroidic patients	24°C	80 m <sup>3</sup> /h per 1 bed 100%		2	»			»	P
Wards for hyper- thyroidic patients	15°C	»		2	»			»	P
1-2 beds room, intensive therapy rooms, combusti- ological rooms	22°C	> 10 eph 100%	80% — aseptic 100% — septic		»			»	VP****
Operating room	22°C	20% thro- ugh nei- ghbour premises inlet with steril air		»	500	1000	0	< 4	VP
Delivery room	22°C			»	750 (in delivery — 1,000)	2,000	0	< 24	VP
Premature chil- dren's wards	25°C	100% 100%	80% — aseptic 100% — septic	»	500	1,000	0	< 4	VP
Newborn's wards	25°C	»		»	»	3,000	0	44	VP
Boxes	22°C	2.5 (from cor- ridore) 100%	2.5	2.5		3,500 7,000		16 36	D
Infection wards	20°C	80 m <sup>3</sup> /h	80 m <sup>3</sup> /h			3,500 7,000		16 36	D
Wards for pati- ents with scar- let fever	20°C	»		—		3,500		75-100	D
Sterilization rooms	18°C	— 3	3	2 2					D P
Dressing rooms	22°C	2	2	2	750	1,500		More than 4 (up to 16)	P
Therapy room	22°C	2	2	2		2,500		32	P

\* — summer/winter; \*\* — pure; \*\*\* — dirty; \*\*\*\* — very pure.

dren and adults and should not be less than 15%, and in other departments — less than 7% of quantity of beds in the department.

The quantity of two-bed rooms in the above-said departments hasn't to make up less than 15%, in all other departments — less than two 3 bed rooms in each section.

The best ratio is 20% of one-bed wards, 20% — two-bed wards and 80% — three- and four-bed rooms.

In the infectious hospital a basic structural unit of the ward department may not be a ward, but complete or incompleated box or boxed room. Boxes provide a complete isolation of the patient. There are one- and two-bed boxes used in Ukraine.

The box (Fig. 43) has two exits: to the department and to outdoor environment. The patient never leave box through the department door, they pass only through the external exit with the tambour. The access of the medical personnel to the box is provided from a "conditionally clean" corridor through sluices, where a medical staff should change their gowns, wash and disinfect hands. The doors in the sluices should be placed on the slanting line. The boxed department have the largest maneuverability and capacity, it is important for small departments.

Incomplete boxes distinguish from boxes because they have no external exit. They are also provided for one and two beds. The mode of non-boxed departments differs from boxed one by that the patients are brought in incomplete boxes through a general corridor department. In boxed departments it is recommended to use 25% of all beds in one-bed boxes, others — in two-bed boxes. In every ward section it should be provided two incomplete boxes for one-two beds.

In the noninfectious department for children older than one year and for adults there are used rooms having no more than 4 beds. Capacity of rooms for infants and newborns in the obstetric department should be no more than by 2 beds each.

The recommended percent of boxes in section for children younger than 3 years is 100%.

At presence of the gynecological department in the structure of health institution it should be isolated from the obstetric one and other "clean" departments. Parturient and pregnant women are divided into 2 streams in the reception department. One stream consists of the parturient and pregnant women, which are directed to the department of pa-

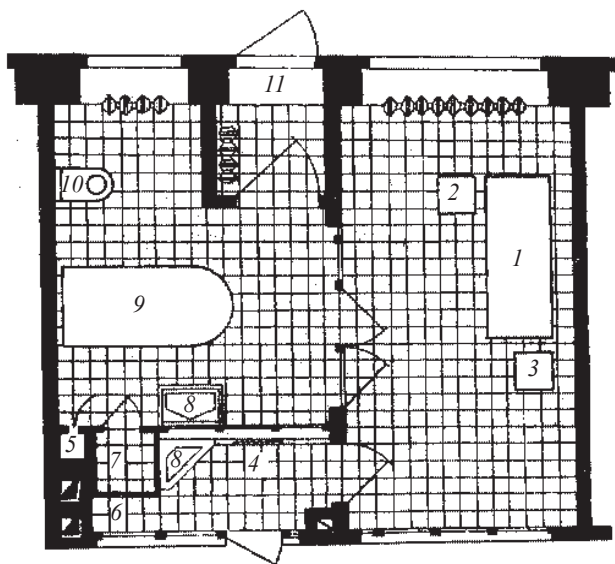


Fig. 43. The Box-Ward by Meltzer:

1 — bed; 2 — chair; 3 — bedside-table; 4 — inner sluice; 5 — food window; 6 — hall-stand; 7 — wardrobe; 8 — wash-stand; 9 — bath; 10 — toilet-pan; 11 — outer sluice

thology of pregnancy and physiological department, others — to observation department.

The observation department of the maternity house is intended for pregnant and parturient women who have:

- fever (the body temperature is  $37.6^{\circ}\text{C}$  and more without other expressed symptoms);

- a long period after amniotic fluid (12 and more h before admission to the hospital);

- thrombophlebitis of any localization (acute or chronic form in the exacerbation stage);

- inflammatory diseases of kidneys and urine tracts (acute stage, an exacerbation of chronic process during pregnancy, symptomless bacteriuria — 100,000 CCU/ml and more);

- signs of any urogenital infection (colpitis, cervicitis, choriamnionitis, etc.);

- clinical or laboratory data about TORCH infection (toxoplasmosis, rubeola, cytomegalovirus, herpes), listeriosis, sexually transmitted diseases (STD);

- intrauterine death of fetus;

- acute respiratory diseases (influenza, tonsillitis), signs of inflammatory diseases (pneumonia, otitis);

- skin diseases of infectious ethylogy;

- tuberculosis (closed forms of any localization for lack of a specialized hospital). Pregnant and parturient women in the childbirth with the open form of tuberculosis should be hospitalized in the specialized maternity house (department); if they are not available — in boxes or isolators of the observation department with the following transferring to the tuberculosis dispensary;

as well as the women having:

- skin diseases of noninfectious ethylogy;

- for lack of the medical documentation;

- abortion by medical and social indications at the II period of pregnancy;

- malignant tumors;
- the fetus development anomalies, revealed during pregnancy (at absence of specialized hospitals);

- puerperant women (in terms within 24 h after deliveries outside of medical institution).

The pregnant, parturient and puerperant women are transferred to the observation department if they have:

- increase of the body temperature up to  $38^{\circ}\text{C}$  and higher (at three times measuring);

- fever of unclear genesis (the body temperature is up to  $37.5^{\circ}\text{C}$ ), that lasts more than 1 day;

- postpartum inflammatory diseases (endometritis, mastitis, wound infection and so on);

- extragenital infectious diseases which do not require transferring to a specialized in-patient department (ARVI, herpes, etc.)

The pregnant, parturient and puerperant women, which suffer from infectious diseases, are subject-

ed to hospitalization and transferring to the appropriate infectious hospitals. The observation department should be placed either in an isolated house, or there should not be the obstetric department above it.

In presence of the gynecological department to it the separate reception is provided. The gynecologic department should be completely isolated from the obstetric departments.

**The Operating Block.** The operating block is a structural unit of the hospital intended for surgical operations.

The operating blocks are divided into general and specialized (traumatologic, cardiologic, neurosurgical). According to the presence of one department (aseptic) or two (aseptic and septic) operating rooms are divided into aseptic and combined.

The operating block has the following functional zones:

1. The sterile zone: an operating room.
2. A zone of stern regemen:
  - a group of premises for preparation to operation: preoperating rooms, wardrobe for overalls;
  - narcosis room;
  - a group of premises for the equipment: apparatus room;
  - a group of premises for postoperating wards;
  - a group of auxiliary premises, which contain also sluice at an entrance to operating room.
3. A zone of the limited access:
  - a group of premises for diagnostic researches;
  - a group of premises for preparing tools and equipment for operation: sterilization, instrumental-material;
  - a group of premises for the personnel: offices for the surgeons, the doctor-anaesthesiologist's office, the room for nurses-anaesthesiologists;
  - auxiliary premises: sluices at an entrance in septic and aseptic departments, room of the central board, plasters and so on;
  - warehouse premises: blood bank, etc.

The number of rooms in CRH, interregional and urban regional hospitals should be 1 in every 30 beds of a surgical profile and 1 in 25 beds in hospitals of emergency care. The ratio of septic and aseptic operating rooms in operating blocks of general hospitals has to be 1:3, but it is no less than one septic operating room per a block.

A number of beds in post-operating wards is accepted as 2 beds per an operating room. In presence of departments of anaesthesiology and reanimation or the reanimation and IT departments, postoperating wards are not provided, and their quantity is taken into account of beds of anaesthesiology and reanimation department.

The postoperating wards are placed in an isolated section at the operating block, or in structure of anaesthesiology and reanimation department separately from the surgical wards.

For maintenance of free patients transportation the width of door apertures is necessary to be no less than 1.1 m. A floor in operating room should have antistatic covering. The ventilation in operation and dressing room provides conditioning of the air. The inflows of the air from system of conditioning — in the top zone of room (not lower than 2.5 from the floor), drawing out — from two zones: top and bottom (0.4 from the floor). The air, which is given in to the operating room has to be cleaned according to the bilateral scheme (rough and thin clearing).

### Monitoring of Hospital Environment

For control on the hospital environment they use the following indicator of air pureness:

*Oxygen:* 20–21%, very stable size, it does not decrease even at intensive consumption (restoration for the infiltration).

*Carbonic gas:*

- very clean air < 0.05%;
- rather clean air < 0.07%;
- satisfactorily clean air < 0.1%.

*Dust pollution:*

- no more than 500 particles in 1 cm<sup>3</sup>;
- clean air < 0.1 mg/m<sup>3</sup>;
- dirty air > 0.15 mg/m<sup>3</sup>.

*Oxydation of the air:*

- clean air — up to 6 mg mg/m<sup>3</sup>;
- moderately-polluted — up to 10 mg O<sub>2</sub> m<sup>3</sup>;
- dirty — up to 12 mg O<sub>2</sub> m<sup>3</sup>.

### Waste Managements in the Hospitals

Hospitals produce about 230 kg of sold waste per bed annually (0.63 g/day). Nowadays various methods are used for waste treatment in the hospitals.

In sewerage dwelling place there are complexes of local purification (CLP):

- with thermal decontamination in liquid and solid phase of waste. It has high effectiveness of decontamination. Power is about 100 m<sup>3</sup>/day;
- with a septic-dehelminthizator (25 m<sup>3</sup>/day);
- with a septic (25 m<sup>3</sup>/day);
- with the contact defenders (10–15 m<sup>3</sup>/day);
- with a 2-level septic (100–150 m<sup>3</sup>/day). It's used in Odessa infectious hospital;
- complex of local waste buildings with a aertank of continued aeration and mechanic aerator (400 (!) m<sup>3</sup>/day);
- complex "Rapid Lock" (to 840 (!) m<sup>3</sup>/day);
- with circular oxygenation channel (COC). It's used for waste treatment of tuberculosis hospitals if volume of waste is up to 700 m<sup>3</sup>/day;
- with emsher and biofilter. They use it for waste treatment of tuberculosis hospitals if volume of waste is up to 500 m<sup>3</sup>/day;
- with septic and biofilter (for small tuberculosis hospitals, waste up to 50 m<sup>3</sup>/day).

For canalized areas there used:

— complex of local treatment units with ground fields of filtration (irrigation); the scheme is used if volume of waste is 50–100 m<sup>3</sup>/day and there is sandy soil;

— complex of local treatment units with underground fields of filtration. Waste pipes (drenas) is placed on the depth of 3 m, loading is about 15–20 l/day The scheme is used if volume of waste is 50–100 m<sup>3</sup>/day;

— complex of local treatment units with sand-gravel filters;

— complex of local treatment units with filtering trench.

For waste treatment in tuberculosis hospitals there are used two stages of biologic purification.

## NOSOCOMIAL INFECTIONS

*Nosocomial infections* (NI) (i.e., infections acquired in the hospital) have become an acute problem in human's medicine because of increasing of drug-resistant microbial strains and the usage of invasive procedures for the patient's support and monitoring. Compliance with handwashing protocols is perhaps the most important means of preventing nosocomial infection. Careful attention to aseptic technique and judicious use of antibiotics are also essential.

The concept "hospitalismus", which is quite often used as a synonym of the term "hospital infection", is wider and unites all diseases caused by medical institutions environment specificity. There are traumatic hospitalismus, mental (psychogenic) and infectious hospitalismus. Joining the basic disease, nosocomial infections worsen its course and prognosis.

According to the data of the American authors, in the USA NI cover about 5% of the patients, (an average level in the advanced countries — 5–12%), taking place during in-patient treatment. Mortality reaches 25%, so nosocomial infections are the basic reason of mortal cases in the hospitals. Nosocomial infections considerably increase the term of patients' staying in medical institutions, that entails huge expenditures (in USA: 5–10 USD billions per year). NI are of great attention due to distribution of so-called hospital bacteria strains, as a rule poly-resistant to antibiotics and chemiopreparations. You know, obviously, the principal antibiotic resistance development mechanisms, such as chromosomal, plasmid, etc.

Chromosomal resistance is characterized by sudden change of sensitivity of one or several strains to an antibiotic (as a rule, this kind of stability is inducted with carbenicilline, streptomycine, levomycetine, aminoglycosides, tetracycline and sulfonamides). This type of the resistance is characteris-

tic for *Klebsiella*, *Enterococci*, *Ps. aeruginosa*, *Neisseria*, *Staphylococci* (in particular — *S. aureus* (MRSA)).

Plasmid resistance is characterized by gradual change of sensitivity of many kinds of microorganisms to one or several antibiotics (tetracycline, ampicilline, cephalosporines etc.), and it's typical for *Enterobacteriaceae* and *Acinetobacter*, *Pseudomonas*, *H. influenzae*. The resistance transfer factor is conjugative plasmid. Sudden or gradual change of types cross resistance of one kind of microbes to two antibiotics (aminoglycoside +  $\beta$ -lactam antibiotic, tetracycline and aminoglycosides) characterizes stability connected with permeability. Last type of resistance is realized for *Pseudomonas*, *Serratia*, *Staphylococci*, *Enterococci*. Polyresistent strains are especially dangerous for children and weak persons, especially elderly people and patients suffering from immunodeficiency of any origin. They represent a group of risk (Table 58).

The transfer of microorganisms can occur by following ways:

- aerogenic;
- fecal-oral;
- parenteral introduction;
- contact.

NI can occur during stay in medical-preventive institutions, and after a discharging from a hospital. They vary according to clinical displays and can proceed as the local forms or generalized septic processes, as well as symptomless carriage of an activa-

Table 58. Risk Factors of Nosocomial Infections Occurrence

Risk factors	Examples
Infringement of protective barriers	<ul style="list-style-type: none"> <li>– constant cateter</li> <li>– dialysis</li> <li>– drainage</li> <li>– tracheostoma</li> <li>– wounds (especially combustions)</li> <li>– operations</li> <li>– punctions of the skin: injections and venepunctions</li> </ul>
Neutropenia	<ul style="list-style-type: none"> <li>Antibiotic treatment</li> <li>Marrow disease</li> </ul>
Decreased activity of neutrophilic white blood cells	<ul style="list-style-type: none"> <li>– chronic granulematous diseases (TB, MFD, lues, actinomycosis)</li> <li>– acydosis</li> </ul>
Cell immunity supression	<ul style="list-style-type: none"> <li>Hodgkin's disease</li> <li>Swiss type of <math>\alpha</math>-immunoglobuline</li> <li>sarcoidosis (Kashine-Beck's disease), etc.</li> </ul>
Hypoimmunoglobulinaemia	<ul style="list-style-type: none"> <li>treatment with steroids, antibiotics</li> <li>Lymphosarcoma</li> <li>others</li> </ul>

tor. The diseases of the medical workers arising during treatment and care of the infectious patients refer also to hospital infections.

There are some modern classifications of NI used now:

1. *According to ethyology:*

*Viral NI:* HIV (AIDS); Mixoviridae (influenza); RSV (respiratory-syntitial infection); rhinovirus (“common cold”); Paramixoviridae (paragryppus, measles); Herpeviridae (herpetic infection); Adenoviridae (adenoviral infection); cytomegalovirus; Enteroviridae (Coxsackie, ECHO, polio); Vira HA, HB, HC, HE.

*Chlamydial:* epidemic conjunctivitis, (very seldom — ornithosis or trachoma).

*Bacterial:* (Gr+) Staphylococci; Streptococci; (Gr-) Klebsiella; Pseudomonas; Neisseria; Legionella; Lysteria; Clostridia; Proteus; Serratia; Enterobacteriaceae; Mycoplasma; Mycobacteria.

*Fungal:* Candida; Actinomyces; Nocardia.

*Protozoic:* Pneumocystis carinii.

2. *According to way of spreading:*

1) Aerogenic: adenoviral infection; cytomegaloviral infection; influenza; parainfluenza; measles; rubella; pneumonia (for example: Friedlander pneumonia or Legionnaires’ disease); diphtheria; pertussis, etc.

2) Fecal-oral: poliomyelitis; viral hepatitis A and E; toxicoinfection, bacteriotoxicozes (microbic food poisonings); dysentery; salmonellosis, etc.

3) Parenteral: HIV-infection; virus of hepatitis B, C, D, etc.

4) Contact: wound infection; implantation infection.

3. *According to localization:*

1) Generalized forms:

- sepsis;
- meningitis;
- osteomyelitis.

2) Local forms:

— infections of the skin and hypodermis: abscess; phlegmona; mastitis; conjunctivitis; otitis; endometritis;

— urogenital infections: urethritis, cystitis, pyelonephritis;

— respiratory infections: ARVI; Legionnaires’ disease (Pittsburg fever, Fort Pontiac fever);

— gastro-intestinal tract: gastroenteritis; enteritis; colitis;

— wound infection (including postinjection complication): erysipelas; pyogenesis;

— others: viral hepatitis.

In “iatrogenic” nosocomial infections they speak, when the direct reason of disease is the rough infringement of medical technology by the personnel.

Last years the ethyologic structure of NI has undergone significant changes. Lately streptococci have been the main reason of NI. Now the main ethiological factors are staphylococci (up to 60%) and

large group of gram-negative microorganisms (*Escherichia*, *Pseudomonas aeruginosa*, *Klebsiella*, *Enterococci* etc.). In the intensive therapy wards the most often activators of NI are staphylococci, *Pseudomonas aeruginosa*, *Escherichia coli*, enterococcus (streptococci of the D group). The increasing role at the hospital pneumonias belongs to legionellae and also Acinetobacter, Achromatobacter, — the latter is met mainly in persons with immunodeficiency.

## NOSOCOMIAL INFECTIONS CONTROL

The basic precondition for NI occurrence is the non-observance of sanitary-epidemiologic and antiepidemic mode in medical-preventive institutions. Distribution of infection is caused by the presence of infection sources among the personnel and patients, infringement by the personnel rules of asepsis, antiseptics, personal hygiene, mode of the current and final disinfection, mode of cleaning, linen mode, infringement of mode of sterilization and disinfection of medical tools and devices. The greatest importance have aerial and intestinal infections (especially in MPI children), capable to form mass flares.

Among directions of preventive maintenance of NI it is possible to allocate two basic ones:

*Non-specific* preventive maintenance covers architectural-planning measures, sanitary-antiepidemic measures, sanitary-technical measures.

*Specific* prevention (immunization) will be carried out in the scheduled order. It’s used an active immunization (vaccine, anatoxines less often; more often — passive immunization (immunoglobulini).

You know that at the hospital area they provide some functional zones. The infectious departments should be isolated from non-infectious. The flows of movement for “pure” and “dirty” (suspicious for communicable diseases) patients should be also isolated from each other according to a principle of one-way flow. It’s very important how departments are distributed by the floors. Departments requiring aseptic conditions (surgical, maternity, neonatological) should be placed on the first floors of a hospital building. At the arrangement of operation-reanimation complex septic operations have to be placed above aseptic. In infectious cases of departments intended for hospitalization of the homogeneous patients they place them by the floors, thus the most contagious patients (with aerial infections) are placed in the top floors.

Sanitary-antiepidemic measures provide health promotion activity among the patients and personnel, monitoring of an epidemic situation, including revealing vira- and bacteria carriers. With this purpose the system of the previous and periodic (current) medical surveys is introduced. So, the students of medical high schools during practice should pass

obligatory physical examination with participation of physician, dermatovenerologist, they have to make fluorography (if this research was not taken during the previous 6 months), feces analysis on carriage of intestinal infections and helminths eggs, and the persons older than 18 years — on HIV, RW and urethral (for women also vestibular and vaginal) smear on *Neisseria gonorrhoea*.

Before practice in maternity houses, newborn wards, children's hospitals (departments), surgical departments etc., it is necessary to pass examination by stomatologist, otholaringologist with an obligatory capture smears on staphylococci tests (from the nose and fauces).

Prior to the beginning work in maternity houses, children's hospitals and other MPI medical workers should pass observation including fluorography (6 months), RV and gonorrhoea tests, HIV analysis they repeat every year, carriage of pathogenic staphylococcus and RW as well, gonorrhoea tests and HIV analysis — 1 time per 6 months, on carriage — 1 time per 6 months will be carried out.

All hospitals should be supplied with linen — accordingly to the number of patients and equipment. Change of linen by the patient should be carried out in the process of its pollution, regularly, but *no less than once in a week*. Polluted linen should be changed immediately. The change of bed-clothes for delivered women should be carried out 1 time per 3–4 days, body linen and towels — daily, under napkins — necessarily. Change of linen by the patient after operation should be carried out regularly to the discontinuance of exudation from wounds.

In maternity hospitals (patrimonial blocks and other premises with aseptic mode for newborns) should be used sterile linen.

The temporary (no more than 12 hs) preservation of dirty linen in departments could be provided in the shut container (metal, plastic boxes, dense boxes, and other capacities subjected to disinfecting). For work with a dirty linen the personnel should be supplied with sanitary clothes (a dressing gown, a cap, a mask, gloves).

The clean linen should be stored in the special premises, deduced for it. In departments they should have a daily stock of linen. Linen and container should be marked.

Washing of the hospital linen should be carried out by centralized way in special laundries at the hospitals. The washing of linen in medical institutions is carried out in conformity with the instruction on technology of processing of linen of medical establishments at centralized laundries.

After recovery of the patient, his death, and also for the prevention of pollution a mattress, a pillow and blankets should be changed and disinfected.

At the reception ward all in-patients will pass special sanitary processing in acceptance branch (acceptance soul or baths, cutting of nails and other

procedures) by the necessity. It depends on results of the examination. They give to each patient soap and wisp of bast for personal use. After sanitary care the complete set clean body linen, pajamas, shoes (slippers) are given out to the patient. They keep the personal clothes and the footwear for safety in a special container with hangers (polyethylenic bags, covers with a dense fabric, etc.) or it is transferred to preservation to its relatives or familiars.

Washing of the patient is carried out no less than 1 time per week with marking in the case history. Hygiene of the seriously ill patients (washing, wiping of the skin, parts of the body, rinsing oral cavity, etc.) will carry out constantly after the meal and at pollution of the body. It should be organized a hair dressing and shaving for the patient. Each patient should be supplied with a personal towel and soap.

The serving medical personnel of the hospital, patrimonial houses and other medical institutions should be supplied complete sets of the replaceable worker (sanitary) clothes: dressing gowns, caps, replaceable shoes (slippers) in quantities, that provides daily change of sanitary clothes. All medical personnel of medical or patrimonial institutions have to be faultlessly tidy and accurate, edge of the worker (sanitary) clothes should completely close personal (home) clothes. The hair should completely be covered with caps. Change of footwear of the personnel of operational, patrimonial blocks, resuscitation, dressing rooms and newborn departments should be with non-fabric material, suitable for disinfecting.

The doctors, nurses should wash hands before the examination of each patient or performance of procedures, and also after "dirty procedures" (cleaning of premises, change of linen, visiting a lavatory, etc).

## OCCUPATIONAL HEALTH OF MEDICAL PERSONNEL

Hospital environment is an occupational environment for medical personnel. By the specific of labor all medical staff could be divided into some groups: health providers, pharmacists and health officers. The complex of occupational hazards is very wide. It includes informational, ergonomical, physical, chemical and biological factors. Usually in their labor medical staff has prolonged contact to factors with low intensity. This peculiarity caused non-specific reactions: changes of immunity and reactivity, decreasing of adaptive capacities.

For all health providers the high intensity of labor is typical. Intensity of labor depends on the rate of occupational stress. Hospital work often requires coping with some of the most stressful situations



found in any workplace. Hospital workers must deal with life-threatening injuries and illnesses complicated by overwork, understaffing, tight schedules, paperwork, intricate or malfunctioning equipment, complex hierarchies of authority and skills, dependent and demanding patients, and patient deaths; all of these contribute to stress.

There are some stress risk factors: high responsibility; night and whole shifts; operator work (dispatchers, EMS specialists); monotony (laborants, specialists of functional diagnostics).

By the rate of labor intensity all medical personnel could be included in four groups: low intensity labor (health promoters); mild intensity labor (the

Table 59. Occupational Hazards for Medical Staff

Factor	Risk group	Level of exposure	Diseases
Occupational stress	All personnel		Hypertension, angina, stomach ulcer, etc.
Discomfortable microclimate	Dentists PHC providers Surgeons Medical personnel of mud bath	24–25 EET (operating room) 14–15 EET (mud bath)	Common cold., ARVI
Ionizing radiation	X-ray specialists	20 mSv/year	Radiation-related disorder
Noise	Dentists EMS personnel	65–75 dBA 53–79 dBA	Stress diseases
Vibration	Dentists Traumatologists Ship doctor	< MAL	Stress diseases
Air dust pollution	Dental technician	< MAC if proper ventilation	
Air chemical pollution	Nurses Roentgenologists Pharmacists Laborants Hospital attendants	< MAC if proper ventilation  MAC  Ampicilline 0.1 Aminazine 0.3 Benzylpenicilline 0.1 Ether 300 Inhalan 200 Nitrogen hypooxide 5 Oxacilline 0.05 Streptomycine 0.1 Chloroform 10 Galotane 10 Florimicin 0.1 Fomaldehyde 0.5 Chloretil 50	Allergic reactions  Class of danger IIA IIA IIA IV IV III IA IIA III III IIA IIA IV
Biological hazards	Phthisiatrist Infectionist Nurses PHC providers Dentists		TB, aerial infections, HVB, HVC, etc.
Intensive visual work	X-ray specialists Ophthalmologists ENT specialists		myopia
Compelled pose	PHC providers ENT specialists Surgeons	60% — sitting. 6% — standing 92.9% — sitting 37.6% — inclined trunk	osteocondrosis

nurse, physician, laborant); intensive labor (surgeon, EMS specialist, gynaecologist, dentist); high intensity labor (the reanimatologist, specialists in micro-surgery).

By the character of mental work the medical specialties are classified into 2 groups: with prevalence of cognitive work (physician) and cognitive emotional work (surgeon).

The peculiarities of physician work are following: high requirements to cognitive functions; operative and long-life memory; creativity; high responsibility.

Energy losses during labour process are 2.5 kcal/kg/hour for surgeon, 2.2 kcal/kg/hour for nurse, 2.0–2.3 kcal/kg/hour — for laborant, 3.7 kcal/kg/hour — for hospital attendant.

It is estimated that 8–12% of health care workers are latex sensitive with reactions ranging from irritant contact dermatitis and allergic contact sensitivity, to immediate, possibly life-threatening, sensitivity.

General surgeons could do more than 150 operations per year, more than 3 per week; ENT surgeons — 170 and 4 correspondly, gynaecologist — 370 and 7 (including minor surgery — 230 and 5).

Due to compelled pose the risk of constipations and hemorrhoids is increasing. Before the end of a working day the area of a surgeon's feet is increased up to 2–4% and circle of leg up to 0.5–0.8 cm. Blood pressure in the vessels of leg is twice increased, in

pelvic vessels — half as much. The risk of varicosis is 1.6 times as much than in other health providers.

The most important occupational hazards are shown in Table 59.

Preventive maintenance in the occupational hygiene of medical personnel:

1. Labor policy and occupational safety: sanitary codexes and other legislation.

2. Sanitary-technical: HVAC, air sanitation.

3. Antiepidemic: aseptics, antiseptics, laundry and mask regimen.

4. Medical-biological: dispensarization, special diet, vaccination (HVB, flue), chemical prophylaxis (TB, lepra, malaria).

Ukranian policy makers established the following duration of a working day for the medical staff:

- 4-hour — for the medical staff dealing with open sources of radiation;

- 5-hour — for the medical staff dealing with closed sources of ionizing radiation, for pathologists, prosectors, forensic medicine experts, etc.

- 5.5-hour — for the staff in TB hospitals, mental health centers, dentists, psychiatrists;

- 6-hour — for the staff of infectious departments, medical laboratories.

Medical examinations of medical staff are regulated by the decree of USSR Health Ministry N 555 on 29.09.1989 and order of Ukraine Health Ministry N 45 on 31.03.1994.

### **HYGIENE OF URBAN ENVIRONMENT**

Hygiene of residential areas is a part of environmental health. It studies the influence of urban and rural environment on the public health, plan and provide preventive measures. The basic parts of hygiene of resident areas are building hygiene, air protection, water supply hygiene, water protection, hygiene of soil, hospital hygiene.

Urban environment is the most important element of human ecology. It's providing life safety and quality. There are some common problems of resident areas:

- growing anthropogenic exploit of the environment;
- natural resources shortening;
- growth of population of synantropic organisms;
- toxicological, epidemiological and radioactive safety;
- demographic problems;
- psychohygienic and psychosocial problems (frustration, stress, delinquent behaviour, hypokinesia, etc.).

The resident areas differ from each other due to the dominant forms of human productive activity. Their basic historic types are villages and towns. The formation of towns was usually followed by life quality increase.

UN indices of life quality are:

- Health
- Food
- Education
- Labor conditions
- Dwelling environment
- Funds of consumption and storage
- Transport
- Employment
- Clothing
- Rest
- Social protection
- Liberty

The city formation factors which motivate the foundation of any city are:

- climate factors (climate, landscape);
- available sources of water;
- available sources for productive activity (fertile soils, minerals, enterprises);
- good communications (roads, caravan routes, water routes).

The oldest of the known towns appeared in XX B. C. They belonged to civilization of Ancient Egypt (Kaghoon, Memphis), India (Moenjodaro) and Sumerians. Their planning was quadrangular. Ancient Greece and Rome civilization were famous for its architecture, but Greek cities were small (Athens and Corinth had about 100,000 inhabitants each) and never became as large as Babylon (1 mln population) or Rome (2 mln population).

In Middle Ages European cities were usually fortified towns placed on junctions of caravan routes. Their population was usually small. In 1337 London the biggest city of Middle Ages Europe has 35,000 population only. These cities were crowded, the life quality was low and they were dirty. The typical planning was radial — the radial streets which led to the downtown were surrounded by the circles of the new streets appearing as the city grew. The cities founded in early Middle Ages were planned rationally enough both in technical and sanitary respect. In XV–XVI centuries the invention of artillery and multiple wars changed the outline of city planning. The dwelling blocks were constructed within the limits of fortress walls. Other motivation of such planning was economical — very high rent taxes.

Eastern (Arabian, Persian, Indian) cities were planned in the other ways. Their streets were crooked. The sanitary state of these cities was comparatively better than in European ones.

Renaissance was marked by the construction of large cities with individual features. Sanitary concerns were taken into consideration by Avicenna and Vitellius recommendations.

In XIX century the lowlife blocks became the main problems of city construction. Multiple origi-

nal projects of city improvements appeared. Such were the “garden city” by E. Howard, “town-sateelites” by Ownwin and “linear city” by Gide and Rad- ing. Howard considered that the total population of the garden city should be 32,000 only. His “ideal city” had to be small, built resident area had to oc- cupy 15% of the area and vegetation more than 50%. Howard considered the radial planning and little cottages are the best. The plans of the great French architect Corbusiere considered functional architec- ture of future city with rational zonal planning of large industrial city with dwelling blocks and office blocks located in 5–6 floors.

## URBANISATION

Urbanisation is one of the most significant proc- esses affecting human societies. Until recent times, urbanisation was regarded as a direct sign of mod- ernization and development. Throughout history, industrialization and urbanisation have tended to occur together. But this relationship, one of which had held for more than 6,000 years since the emer- gence of the first cities, has changed fundamentally since 1945. We are currently experiencing an en- tirely new era of world urbanisation.

The above mentioned three processes have tend- ed to occur together through history, but they are separate processes. This is shown for instance, in industrial countries such as Britain and the United States, where urbanisation has reached a peak and may even be declining, a situation which is called *counter-urbanisation*. However, even in these cir- cumstances, individual cities may still be growing as a function of total population increase. Similar- ly, with respect to the Third World, it is sometimes argued that the rapid influx of rural migrants, who are used rural ways of life, is leading to a reduction in urbanism at a time when both urbanisation and urban growth are increasing rapidly. This is yet an- other indication of the special nature of current ur- ban development in the Third world.

Urbanisation as a historical process of raising the role of urban settlements and the corresponding mode of life in the development of society has achieved a large scale. The urban population in Ukraine in early 1999 reached 68% of the total pop- ulation. The number of urban settlement in Ukraine is increasing as well. At the beginning of 2,000 there were 448 cities and 897 settlements.

Already, the world’s cities are growing in total by more than 60 million — equivalent to the entire population of the United Kingdom or France — each year.

This growth will not be equally distributed: the explosive growth is occurring, and will occur, in the cities of the developing countries, in Asia, in Afri-

ca and in Latin America. In the developed world, the great period of urbanisation has already been and gone: here, 76% of the population already live in urban places, and people and jobs are moving out away from the big cities to smaller places. Eastern Europe and the Commonwealth of Independent States have actually experienced a recent decline in their urban growth rates as people move back from city to farm, for the first time in half a century.

In sharp contrast, at the millennium less than 41% of the population of the developing world live in cities. And here, the process of urbanisation is still in full flood. There will be a doubling of the urban population, between 2000 and 2025, in Latin America, in Asia and in Africa — above all in Af- rica.

But the developing world, too, exhibits huge dif- ference: already, nearly three quarters of the popu- lation of Latin America and the Caribbean is urban, and in some key countries figures are higher: Ar- gentina (89% urban), Chile (85% urban) and Uru- guay (91% urban). In contrast less than one — third of the populations in Africa and Asia lives in urban areas. The central challenge lies here, in the explod- ing cities of some of the poorest countries of the world. For it is here that the greatest urban trans- formation has recently been occurring, and will con- tinue to occur.

The following map illustrates global trends of annual percentage increase in urban population. It is clear that urbanisation is occurring rapidly in the third world (Fig. 44).

The following graph demonstrates the increas- ing of million cities and its association with the less developed world. The world’s biggest 25 cities shown in the Table 60.

*Why does urbanisation continue?* We can make a few general observations. For the most part, ci- ties have grown as a result of three things: econo- mic growth, natural increase and rural-urban migra- tion. There are exceptions to this general rule. Some cities, for example, are “created” by governments that want to take the burden off the large cities. Sometimes, such cities are made the capitals of the country, as in the case of Yamoussoukrou which has replaced Abidjan as the capital city of Cote d’Ivoire. Assigning a new capital usually means transferring government offices, foreign embassies and business- es to a smaller city in order to attract people away from over-crowded and over-burdened sites. Another “created capital” city is Brasilia, in Brazil. In the past rapid urban growth was attributed mainly to migration. Migration still accounts for a substantial proportion of urban population growth in the devel- oping world, but the natural growth of the existing urban population account for an increasingly large share of the total. For example in the Philippines, the in-migration rate to urban areas was 1.8% per year during the 1970s, out of a total population

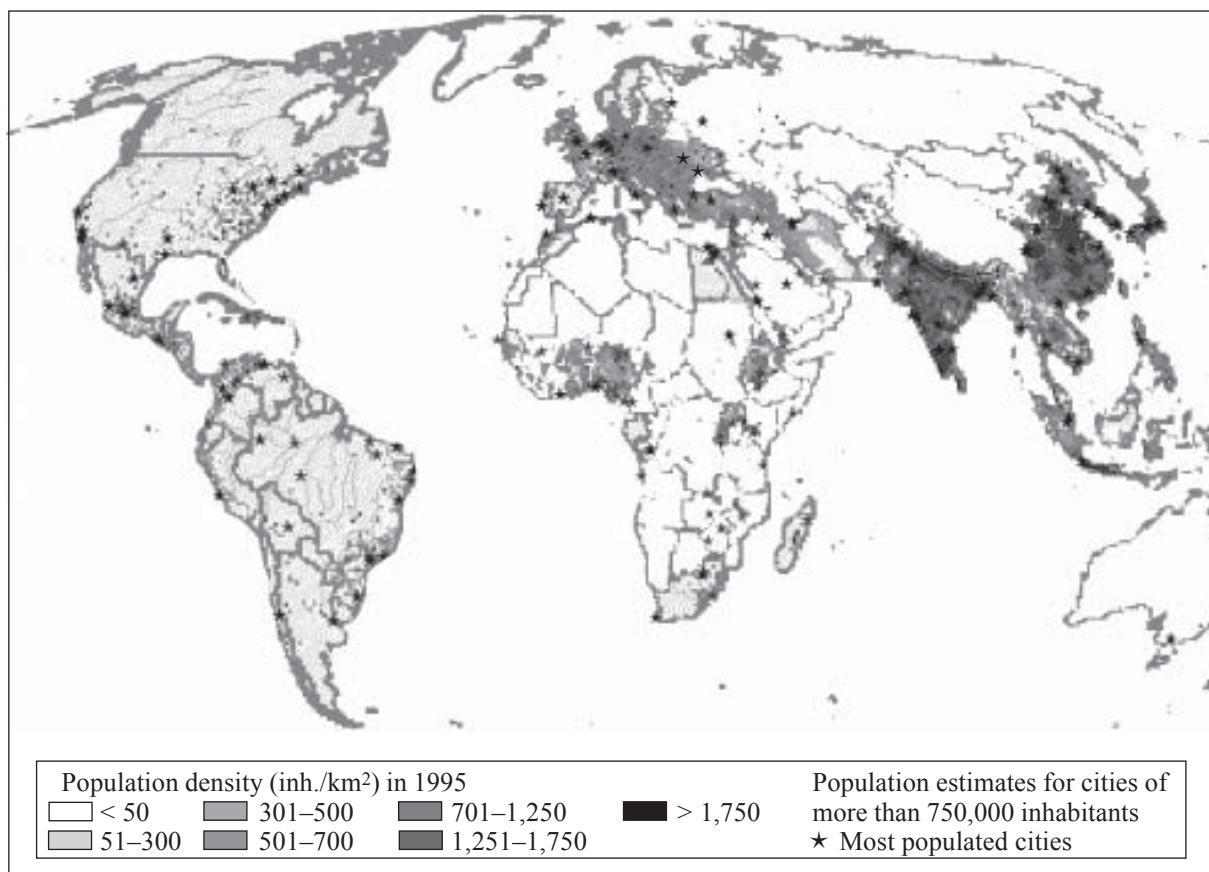


Fig. 44. Urbanisation in the World

growth rate of 3.9%; for other countries during that period figures were comparable — Brazil: in-migration of 2.2% out of total urban growth of 4.4%; Indonesia: 2.7% out of 5.0%; South Korea 2.9% out of 5.3%; Kenya: 4.6% out of 8.5%. Thus, the growth of cities can no longer be regarded simply as a “problem of migration”: cities will continue to grow rapidly even if there is no further migration. In addition; the young age of most migrants (well over half of urban migrants in most developing countries) are under 24 tends to increase the natural growth rate of the urban population. People move to the city for various reasons, but the most significant reason

is economic — when a city’s economy is prospering it attracts people. The promise of jobs and comfort, glamour and glitter, “pulls” people to cities. There are also “push” factors: droughts or exploitation of farmers can cause extreme rural poverty and that “pushes” people out of the country-side. The city’s promises are not always fulfilled. Cities may be known for their bright lights, but not everyone who moves to the city, or is born there, benefits from it. The city can’t always keep up with the number of people who move there, so urban poverty and homelessness have become global phenomena. The question that remains to be answered is how we can

Table 60. The Biggest Cities of The World (2000)

City	Country	Population, mln	Average annual growth, %
Tokyo	Japan	26.8	1.41
San Paulo	Brazil	16.4	2.01
New York	USA	16.3	0.34
Mexico	Mexico	15.6	0.73
Bombay	India	15.1	4.22
Shanghai	China	15.1	2.29
Los Angeles	USA	12.4	1.6
Beijing	China	12.4	2.57
Calcutta	India	11.7	1.67

transform the disadvantages of cities into advantages for its inhabitants.

Urbanisation usually accompanies social and economic development, but rapid urban growth on today's scale strains the capacity of local and national governments to provide basic services such as water, electricity and sewerage. Cities draw migrants with the promise of higher living standards. City residents have greater access to health care, more employment and opportunity and access to more social and cultural events. Cities have been at the center of civilizations and continue to be the engines of social and economic growth. For all the relative advantages of city life, however, widespread poverty, deterioration of urban living conditions and environmental pollution cast a shadow over the urban future. A vast number of people in urban areas are threatened by homelessness, health hazards and violence among other things. These may affect a portion of the urban population directly, but their indirect effects are felt by the whole society.

Up to 600 million of people in urban areas in developing regions (nearly 28% of the developing world's urban population) cannot meet their basic needs for shelter, water and health from their own resources. Up to half the population of cities in some of the world's poorest countries are living below official poverty levels, women and children being among the poorest people in the world. The World Health Organisation estimates that there may be as many as 100 million street children worldwide. In-

come does not tell the whole story of urban poverty as many who may be considered above the poverty line may be exposed to other forms of poverty. As a result of the rapid urban growth job market can not provide enough jobs. The result is poverty — and by extension poor health and homelessness. This is especially true for cities in poor countries

The flow of large numbers of people places a heavy burden on cities. The infrastructure is unable to cope with such large numbers. The result is a lack of potable water, sanitation, basic community services such as hospitals and schools.

Pollution and other health hazards present a major risk for residents of urban areas. Pollution from cars, the burning of fossil fuels and industry cause illnesses such as respiratory infections and lead poisoning.

Homelessness is a growing problem in cities all over the world. In addition, there is the problem of poor housing. Estimates of the world's homeless population plus those living in poor housing can reach a figure of 1 billion of people. People who are homeless or live in poor housing are constantly threatened by illnesses and have a much lower life expectancy than other portions of the population.

Crime and violence are other, specifically urban, problems that are not limited to one region of the world alone. Urban violence has been growing by about 3 to 5% a year over the last two decades. Poverty and social disintegration are cited as the causes of urban crime and violence (Table 61).

Table 61. Consequences of the Urbanisation

Results	Positive	Negative
Economical	High investments profit Concentration of productive forces Increasing funds of consumption Increasing employment	High rent taxes High energy expenses High costs expenses on sanitary needs Complicated financial management Risk of transport and communication collapse
Social	High education level High salary and better work conditions High life quality More available jobs Better food and goods supply Better rest Good social protection Good health care system More types of available activities	Information pressing Risk of traumatism Hypokinesia Unemployed problems Low birth rate "Senility" of population Bad sectors problems (slums, squatter blocks) with low income and criminal population Increasing delinquent behavior (addictive behavior — drugs, alcohol, gambling), promiscuity (STDs, early pregnancy), crime and violence
Ecological-hygienic	Comfortable conditions Good water supply at centralized water supply system, good quality of water Hygienic certification of products Modern ways of sanitary cleaning	Anthropogenic pollution Biocenosis denaturation Forest destruction Water deficiency "Junk food" Epidemic risk Mental disorders risk Problem of synanthropic organisms (rodents, flies, termites, ants)

Table 62. Assessment of Agglomeration Rate

Agglomeration grade	Agglomeration rate
Low	Over 30
Medium	20–30
High	10–20
Very high	Under 10

Urbanisation brings agglomeration formation (functional complexes of large cities with satellite towns) with their fusion in megapolities (metropolitan area in USA, conurbation in Europe). The agglomeration rate (ratio of peripheral region population to the central region population) is used to evaluate the urbanisation processes (Table 62).

Urbanized area with high agglomeration rate and population density are characterized by group systems of populated areas with their optimal limits depending on climatic factors, downtown size and the range of everyday population activity. Large group systems with agglomeration population over 500,000 have the range of system population activity approximately 2.5 h. Small and medium (100,000–50,000) systems have that radius as 2 and 1.5 h correspondingly.

Optimal group system should have the population density under 33 men per km<sup>2</sup> and the ratio of city dwellers under 71%, downtown population under 34%. The existing agglomerative forms should have the group population distribution, index should be at least 3.0 the index of agglomeration complicity under 5.3 (medium degree of agglomeration). Medium group systems are optimal if water territory and recreation supplies are short. It's especially important for oasis population distribution (Asia, Northern Africa).

## URBAN PLANNING

Planning of the city foresees the most comfortable conditions of life and health care. It enables complex improvement and prophylaxis of pathogenic influences of environment. Some sanitary rules should be kept while planning cities, dwelling territories, district planning, countryside planning, industrial construction, transport routes planning. The permission for construction and exploitation of resident houses should be certified by the State Hygienic Sanitary Service if the condition of the object meets the sanitary demands. Those demands were proven scientifically (evidence based) and adapted in hygiene of resident areas, air hygiene, water hygiene and sanitary engineering. Planning of city, town or village is the functional division of its territory, its technical equipment and social organisation which enable the best conditions of life, health, social and professional activity of the population, education, rest and sport.

Planning of the site foresees the rational involvement of natural resources. There are climatic factor, landscape, soil, water reservoirs, subterranean waters and forests. Climate is the multiannual weather regimen, which is typical of the area. It influences human's life, health and activity greatly. Sun radiation, air temperature and humidity, atmospheric pressure, wind direction and velocity, sedimentation rate are the points of great sanitary concern. Climatic factors should be taken into consideration during general planning, area choice, building system, houses orientation, thickness of walls and deepness of the basement, aeration type, central heating planning, water supply and gardening planning. Microclimate is the complex characteristic of air temperature state in some area. Microclimate can change every hundred meters due to the type of surface (water, meadow, forest) or landscape (highland, valley, northern or southern slope). Large cities have special microclimate different from the one in the neighboring areas. The reasons of this phenomenon are as follows:

1. Concrete and asphalt pavements and large buildings consume heat at summer and then irradiate it (average annual air temperature in the city is 1–3°C higher, humidity is lower by 5–10%).

2. Uprising air flows from the city cause the migration of peripheral cold air to the center (as quiet weather).

3. Multistoried houses decrease the wind velocity two and more times.

4. Atmospheric smoke decreases sun UV radiation by 20–50%.

Landscape relief changes microclimate greatly. Various slopes get different amount of sunrays. The best territory for construction should have the slope angle within 0.5–10%. Forests and meadows improve the microclimate by decreasing the wind velocity and serve as a reservoir of fresh air and as recreation territory.

Underground waters provide good water supply with high quality water. Rivers and lakes serve as water supply source and place for recreation. They improve the microclimate by moderating the air temperature and increasing air humidity. Good water supply means good gardening. If natural reservoirs are absent, artificial ones should be constructed.

*Requirements to the city territory:*

- no marshes or flooding danger, low ground water level, unpolluted soil, available vegetations;
- relief slope within 0.5–10% providing drainage of rainwater and ditch drainage;
- sufficient water supply;
- no minerals under the construction zone;
- good transport connection.

### **Functional Organisation of the City Territory.**

Division of the city into functional zones is the basic principle. There are five basic functional zones of the city: a residential zone, an industrial zone, a

communal storage zone, an external transport zone, a suburb.

*Residential (dwelling) zone* is the most important zone with resident buildings, offices, shopping centers, streets, public gardens, stadiums. It's subdivided into the dwelling districts consist of micro-districts with school, kindergarten, shops, offices, sport cites and other units needed for everyday functioning. The radius of microdistrict area is up to 800 m.

Dwelling block or district is the main structural part of the dwelling zone. Highways or streets should not cross it. Rational planning, sparse building location, construction system, good attraction and isolation, vegetation, beneficial microclimate and low noise provide good conditions for living, sport and leisure. The close interaction of dwelling apartments and the city environment is a part of the system "man — apartment — building — block — district" or "dwelling environment".

Density of the blocks is the ratio of built area to the area of the block itself. Higher density means less available free location of buildings, insolation, vegetations, etc. The density rate in blocks with 5–6 storied buildings is 20–21%, with 3–4% less in blocks with high buildings and 4–5% more in blocks with 1–2 storied building blocks. The density of population is the ratio of resident amount to 1 ha of area. There are brutto density (to the total city area) and netto density (ration to the area of dwelling zone only).

The most popular systems of block constructions are linear, perimetric, mixed and free schemes. Total, closed perimetric, row and group schemes do not meet hygienic demands. Linear planning was typical for 30–50s in the USSR. Perimetric planning has the building along the perimeter other staying separately. It's useful to protect the area from winds with the perimetric buildings. Free planning has no connection between the streets direction and building location. They have been built to achieve better insolation, aeration and better landscape exploitation.

Under the conditions of plain landscape the best buildings orientation becomes available — their longer side runs along the heliothermic axis. The buildings should not be located on the red line — the border between the street and the block area, — in any way. This space is filled with vegetations.

*Streets.* There are highways (60 m width and more), district streets (over 35 m in width) and intrablock passaged (15 m at low storied sites, 25 m in multistoried sites). The means of streets improvement are: pavement drainage, trash cans, street lights, small architecture constructions, street vegetations.

Natural light has bactericide properties and general beneficent effect on health. General health respect at least 3 h of direct insolation of dwelling

places daily at any time. Thermal effect: limitation of direct insolation in latitudes southern to 55° n. l. or to 55° s. l. Insolation should be determined at the ground floor as the darkest one. The distance between the building provides good insolation. The standard is two heights of the highest building. Heliothermic curves and heliothermic axis should be taken into consideration during the planning. The relation of the long sides of building to the meridian are meridional (0°), heliothermal (25°), diagonal (45°) and equatorial (latitude orientation). The last one is optimal in tropical and subtropical regions.

The means of overheat protection in hot climate are:

1. High vegetation rate, low hard pavement rate.
2. Artificial water reservoirs, water sprinkling.
3. Thick walls (0.5 m and more), optimal construction material — clay, brick, porous concrete, obligate hydroisolation layer.
4. High ceiling (3.2 m and more).
5. Gallery constructions.
6. Shields, profiles, grates and other sun-protective elements.
7. Isolation of kitchens and laundries.
8. Painting walls in white color.
9. Double isolating roof, roof with water cooling.
10. Proper ventilation.
11. Air conditioning.

*Industrial zone* contains enterprises and other industrial sites. It should protect the dwelling district from pollution and keeps good connection between two zones. The means of pollution prevention are: creation sanitary protective zone (its size depends on the type and intensity of the pollution); enterprises should be located down by the river, liquid waste should be deactivated; hard waste should be collected and removed to special sites; industrial traffic should be run on separate traffic lines not involving dwelling zone transport system.

Industrial zone should be down from the city by the dominating wind direction. There are five classes of industrial sites according to the Ukrainian system — SN-245-71.1 : 1st class enterprises (1,000 m protective zone), 2nd class (500 m), 3rd class (300 m); 4th (100 m), 5th (50 m). Sanitary protective zone is planned to solve the gas toxic waste, passing over it. No dwelling construction is allowed here. Construction of baths, laundries, canteens, offices, construction bureaus and laboratories, garages and technical construction is permitted. Antenna areas, radiolocation sites and other power sources of microwaves fields should have the sanitary zone as 1 km and 10–20% of this area should be occupied by vegetations.

*Communal-storage zone* includes the stores for:  
— construction materials;  
— hard and liquid fuel;  
— food and goods, refrigerators and vegetable storages;



- transport garages and routes;
- water supplies and sewer system,

Food storage should be kept away from sources of dust and odor. The best to use some storage zones for better supply of residential area but each zone should be separated from dwelling area. Some storage sites should be surrounded by protective zones (concrete elevators — 500 m, dust fuel and dusty construction materials — 300 m, etc).

*External transport zone.* The primary task is to isolate the railroad from dwelling area or recreation zone. Technical building for transport supply should be located out of the city. Sanitary zone between them and the dwelling zone is 300 m, for railway station — 300 m, for railway itself — 200 m. the sanitary zone between sea port and dwelling area is 100 m, the zone for dusty cargo is 300 m. Fishing ports should be located at least 1 km away from the dwelling zone. The airport should be located on low efficiency grounds. The distance between the dwelling area and class A (international terminals) and B airport is 30 km, for class C — 20 km and 5–10 km for small airports.

*Suburb.* It's close to the dwelling zone and has multiple functions. Its gardening helps the recreation by improving the microclimate and decreasing wind influence. It includes the protective line of forest and parks and the places of rest. Its parks are connected to the city parks. Suburb area is also a source of food supply and recreation.

*Vegetation zone* should occupy at least 40–50% of the dwelling territory (Table 63).

Trees and bushes with poisonous fruit, prickles or allergic activity are not used for city vegetations. In hot climate the plants should be steady to heat and dust (apricot tree, sofora, poplar). In arid hot climate the vegetation should be dense, in humide — sparse grass sods and flowers also improve the microclimate. Parks should have have the leisure zone, sport zone and children playing zone.

Table 63. Hygienic Importance of Vegetations

Positive	Negative
Protection from wind, dust and noise	Potential source of allergens
Microclimate optimization, humidity normalizing, aerodynamic shadow	Poisonous plants
Bactericide activity of phytoncides	Possible traumas
Oxygenation	Dust absorption on plants surface
Dust fixation by grass	
Architecture concern	
Esthetic and psychohygienic concern	

## COUNTRYSIDE DWELLING

The general principles of planning are the same but country has some peculiarities. The area for a new village should be located in healthy zone with low ground water level, free from flooding, with a good water supply and natural rainwater drainage, protected from winds if possible. Absolute demand: no highways should cross the village dwelling zone; the same concerns agricultural routes and cattle routes. The elements of planning are dwelling zone, municipal center and production zone. The improvements are water supply, sewers (especially in farming villages), rational cleaning mode, vegetation rate and optimal ration of zones.

The structure of dwelling zone depends on its constriction planning: sectional dwelling, houses without gardens (gardens stay separately), blocked building with gardens (garden area 0.06 ha) and farmhouses with garden areas 0.12–0.15 ha. These construction zones differ in building types, gardening areas and the sanitary technical supply. Farmhouses can be located along the streets or stay in groups. Production zone contains mechanical bay, farms and other technical buildings. It has some hazardous properties (odor, dust, noise, water waste) and should answer the following demands:

- 1) It should be built in the distance from dwelling zone.
- 2) It should be located down the river and the domination wind direction.
- 3) The space between the zones should be 50–1,500 m (depending on the farm size and its type), the space should be vegetated.

Municipal center accumulates school, kindergarten, medical center, club, bath, laundry, canteen, bakery, shops, post office. It should be placed close to the most improved part of the dwelling zone.

## SOIL HYGIENE

Soil is the natural formation of genetically bounded horizons formed by the modification of the lithospheric upper layers by air and living organisms. Soil is an important component of biosphere. The soil-forming factors of parent material and topography are largely site-related (attributes of the terrain), whereas those of climate and organisms are largely flux-related (inputs from the surroundings).

Soil fertility depends on a variety of properties (humus content, available nutruves, moisture, etc.). Harvest amount totally depends on soil fertility. There are potential (natural) and effective (increased by cultivation, fertilizers or melioration) fertility.

Hunger and malnutrition and the deterioration of the environment are the two important international problems that mankind faces today. As guardians

of the soil, soil scientists are uniquely placed to participate in environmental programs, specifically those that deal with land degradation. In the last decades, the soil science culture has extended to many other fields in addition to agriculture, including: cycling of bio-geo-chemicals, buffering the hydrological cycles, providing habitat for biota, and social relevance.

Ecological importance of soil degradation means not only shortening of food sources and inadequate vegetation. Climate changes, destroying of the ecological balance result soil degradation.

Sanitary importance of the residential area soil depends on the following factors:

- it's environment for arthropods living (mechanic vectors of intestinal infections flies and cockroaches);

- it's environment for geohelminthes;

- soil is a container of pathogenic bacteria vegetative forms, sporogenic bacilli, viruses;

- soil capability to self-recreation;

- probable source of secondary pollution of underground water-containing horizons and opened water reservoirs;

- dust formation;

- radioactive properties.

Sanitary condition of soil depends greatly on its structure. Soil consists of dense, liquid, gas and alive components. Soil solution is water with solved gases, mineral and organic compounds. The types of soil liquid component are film, capillary and gravitation water. Dense component consists of mineral compounds and humus — biogenic heavy-molecular dark colored soil (humine acids, humane and ulmine). Gas components ration depends on amount of pores and the sanitary condition of soil. Soil microflora, plants and animals inhabiting depends on climatic and geologic conditions.

Arctic areas are presented by tundra soils, with maternal levels covered with moss. Southern regions have podzol soils covered with acidic humane layer (12–15 cm). Forest-sleep zones are presented by gray forest soils.

Mechanic analysis data makes available the following divisions of soils: stony, gravel, cartilage, sandy (> 80% sand and < 10% of clay); sandy loam soil (50–80% of clay), lesser loamy soil (30–50% of clay), loamy soils (50–80% of clay), clay soils (> 80% of clay), lime soils (> 80% of clay), chalk soils, lessic soils (mixture of small sand particles with lime clay), black carth (> 20% of humus), turf soils, etc. (Table 64).

There are the indices of soil disperse capacity. The disperse properties of soil determine its air content. Filtration capacity, water content, capillarity, hygroscopic properties, evaporation capacity.

The epidemiological importance of soil depends on its capacity of infections, invasions and infestations spreading.

Table 64. **Classification of Soils**

Soils	Content of particles lesser than 1 $\mu$ in size
Heavy clay	> 80%
Medium and light clay	50–80%
Loamy soils:	
heavy	40–50%
medium	30–40%
light	20–30%
Sandy loam	10–20%
Sand:	
bounded	5–10%
crumbly	< 5%

Ecologic and epidemiological analysis of soil should include the evaluation of their biogeocenoses, the following ways of toxic, radioactive and biological agents transmission are possible.

In some regions with warmer climate the rate of ascaridosis and trichocephalosis among the population (especially children) reaches 90%. Lethal cases of massive ascaridic invasion (death comes as a result of ileus and necrotic enteritis) have been described. Statistic data state that each African is invaded by two types of helminthes approximately. The rate of ascaridosis at 1984 in India was 20%, in Southern Texas and Mesico — 35%, in Nigeria — 30%, in Costa Rica — 40%, in Brazil and Ethiopia — 58%, in Thailand — 70%, in Indonesia and Philippines — 85%.

Sanitary-entomological studies determine a number of winged flies, maggots, pre-chrysalis and chrysalis.

Sanitary-helminthological analysis defines quantity of helminth eggs and larvae.

These indices of sanitary-epidemiological state of soil are used (Table 65):

Self-regeneration of soil results in destruction of organic compounds to the level of mineral salts: nitrates, sulfates, carbonates which can be consumed by plants. Pathogenic microflora perishes suppressed by the antagonistic soil microbes associations and the soil chemical aggression (Table 66). Helminthes eggs are being destroyed by UV sun radiation, parching, etc. Fitoncides produced are able to kill pathogenic microbes.

Nitrification is the basic process of soil regeneration. It's the conversion process of restored organic nitrogen compounds into oxydated inorganic ones. There are heterotrophic and autotrophic nitrification ways. Heterotrophic nitrification is performed by living organisms (fungi included) which affect both organic and inorganic niter compounds.

Nitrite-oxidizing bacteria are found in aerobic, but occasionally also in anaerobic, environments where organic matter is mineralized. They are wide-

Table 65. **Hygienic Assessment of Soil**

Kind of soil	Coli-tytre	Perfringens-tytre	Number of helminthes eggs in 1 kg	Sanitary index*	Flies larvae in 0.25 m <sup>2</sup>
Clean	> 1.0	> 0.1	0	0.98–1.0	0
Low pollution	1.0–0.01	0.1–0.001	10	0.85–0.98	1–9
Polluted	0.01–0.001	0.001–0.0001	10–100	0.7–0.85	10–25
Heavily polluted	< 0.001	< 0.0001	> 100	< 0.7	> 25

\* — ratio of humus nitrogen to inorganic soil nitrogen.

ly distributed in soils, fresh water, brackish water, seawater, mudlayers, sewage disposal systems, and inside stones of historical buildings and rocks. They are also found inside corroded bricks and on concrete surfaces such as in cooling towers and highway-automobile tunnels.

Nitrification aids in the decomposition of nitrogenous material and thus in the recycling of nitrogen atoms since the deamination of organic nitrogen produces ammonia that is subsequently oxidized to nitrate by nitrification.

The microbes that perform nitrification are inefficient. Most of them are autotrophs that use the energy gained from oxidizing ammonia to fix carbon. Thus these bacteria have a dual ecological role — they are involved in recycling nitrogen and in fixing carbon into organics. Carbon fixation by this method is not very efficient. Therefore a lot of nitrogenous oxidation is required to acquire enough energy to fix carbon. The fixation of one mole of carbon requires the oxidation of 35 moles of ammonia to nitrite and of 100 moles of nitrite to nitrate.

The microbes that perform nitrification are fragile. These organisms are acid-sensitive even though they produce acid. If a large source of nitrogen is dumped into the environment, these organisms can potentially kill themselves by metabolizing it to nitric acid. Since they are also strict aerobes, they can be killed if introduction of waste leads to excessive growth of other species that deplete oxygen (i.e. eutrophication).

Nitrification is the basic natural way of nitrates conversion. The optimal temperature range for nitrifying bacteria is 25–37°C, the process fails under 3°C and over 50°C. Most nitrifiers are aerobic, their growth and development claims good soil aeration. The most active nitrification processes run in porous soils with particles sized 2–10 mm (sandy soils, sandy loam, black earth). Soil cultivation and ploughing helps aeration. Soil humidity under 25–30% suppressed nitrification.

Sanitary protection of inhabited areas soil include preventive measures like sanitary monitoring and sanitation measures. The objects for sanitary supervision are natural soils outside the residential areas or sites for future constructions, artificial soils in residential areas (polluted usually), removed ground

Table 66. **Survival Terms of Pathogenic Microflora in Soil**

Bacteria	Average (weeks)	Maximum (weeks)
<i>Salmonella sp.</i>	2–3	Over 12
<i>Shigella sp.</i>	1.5–5	Appr. 9
<i>Vibrio cholerae</i>	1–2	Up to 4
<i>Brucella sp.</i>	0.5–3	Up to 4
<i>Francisella tularensis</i>	1–2	Up to 2.5
<i>Yersinia pestis</i>	0.5	Up to 1
<i>Mycobacterium tuberculosis</i>	13	Up to 7
<i>Enteroviridae sp.</i>	–	3–6

formed by vertical planning, artificial pavements.

Sanitary protection contains: sanitary melioration; drying of marshes; decrease of soil water level; irrigation; vertical planning (for regulating rain water superficial drainage, drainage improvement); planting, erosion termination; pavement construction; prevention of soil pollution; sanitary purification of residential areas; sanitary means of water reservoirs and air pollution.

For prevention of ancylostomidosis it is used: treatment of invaded persons; health promotion; hygienic sanitary sanitation; personal hygiene (no barefoot walking, laundering in opened water reservoirs, eating unwashed raw vegetables).

There are the following measures of schistosomiasis prevention: determination and treatment of invaded persons; destruction of intermediate hosts (mollusks) with molluscicides (2-cyclohexane-4.6-dinitrophenole, mechanic destruction, water plants destruction); prevention of water reservoirs pollution; personal hygiene; health promotion.

## SANITARY PURIFYING OF POPULATED AREAS

Purifying and removal of waste is one of the most important sanitary problems, it is especially important for countries with hot climate where the sanitary hazard of waste is much higher than in colder

regions. Poor state of purifying process causes the increase of infectious and parasite diseases. The cost of their management is much higher than the sum needed for rational hygienically monitored purifying system organisation.

Methods of waste disposal date from ancient times, and sanitary sewers have been found in the ruins of the prehistoric cities of Crete and the ancient Assyrian cities. Storm-water sewers built by the Romans are still in service today. Although the primary function of these was drainage, the Roman practice of dumping refuse in the streets caused significant quantities of organic matter to be carried along with the rainwater runoff. Toward the end of the Middle Ages, underground privy vaults and, later, cesspools were developed. When these containers became full, sanitation workers removed the deposit at the owner's expense. The waste were used as fertilizer at nearby farms or were dumped into watercourses or onto vacant land. A few centuries later, there was renewed construction of storm sewers, mostly in the form of open channels or street gutters. At first, disposing of any waste in these sewers was forbidden, but by the XIX century it was recognized that community health could be improved by discharging human waste into the storm sewers for rapid removal. Development of municipal water-supply systems and household plumbing brought about flush toilets and the beginning of modern sewer systems. Despite reservations that sanitary sewer systems wasted resources, posed health hazards, and were expensive, many cities built them.

At the beginning of the XX century, a few cities and industries began to recognize that the discharge of sewage directly into the streams caused health problems, and this led to the construction of sewage-treatment facilities. At about the same time, the septic tank was introduced as a means of treating domestic sewage from individual households both in suburban and rural areas. Because of the abundance of diluting water and the presence of sizable social and economic problems during the first half of the XX century, few municipalities and industries provided wastewater treatment.

The waste of everyday human life are slops, food waste, garbage, trash, laundry water waste, construction waste, industrial waste, etc. One human being produces about 0.5 m<sup>3</sup> of waste per year.

The common classification of waste are:

*Liquid waste:*

- urine and feces;
- slops (kitchen water waste, bath water waste, cleaning water);
- landry and bath waste;
- industrial water waste;
- rainwater.

*Solid waste:*

- home garbage (trash, wood, paper, cardboard, cloth, bones, coal, metal, gum, glass, plastic);

- kitchen waste (food leftovers);
- industrial waste;
- animal waste;
- animal corpses;
- laughter houses waste:
  - a) confiscates (animal corpses and their parts confiscated by the veterinary-sanitary service);
  - b) skins of the infested animals;
  - c) contents of the herbivorous animals stomach
  - d) embryos of horses and pigs;
  - e) unusable organs (genitals, trachea, fat and meat);
- food confiscated by the sanitary service;
- human body parts from anatomic classes and obstetric and surgical departments;
- manure.

Sanitary and epidemical state of cities depends on purifying greatly. Solid waste pollutes streets and yards. Decay of human and animal feces produces odorous gases. Waste can contain infectious agents (bacteria, viruses) and parasites (protozoa, eggs and larvae of helminthes). Viruses can stay alive for 6 months, salmonella typhi — for 4 months. Tuberculosis agents and anaerobic agents (clostridium) stay alive for the longest period. Poorly purified waste can pollute soil opened water reservoirs and subterranean waters. Flies inhabiting waste increase their epidemic danger. Winged fly body surface contains pathogenic microbes, these insects act as mechanic vectors and pollute food.

Sanitary purification is one of the main ways of inactions and helminthoses prophylaxis.

## WASTE MANAGEMENT

Sanitary purification includes the ways of collection, removal and disinfection of waste. The contact of human with unprocessed waste should be minimal, thus collection and removal of waste should be performed regularly and often, maximally mechanizing and hermetising the technological process.

Waste contains a lot of niter, phosphorus, potassium and other microelements which could serve as fertilizers. These elements should be mineralized from organic compounds. Mineralization is an important sanitary and agricultural process.

In village home waste can be collected, deactivated and utilized at gardens. The way of waste utilization in cities depends on the city system type.

Liquid waste is utilized in two ways: extraction (assainization) and sewage. The first way includes special transport removing the liquid waste out of town in the second way the waste waters run in pipes. Sewage is a more effective way replacing assainization. Hard waste is removed to special sites for deactivation. The purifying of liquid waste consists of the following periods: (1) collection and temporary keeping; (2) transport (hydraulic or by vehicles); (3) deactivation.

Latrines and water closets are the first part of this system, the latrine should answer the following requirements: it should be available, comfortable, and simple, produce no odor and it should not pollute soil or subterranean waters.

Feces should be isolated from flies and insects.

Water closets answer these demands in the best way. Their functioning demands water supply and sewage systems.

In rural areas they can be used in presence of small sewage systems. Latrines with extraction pits, aquatic latrines and compost latrines are popular in countryside. Latrines with extraction system is the most typical. Temporary dwelling places are equipped with latrine trenches. Older system "heidelberg" barrel latrine, "finnish" and fire latrines are not used now.

Latrine with the extraction pit is the typical for a countryside: it should be placed on dry soil without flood danger not far from the house (but at least at 15 m distance), and at least at 30 meters from the well, on a lower landscape level. The latrine pit should be water resistant (concrete, bricks, clay). The depth of the pit is 2–2.5 m, diameter — 65–90 cm the pit is constructed for 10–15 years (at least 4 years), the latrine should be removed when the feces level reaches the 0.5 m level from the ground surface.

If the waste is used for fertilization, the latrine should be planned for 1 year usage. Then the latrine should be removed, and the excrements are left for 1 year more for decay and disinfection and then utilized, then the cleaned pit is ready for a new cycle, the extraction pit should be ventilated with pipe (more effective in countries with cold climate) and covered with a plate with the opening (in a turkish way). The opening should be covered to protect excrements from flies. Walls and roof of the latrine should have no openings. The door is to be equipped with blocking system, the ventilation pipe is covered with a net. The rainwater should be removed from the latrine by a draining ditch. Public places are equipped by the "turkish" latrines with a few seats for males and females. The separation walls between the seats should not exceed 1.5 meters. Ukrainian hygiene recommends 2.75 m<sup>2</sup> for a seat and 1.5 m for a pissoire. The cabin doors should leave the 15 cm space over the floor. In public latrines excrement are processed with chloral time (1–2 kg/m<sup>2</sup>), walls and floor are disinfected. The contents of the pit are evacuated systematically.

The rural areas are usually equipped by latrines with the extraction and covering system (turf closets, pudreloscis, ground closets) feces are collected in a metal basin with turf or ground then covered with the same material and evacuated to the compost site each day. This type is effective in areas with the high level ground water usually they are constructed in special buildings. Temporary dwelling places are equipped with latrine ditches. The depth

of the trench is 0.6 m, the width 0.3 m. The length depends on the amount of people. The walls of the trench are widened in the lower part to protect it from rainwater. The trench is filled with earth after usage for disinfection and isolation when its 2/3 is filled. The trenches are surrounded by bushes or film.

Fertilization of soil with unprocessed feces creates the danger of vegetations pollution. Watering the plants with the mixture of feces and water is most dangerous. Excrements disinfection is performed by composting or by other biothermic methods. Biothermic methods are based on cultivation of thermophilic bacteria (*Thermoplasma*) in excrement. Their activity increases the medium temperature to 50–70 c. Under such conditions pathogenic microorganisms, helminthes eggs and fly larvae die, organic compounds undergo mineralization. Composting and biothermic cameras are used in countryside. Composting sites are constructed on clay surface 2–3 meters in width. The surface is covered by 15 cm layer of turf and then with garbage, latrines contents, manure, ashes, straw and leaves. The heap is covered with 15 cm layer of material — turf to protect it from parching and isolate it from flies. Then the new layer of waste is placed. The cycle repeats until the heap reaches 1.5 m in height the heap is covered by water-resistant film or by the root the compost side should be periodically sprinkled with liquid manure or slops. Ashes increase the mineralization process.

The ripening of compost in hot climate lasts for 3–4 months. Garbage and fecal composts ripe faster. The process can be forced by digging of compost heap. The 10 digging procedures (about 50 days) make the compost ready (in hot climate). Ripe compost is a brown powder without any stench and unfavored by flies.

In tropical countries with strong winds or showers compost trenches are preferable, their width is 2 m and depth is 1 m. Each day the new layer of waste is covered by the 15 cm layer of ground.

Biothermic cameras are water and thermoresistant buildings. Their contents are extracted after ripening and the building becomes ready for a new cycle.

### Liquid Waste Management

The waste transport ways in sites without sewage are as follows:

- barrels manually (with basins);
- hermetic barrels filled by pneumatic pumps;
- auto cans.

Manually filled barrels are especially epidemically dangerous in hot climate. Pneumatic barrels are imperfect too. Large auto cans containing up to 50 m<sup>3</sup> of waste can be used in large villages only. Remote farms can be served by them, as feces do not stand long-term transportation.

In sites with partial sewage the sewage centers are equipped with pouring systems, where solved excrements are poured into and join the sewage waters. The sites without any canalization are equipped by assimilation field where the waste is buried for deactivation.

Assainisation fields are used both for liquid waste deactivation and for agriculture. The digging fields are used for deactivation only.

Assainisation fields are separated into summer (2–3 sectors) and winter (1 sector) parts, the loading is 1,000 m<sup>3</sup> of excrements per 1 ha. The agricultural turn should last for three years at least: 1 year — excrements grounding; 2–3 years — animal food cultures (clover, lucerne, turnip), corn, grain, wheat (not rice), technical cultures; 4 year — vegetables.

Assainisation field should be located at a distance of 500 m or more from the dwelling area.

The digging fields are separated in two sectors — one is used within a year another one for regeneration. The loading is 2,000 m<sup>3</sup>/ha. The distance between them and the dwelling area should be 2 km at least. 1,000 population needs 0.6 ha of diggings fields (with roads).

**Wastewaters Management.** Wastewaters contain nitrogen and phosphates that, being fertilizers, encourage the growth of algae. Excessive algae growth can block sunlight and foul the water.

Wastewaters also contain organic material that bacteria in the environment will start decomposing, and when they do these bacteria consume oxygen in the water. The lack of oxygen kills fish. The increased algae, reduced oxygen and murkiness destroy the ability of a stream or lake to support wild-life, and all of the fish, frogs, and other life forms quickly die.

Waste waters are evacuated by the drainage system based on hydraulic transportation principle. Sewage system is a complex of engineering and sanitary means subjected to deactivation of wastewaters and industrial liquid waste and to transport them by pipes away from the city.

Wastewaters are separated into hose fecal, industrial and atmospheric. 1 ha of dwelling area produces 10,000–25,000 m<sup>3</sup> of wastewaters per year.

Basic types of sewage system are general and separated. General system is characterized by one net of pipes for all sorts of liquid waste. Separated system has isolated pipes for different types of wastewaters. Sewage for rainwater is called rain sewage, fecal sewage is constructed for home liquid waste sewage systems for industrial liquid waste only are called industrial sewage system for both industrial and home waste, etc.

Separated sewage system includes complete and incomplete types. Complete separated sewage has

two independent lines rainwater and industrial fecal sewage systems. Incomplete type has one system only for industrial and fecal waste. Rainwater is evacuated by drainage trenches and talvets.

Partially separated system is a type of sewage with two independent pipe systems rainwater and industrial-focal with special shunts for pouring of the polluted rainwater into the fecal system and transport it to purifying stations. At great showers the pure rainwater reservoirs. The fecal pipes are placed below the rainwater ones.

Combined system is typical for large cities with general sewage system. Old city sectors are equipped with the general system, new sectors receive a separated one. The sewage constructions are separated in three groups:

1. Equipment and constructions for obtaining and transporting waste:

— lavatory bowl, tubs, bathtubs;

— a network of extracting pipes, flush pipes and extractors;

— network — yard block street network collector.

2. Pump station and pipelines.

3. Constructions of treatment plant.

Sanitary equipment is located in kitchen, toilet, bathroom. In some countries (UK) the tubs are located in bedrooms. Water traps are placed between the pipeline network and house waste collectors to isolate the air from gases and odor. These traps are the parts of lavatory bowls and are constructed during the fixation of tubs and other equipment. Revision hatches are constructed for pipes cleaning. Waste water run into yard pipeline system through the flush pipe. These pipes are constructed in the walls or in special shafts, their upper ends are located on the roof and equipped with a ventilation tube with a deflector; industrial sites are equipped by traps and hatches for collectors.

A part of sewage system collecting waste from one or several sectors is called the collector. There are the following types of collectors:

1. Collector of the sewage sector.

2. General collectors.

3. Extracting collectors.

Large collectors are sometimes called channels. Collectors are placed along the landscape angle. To raise the water to upper levels pumping stations are constructed.

**Septic Tank.** In rural areas where houses are spaced so far apart that a sewer system would be too expensive to install, people install their own, private sewage treatment plants. They are called septic tanks (Fig. 45).

A septic tank is simply a big concrete or steel tank buried in the yard. The tank might hold 1,000 gallons (4,000 liters) of water.

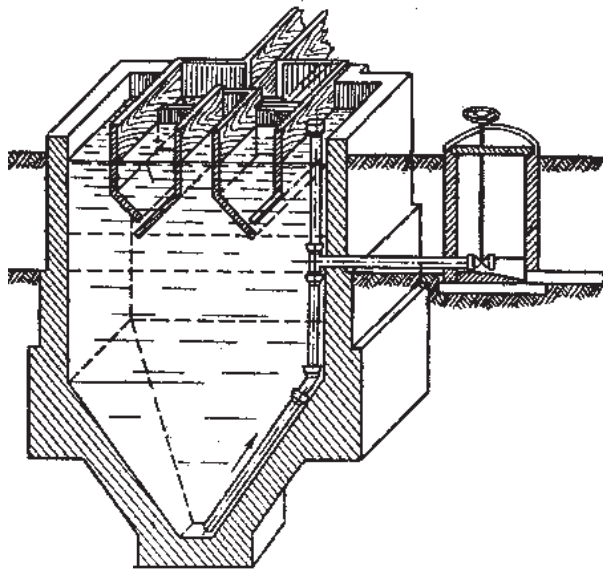


Fig. 45. Septic-tank

In this picture you can see three layers. Anything that floats rises to the top and forms a layer known as the scum layer. Anything heavier than water sinks to form the sludge layer. In the middle is a fairly clear water layer. This body of water contains bacteria and chemicals like nitrogen and phosphorous that act as fertilizers, but it is largely free of solids.

A septic tank naturally produces gases (caused by bacteria breaking down the organic material in the wastewater), and these gases don't smell good. Sinks therefore have loops of pipe called P-traps that hold water in the lower loop and block the gases from flowing back into the house. The gases instead flow up a vent pipe — if you look at the roof of any house you will see one or more vent pipes poking through the shingles. As new water enters the tank, it displaces the water that is already there. This water flows out of the septic tank to a drain field. A drain field is made of perforated pipes buried in trenches filled with gravel. A typical drain field pipe is 4 in (10 cm) in diameter and it is buried in a trench that is 4 to 6 feet deep and 2 feet wide. The gravel fills the bottom 2 to 3 feet of the trench and dirt covers the gravel.

The water is slowly absorbed and filtered by the ground in the drain field. The size of the drain field is determined by how well the ground absorbs water. In places where the ground is hard clay that absorbs water very slowly, the drain field has to be much bigger.

A septic system is normally powered by nothing but gravity. Water flows down from the house to the tank, and down from the tank to the drain field. It is a completely passive system.

In urban and suburban areas where people are packed closer together and where there is a lot more wastewater to treat, the community will construct a

sewer system that collects wastewater and takes it to a wastewater treatment facility.

In the ideal case, a sewer system is completely gravity-powered as well. Pipes from each house or building flow to a main collector that runs, for example, down the middle of the street. The main collector might be 1–1.5 m in diameter. Periodically a vertical pipe will run up from the main collector to the surface and is covered by a manhole cover. Manholes allow access to the main for maintenance purposes.

The sewer mains flow into progressively larger pipes until they reach the wastewater treatment plant. In order to help gravity do its job, the wastewater treatment plant is usually located in a low-lying area, and sewer mains will often follow creekbeds and streambeds (which flow naturally downhill) to the plant.

Normally the lay of the land will not completely cooperate, and gravity cannot do all the work. In these cases, the sewer system will include a grinder-pump or a lift station to move the wastewater up over a hill.

Once the water reaches the wastewater treatment plant, it goes through one, two or three stages of treatment (depending on the sophistication of the plant). Here's what each stage does:

*The first stage*, also known as *primary treatment*, does the same thing a septic tank does. It allows the solids to settle out of the water and the scum to rise. The system then collects the solids for disposal (either in a landfill or an incinerator). Primary treatment is very simple — it involves a screen followed by a set of pools or ponds that let the water sit so that the solids can settle out. Primary treatment might remove half of the solids, organic materials and bacteria from the water. If the plant does no more than primary treatment, then the water is chlorinated to kill the remaining bacteria and discharged.

*The second stage*, also known as *secondary treatment*, removes organic materials and nutrients. This is done with the help of bacteria — the water flows to large, aerated tanks where bacteria consume everything they can. The wastewater then flows to settling tanks where the bacteria settle out. Secondary treatment might remove 90% of all solids and organic materials from the wastewater.

*The third stage*, also known as *tertiary treatment*, varies depending on the community and the composition of the wastewater. Typically the third stage will use chemicals to remove phosphorous and nitrogen from the water, but may also include filter beds and other types of treatment. Chlorine added to the water kills any remaining bacteria and the water is discharged.

Wastewater is carried from its source to treatment facility pipe systems that are generally classified

according to the type of wastewater flowing through them. If the system carries both domestic and storm-water sewage, it is called a combined system, and these usually serve the older sections of urban areas. As the cities expanded and began to provide treatment of sewage, sanitary sewage was separated from storm sewage by a separate pipe network. This arrangement is more efficient because it excludes the voluminous storm sewage from the treatment plant. It permits flexibility in the operation of the plant and prevents pollution caused by combined sewer overflow, which occurs when the sewer is not big enough to transport both household sewage and storm water. Another solution to the overflow problem has been adopted by some cities to reduce costs: instead of building a separate household sewer network, large reservoirs, mostly underground, are built to store the combined sewer overflow, which is pumped back into the system when it is no longer overloaded.

Households are usually connected to the sewer mains by clay, cast-iron, or polyvinyl chloride (PVC) pipes 8 to 10 cm in diameter. Larger-diameter sewer mains can be located along the centerline of a street or alley about 1.8 m or more below the surface. The smaller pipes are usually made of clay, concrete, or asbestos cement, and the large pipes are generally of unlined or lined reinforced-concrete construction. Unlike the water-supply system, wastewater flows through sewer pipes by gravity rather than by pressure. The pipe must be sloped to permit the wastewater to flow at a velocity of at least 0.46 m/s, because at lower velocities the solid material tends to settle in the pipe. Storm-water mains are similar to sanitary sewers except that they have a much larger diameter. Certain types of sewers, such as inverted siphons and pipes from pumping stations, flow under pressure, and are thus called force mains.

Urban sewer mains generally discharge into interceptor sewers, which can then join to form a trunk line that discharges into the wastewater-treatment plant. Interceptors and trunk lines, generally made of brick or reinforced concrete, are sometimes large enough for a truck to pass through them.

Purifying constructions deactivate waste waters. The pipe for the pumped waste is called the extractor. Emergent extractor is located on pumps station to shunt the unprocessed waste into water reservoirs. Chief collectors are sometimes equipped with rainwater drainages for shunting of rainwater.

### Burying

Burying corpses is an important problem. Corpses undergo quick decay. They produce odorous gases, infected corpses are especially epidemically dangerous. Infected corpses should be isolated as soon as possible, wrapped in a cloth with disinfected liquid and placed in a coffin with disinfecting com-

pounds (chloral time) with turf; ground or sawdust. Quick burying is an important epidemiologic mean, the corpse can be both buried or cremated.

After burying the corpses undergo decay and mineralization. The process speed depends on the soil type. Overloading of soil with corpses makes the process longer. Complete mineralization is finished approximately in 20 years.

Cremation is the best way of corpse utilization. No area for cemetery should be used, a lot of place for construction becomes free. Cremation is performed in crematoriums at the temperature of 800–1,000°C. The corpse turns into ashes in 1–2 h, the weight of ashes makes about 2.5 kg. In some countries cremation is the national tradition.

### Solid Waste Management

For solid waste disposal they use landfills and incineration. Last way is the best for medical waste and any infected solid waste. Organized landfills should be placed in 500 m from residential area, but no-organized (“wild landfills”) — in two and more kilometers. The number of landfills in developed countries is steadily decreasing — for example, in USA from 8,000 in 1988 to 2,400 in 1996. The capacity, however, has remained relatively constant. New landfills are much larger than in the past.

The modern methods of waste treatment are following:

*Biological treatment:* usually involves treatment of waste by bacteria, fungi, or algae to remove and degrade the hazardous constituents.

*Boiler:* is a type of device that can be used to treat hazardous waste. Boilers use controlled flame combustion and recover thermal energy in the form of steam or heated gases.

*Carbon adsorption:* uses activated carbon to adsorb hazardous waste constituents. Gaseous and aqueous waste streams can be treated by carbon adsorption.

*Chemical oxidation:* uses strong oxidizing agents (e.g. hypochlorite, peroxides, persulfates, perchlorates, permanganates, etc.) to break down hazardous waste constituents to render them less toxic or mobile.

*Chemical reduction:* uses strong reducing agents (e.g. sulfur dioxide, alkali salts, sulfides, iron salts, etc.) to break down hazardous waste constituents to render them less toxic or mobile.

*Deactivation:* is a process that removes the hazardous nature of the waste by neutralizing the characteristics of ignitability, corrosivity, and/or reactivity.

*Extraction:* is a process that removes hazardous constituents from either gaseous or liquid waste streams by means of settling, filtration, adsorption, absorption, solvents, or other means. Although the extracted hazardous constituents are removed from the waste stream, they usually must be treated further to render them less toxic.



*Incineration:* is the high temperature burning (rapid oxidation) of waste, usually at 1,600 to 2,500 degrees F. It is also known as controlled-flame combustion or calcination and is a technology that destroys organic constituents in waste materials.

*Industrial furnace:* is a type of hazardous waste treatment device that uses thermal energy to recover energy or materials. It includes cement kilns, lime kilns, aggregate kilns, phosphate kilns, coke ovens, blast furnaces, smelting furnaces, etc.

*Microencapsulation:* is a process that coats the surface of the waste material with a thin layer of plastic or resin to prevent the material from leaching hazardous waste constituents.

*Neutralization:* is a process that is used to treat corrosive hazardous waste streams. Low pH acidic corrosive waste streams are usually neutralized by containing bases. High pH corrosive waste streams are usually neutralized by adding acids.

*Physical removal:* is a process that removes the hazardous constituents from waste streams by separation techniques such as ion exchange, adsorption, reverse osmosis, chelation, solvent extraction, crystallization, precipitation, distillation, filtration, evaporation, etc. The removed hazardous constituents may require further treatment to make them less toxic.

*Smelting:* is a technology that uses high temperature heating to recover metals from waste streams (e.g. lead, zinc).

*Stabilization:* is a process that reduces the mobility of the hazardous constituents of a waste or that makes the waste easier to handle. The most common stabilization agents added to waste streams are Portland cement, lime, fly ash, and cement kiln dust.

*Steam stripping:* is a treatment technology that is usually used to remove organic compounds from liquid waste streams. The process involves direct application of steam to the liquid and subsequent condensation of the extracted organic compounds. Steam stripping not only removes hazardous constituents from the waste stream but it also can have the added benefit of making the constituents less toxic.

*Treatment in tanks:* mechanical settling, gravity settling, chemical oxidation, and neutralization are examples of hazardous waste treatment technologies that are allowed to take place in tanks.

*Vitrification:* is a process that uses high temperatures to melt hazardous waste into molten glass. Subsequent cooling of molten glass material results in solid blocks of material which are resistant to leaching hazardous constituents.

*Waste to energy incineration:* is a technology that is usually associated with municipal waste combustion where the waste is burned at a high temperature. Heat energy is recovered from the combustion process and is usually used to generate steam and/or electricity.

## Industrial Waste Management

Each year, industrial facilities generate and manage billions tons of nonhazardous industrial waste in land application units. Generated by a broad spectrum of U. S. industries, industrial waste is process waste associated with manufacturing. This waste usually is not classified as either municipal waste or hazardous waste by federal or state laws. Although state, tribal, and some local governments have regulatory responsibility for ensuring proper management of industrial waste, their regulatory programs vary widely.

Although source reduction, reuse, recycling, and composting can divert large portions of municipal solid waste (MSW) from disposal, some waste still must be placed in landfills. Modern landfills are well-engineered facilities that are located, designed, operated, monitored, closed, cared for after closure, cleaned up when necessary, and financed to insure compliance with federal regulations. The federal regulations were established to protect human health and the environment. In addition, these new landfills can collect potentially harmful landfill gas emissions and convert the gas into energy.

To reduce waste volume, local governments or private operators can implement a controlled burning process called combustion or incineration. In addition to minimizing volume, combustors, when properly equipped, can convert water into steam to fuel heating systems or generate electricity.

A variety of pollution control technologies reduce the toxic materials emitted in combustion smoke. Among these are scrubbers — a device that uses a liquid spray to neutralize acid gases in smoke — and filters, which remove tiny ash particles from the smoke. Burning waste at extremely high temperatures also destroys harmful chemical compounds and disease-causing bacteria. Regular testing ensures that residual ash is nonhazardous before being landfilled.

Common household items such as paints, cleaners, oils, batteries, and pesticides contain hazardous components. Leftover portions of these products are called household hazardous waste. These products, if mishandled, can be dangerous to health and the environment.

Medical waste<sup>1</sup> is generally defined as any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in researches, including but not limited to:

- soiled or blood-soaked bandages;
- culture dishes and other glassware;
- discarded surgical gloves-after surgery;
- discarded surgical instruments-scalpels;
- needles-used to give shots or draw blood;
- cultures, stocks, swabs used to inoculate cultures;
- removed body organs — tonsils, appendices, limbs, etc.

<sup>1</sup>see the chapter “Hospital Hygiene”.

## Chapter 10

# PERSONAL HYGIENE

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### BASIC CONCEPTS

In the system of measures of a healthy life style support there is increasing value gained by personal hygiene. Personal hygiene is one of major sections of hygiene studying the principles of saving and strengthening health by keeping the hygienic requirements in daily individual life and activity. Personal hygiene is a basis of a healthy life style, a condition of effective primary and secondary prophylaxis of various diseases.

In epoch of scientific and technical progress, which the negative consequences of urbanisation accompany chemical and physical environment, the personal hygiene becomes the potent factor of warning of cardiovascular and other most wide-spread diseases. It allows to struggle effectively with hypokinesia, psychological overstrain, weakens unpleasant consequences of influence of various professional harmfulness, and also negative effects of the natural and man-made environment.

It is known, that a healthy life style, refuse from harmful habits, the regular keeping of the rational mode of day and nutrition enlarges by 7–10 years life expectancy of a man. However, according to the data of WHO, the appreciable part of the population worldwide admits gross infringements of personal hygiene rules, smokes, abuses with alcoholic drinks, does not give a proper attention to physical culture, hardening and other units of a healthy way of life. All this promotes rise of a case rate, lowering of serviceability, shortening of active longevity and life expectancy.

The public value of personal hygiene is defined by the fact that not keeping of its requirements in daily life can render unfavorable influence on health enclosing (passive smoking, distribution of infectious diseases and helminthism, excavation of denaturation of the indoor air environment). Awareness and the skills of personal hygiene should be promoted from early age.

Into sphere of personal hygiene they determine:

- Hygiene of a body and oral cavity
- Physical culture and hardening
- Prophylaxis of harmful habits
- Sexual hygiene
- Hygiene of clothes and footwear
- Hygiene of rest and sleep
- Hygiene of individual power supply
- Hygiene of mental work and others

Health of the man is determined by two factors: heredity and conditions of life (or quality of environment). It would be fair to name also the third factor — the way of life.

Major factors of risk accompanying our daily life are following:

1) hypodynamia is for overwhelming majority of the population one of the most important factors. On the average during the day a man passes about 1.5 km, however by representatives of the defined categories of the population — less than 0.5 km. In ancient times and later man on the average passed 15–20 km.

2) non-rational nutrition, unbalanced in essential components, with predominance of energy rich products (sugar, etc.)

3) the increased level of psychological strength of life connected with proceeding urbanisation, increase of density of the population, increasing of automation, number of computers, non-rational loads at schools and other educational institutions and others.

4) a wide circulation and increase of a social significance of mental work;

5) a chemical denaturation of an environment pollution of free air, air environment of industrial and inhabited rooms, water, food-stuffs;

6) a physical denaturation of an environment; intensifying of the noise and vibratory factors, change of a radiation and electromagnetic background. In connection with the stated the guidelines in the sphere of personal hygiene should be directed at weakening or preventing negative consequenc-

es of influence on the organism of the indicated risk factors.

## PHYSICAL CULTURE

The physical culture is the major alternative to a more and more extending hypodynamia. The physical culture and sports are the very important unit of personal hygiene and healthy way of life of each man. Physical exercises allow to balance utilized energy with amount of consumed nutrition, stimulate activity of cardiovascular and respiratory systems, make a favorable influence on the function of the CNS, other organs and systems, weaken hypoxia connected to stagnation of blood in organs of the small pelvis, activate metabolic processes, raise stability to diseases and serviceability.

Components of physical culture and sports are walking, different kinds of sport games. In the elementary sorts of physical culture practically all the healthy adults and children should be engaged. The adapted physical exercises are useful as well as for the most part of the persons suffering from any chronic diseases.

However physical exercises should be individualized and proceed from a substantial state of health, age and the degree of preparedness of a man.

To determine a degree of functional preparedness to physical exercises and control at their execution the various tests are offered. With this purpose, for example, 12-minute Kuper's test can be used. It is based on the fact that between a distance (km) and consumption of oxygen (ml/kg in a minute) there is a link mirroring function preparedness of a man. So at the age of 30–39 years preparedness is considered bad, if the consumption of oxygen makes up 25 ml/kg per a minute, satisfactory — 30–40 ml/kg in a minute, excellent — 48 ml/kg per a minute and more.

Proceeding from this dependence, K. Kuper has offered criterion based on definition of extent of a distance, which the examinee is capable to pass or to run for 12 minutes, keeping good common state of health without feeling strong dyspnea, palpitation, other unpleasant sensations. So, for example, if a man at the age till 30 years for 12 minutes can pass no more than 1.6 km, keeping good common state of health, the degree of his function preparedness is estimated as unsatisfactory, 1.6–1.9 km — unsatisfactory, 2.0–2.4 km — satisfactory, 2.5–2.7 km — good, 2.8 km and more — excellent.

Academician Amosov offered to estimate change of the initial pulse rate after 20 knee-bends in sluggish rate, with the extended forwards hands and widely put knees. If the pulse rate will increase no more than by 25% from the initial one — state of the cardiovascular system is good, by 25–50% — satisfactory, by 75% and more — unsatisfactory.

There is one more accessible test — change of a pulse rate and common state of health at usual rise on foot on the fourth floor. The state is estimated as good, if the pulse rate does not exceed 100–120 per a minute, respiration is free, mild, there are no unpleasant sensations. A pulse rate — 100–120 per a minute and mild dyspnea characterize a state as satisfactory. If already on the third floor the dyspnea appears, the pulse rate is more than 140 per a minute, weakness — the functional state of cardiovascular and respiratory systems is estimated as bad.

The estimation of a functional state and health condition during physical exercises can be given by a pulse rate gauged in 1–2 minutes after completion of exercises. It should not fall outside the limits of 75–80% of the estimated figure received by subtraction of number of years from the digit 220. For example, at the age of 40 the estimated figure is  $220 - 40 = 180$ ; 75% from 180 makes 135; 85% — 153 (at the age of 50 years — accordingly 119–114). The physical exercises does not exceed functionalities of the organism, if the pulse rate will correspond to the age.

The most ancient and accessible sort of physical activity having no contraindications practically for overwhelming majority of the people, is the walking. A French doctor Tisset's saying: "the movement as such can replace any medicine, but all medicines of the world are not capable to replace movement" fully concerns walking. K. Kuper marked, that the honestly fulfilled walking can give to health as much, as a number of intense exercises. At walking with speed of 3 kms/h (70 steps per a minute) utilization of energy of a man of weight 70 kg makes 195 kcal/hour, with speed 5 km/hour (110 steps/min) — 290 kcal/h, 6 kms/h — 390 kcal/h. During day each adult man should pass no less than 8–10 thousand steps (approximately 1.5–2 h of walking), and 75% from them — at fresh air.

The second important kind of physical culture — morning hygienic gymnastics (MHG). It includes the complex of rather simple, not requiring large physical power, commonly developing power movements effecting basic groups of body muscles. It is necessary to make MHG after a sleep, before hydrotherapeutic procedures, it is desirable at the open air, or in the well ventilated clean room, accompanied by music as far as possible. 12–15 exercises including inflections, extensions, knee-bends, ranges, turns of the head, runk, circle movements of hands, legs, walking, running, jumping and other movements enlarges ejection of blood from depot and its circulation, increase tonus of the CNS and muscles, stimulate metabolic processes, develop the locomotorium, organs of respiration and cardiovascular system, improve activity of the digestive tube, promote more effective physical and mental activity during a working day. The utilization of energy is insignificant (80–90 kcal), however physiologic-hygienic value of morning exercises is very great

and it results in further increasing of energy utilization.

The important factor of personal hygiene is the tempering. In the narrow sense of the word tempering is a rise of stability of the organism to effect the air and water temperature variations, air humidities, atmospheric pressure, solar radiation and other physical factors of the environment. In the physiological ratio the tempering is surveyed as rise of adequate possibilities of the organism achievable by multiple training effect of this or that tempering factor or a complex of factors. The tempering raises adaptation of the organism not only to low temperature and other weather factors, but also to a lot of other unfavorable effects — physical, chemical, biological, psychological. It reduces a susceptibility of the organism to respiratory and other infectious diseases, raises serviceability, promotes creation of positive psychophysiological responses. Tempering is an effective path of correction of the genetically stipulated and acquired hypersensitivity to unfavorable natural effects.

The main tempering factors are air, water and solar radiation.

At carrying out tempering procedures it is necessary to adhere to the following philosophy gradualness (step-by-step increase of intensity and duration of operation of the tempering factor), it is necessary to fulfil systematic characters (tempering procedures not incidentally, and regularly, on the defined system), integrated approach (the combination of operation of the several factors, for example, air, water and sun), individualized approach (character, intensity and the mode of tempering should take into account individual features of a man — age, sex, state of health and others). The tempering can be started and carried out at any time of year.

As a result of tempering procedures in the organism the useful morphological and functional changes occur: the processes of thermoregulation improve, the barrier function of the skin raises, there is a compaction of false skin, the contents of sebum in sweat enlarges and the water content in tissues decreases.

## HYGIENE OF THE BODY

The important part of personal hygiene is hygiene of the body and oral cavity, support of cleanness of the body, a maintenance of the skin and hair are the most ancient units of hygiene.

The regular washings provide cleanness and normal functioning of the skin, that is very important in connection with its large physiological role. The skin containing a several millions of thermoreceptors, sweat and sebaceous glands, plays a very important role in thermometabolism. Through the skin

by infra-red irradiation, evaporations and conduction the organism loses more than 80% of formed heat, that is necessary for maintenance of thermal equilibrium. In conditions of thermal comfort through the skin 10–20 g of sweat in an h are secreted, during severe work and condition of overheating microclimate — 300–500 g and more. By the skin of an adult man 15–40 g of sebum, which composition includes various fatty acids, proteins and other substances are secreted; the excretion of flakes of false skin up to 15 g occurs. Through the skin the appreciable quantity of fugitive substances, including propanol, acetic acid, acetone, methanol, organic and inorganic salts, enzymes are excreted. The dump of these and other substances promotes bacteria and fungi reproduction on the skin, especially in the area of perineum, anus, sexual organs. The polluted skin becomes a source of stinky smell.

The skin participates in gas metabolism (excreting CO<sub>2</sub>), provides the organism with ergocalciferol (vitamin D, which will be derivated in its high layers from dehydrocholesterine under influence of ultraviolet rays).

The infiltration of pyogenic microorganisms into the skin can result in local and generalized inflammatory processes.

At the same time the skin (especially clean) have bactericidal properties: the quantity of microbial bodies put on the clean skin is reduced more, than by 90% during two hours. The bactericidal action of the well washed up skin is 15–20 times higher, than of the dirty one. Therefore regular washings of all body by warm water are necessary. It is necessary daily in evening to wash legs, daily washing of outer sexual organs (especially for women). There is recommended to wash hair once per a week if dry skin and once per 3–4 days if fatty skin.

The various soaps and synthetic washing-up liquids are applied to more effective deleting of pollution from a surface of the skin and hair. As a resource of hygienic maintenance of the body for the population of many countries of the world the bathings in bathhouses are widely widespread.

The hydrothermal procedures in a bath-house render the tempering action to the organism, normalize all sorts of metabolism, promote excreting of various slags from the organism, reduce quantity of bacteria on the skin, cause an original psychological relaxation and so on.

It is necessary, however, to take into account, that the air environment of bathhouse is characterized by the reduced contents of oxygen. The partial pressure of oxygen corresponds, approximately, to the pressure at height of 2,000 m above the sea level. The hypoxia effect capable to cause unfavorable response of spastic character for the patients with hypertension and coronary disease is possible. Very high temperature in a bath house can cause disorder of atrioventricular conduction.

In rooms of bath-houses there should be a good cooling, strict sanitary-antiepidemic mode, no less often than once per month the wet chemical disinfection should be carried out.

The great doctors of ancient Greece (Hippocrates) and ancient Rome (Halen) considered the bathhouse as a potent treatment-and-prophylactic resource and included bathing in a number of medical procedures. Nowadays regular bathing is considered to be a crucial element of primary prevention and disease control.

**Ear Wax.** Cerumen or ear wax accumulates in the ear canal that leads from the outer ear to the ear drum. As the secretion comes out of the ear it collects dust particles which might have got in from outside. Daily washing with soap and water is enough to keep the outer ear clean. Putting in hairpins, safety pins or blunt edged things for cleaning purposes might harm the ear. If person feel wax has accumulated and is plugging your ears and interfering with hearing, he or she should consult a doctor.

**Skin Hygiene.** In Victorian England, modest young women were taught to wash themselves without getting quite naked. In Hindu culture baths were, apart from daily ablutions, mandatory as part of observing pollution for various reasons and occasions. But ritual bathing, or a dip, is quite different from the daily bath personal hygiene demands. Soap and water are essential for keeping the skin clean. A good bath once or twice a day is recommended, especially in tropical countries like India. Those who are involved in active sports or work out to a sweat would do well to take a bath after the activity. A mild soap will do the job adequately. Germicidal or antiseptic soaps are not essential for the daily bath. They recommend to use a bath sponge for scrubbing. Back brushes and heel scrubbers are also available. People should be educated to avoid sharing soaps and towels and to change into clean underwear after bath.

Around middle age the skin tends to get dry a bit. A moistening oil or cream can be used. It is better to use this at night, because if an individual goes out in the sun or commute on dusty roads when the skin is wet, dust sticks to it.

The body has nearly two million sweat glands. These glands produce 1.5–2.0 litres of sweat in a day. In tropical countries, naturally, more sweat is produced. The perspiration level increases with an increase in physical exertion or nervous tension. Fresh perspiration, when allowed to evaporate does not cause body odour. An offensive smell is caused when bacteria that are present on the skin get to work on the sweat and decompose it. This is specially so in the groin, underarms, feet or in clothing that has absorbed sweat. Diet influences the odour too. Two baths a day, with liberal lathering and change of clothes in close contact with the body should take care of the problem. Talcum powders, of a non-

medicated kind, can be used under the armpits. Deodorants or antiperspirants may be used too. Most commercial skin deodorants contain also an antiperspirant, such as aluminum chloride, which reduces sweating by forming a hydroxide gel in the sweat ducts. But sweat suppressed in one area, comes out in another one. The addition of perfumes masks the odour. Deodorant soaps do not interfere with sweat secretion, but contain hexachlorophene which destroys the bacteria that causes body odour. If daily cleanliness routines do not reduce body odour, doctor's consultation is required.

The individuals should be educated to scrub feet with a sponge, pumice stone or foot scrubber that is not made of very abrasive material when they are having a bath. They should dry after bath between toes and keep toenails clipped. In many Indian households it is mandatory to wash feet as you enter the house. The individuals should wear a clean pair of cotton socks everyday. Many people have sweaty feet, and socks and shoes can get quite smelly. If possible they should not wear the same pair of shoes every day. The pedicure should be done once in three weeks. Give importance to wearing comfort in the choice of footwear. For those who go barefoot indoors, floor mats must be cleaned or changed frequently. Extra foot care is required for diabetics.

Athletes foot is the fungal infection of the skin and nails of feet. The skin becomes scaly. There are sores or blisters between toes. Often it spreads to the soles. This infection is caused by a fungus breeding in warm wet places. Clinical signs: minor irritation, sometimes cracks and sores become the site for other infections. Proper foot care can alleviate the condition. The preventive measures include rubbing off peelings, washing feet well with applying powder. A mild fungicidal ointment at bedtime will help. They advise to wear cotton socks and change them one-two times per day.

**Hands Hygiene.** The individuals should wash hands thoroughly with soap and water before and after every meal and after visiting the toilet. Soaping and rinsing should cover the areas between fingers, nails and back of the hand. Hands should be dried with a clean towel after wash. The towel at the wash stand has to be washed and changed everyday. While cooking, especially when packing lunches, you can prevent food from spoilage and minimize contamination by keeping your hands clean. While handling food avoid scratching, or touching the ears, nose, mouth or other body orifices. If a person needs to use a handkerchief he should wash hands after that. Nails should be kept short. Nail polish users should see that it does not chip off into the food.

**Nails.** A healthy body ensures healthy nails. It takes five months for nails to replace themselves. Woman should grow nails only if they can keep them

clean. They should not keep their nails painted continuously. It causes the keratin, of which nails are made, to split. Short nails make less trouble. But individuals should not cut them so close that it pinches the skin. Brittle or discoloured nails show up deficiencies or disease conditions. They advise to pamper hands and nails once every three weeks with a manicure. This requires soaking hands in warm water for ten minutes, massaging of hands, thorough cleaning and shaping of nails.

**Hair Hygiene.** Hair is woman crowning glory. Nuns were required to cover it. Orthodox Hindu widows were required to shave it. Perhaps because a mop of hair can add to sex appeal too much. In the promotive activity you will advise to keep hair at a length and style at which persons can maintain it. They should wash their hair at least once a week using soap or mild shampoo. It's better to avoid shampoos with borax or alkalis and to rinse hair well. After wash hair should be dried. Brushing hair is important: they should do it three to four times a day with a soft bristled brush or a wide toothed comb. Brush and comb should be washed frequently, e.g. every time person wash his/her hair. Use of oil is acceptable, it's better to do it once a week, preferably an h before hair wash. There are no completely safe or permanent hair dyes. Apart from causing scalp allergies, dyes can also cause allergic rhinitis and pharyngitis. Some evidence exists that frequent colouring hairs can increase risk of breast cancer.

Dead skin on the scalp comes off in tiny flakes (dandruff). This is associated with some disturbance in the tiny glands of the skin called the sebaceous glands. They excrete oil, or sebum. When there is too little oil the skin becomes flaky and dry. When there is too much oil also dandruff is possible. It may have a slight yellow colour. Hair wash twice or three times a week might be necessary. Combs and brushes must be washed as well. Hair should be brushed regularly. A wholesome diet and overall cleanliness will help. Massage the scalp everyday to improve circulation. A shampoo with selenium sulfide or salicylic acid helps too.

Lice are tiny insects that live on the human scalp and suck blood to nourish themselves. Lice make a pinprick like puncture on the scalp, emit an ant clotting substance and feed with blood. Lice thrive on unclean hair. Children are especially prone to lice infestation. Lice spread from one head to another when there is close contact as in school environments. Lice eggs are wrapped in a shiny white sheath and these show up on the upper layers of hair as the infestation increases. They make the scalp itchy and are a cause of annoyance and embarrassment. In infants they may cause disturbed sleep and bouts of crying. Unchecked, they can produce scalp infection. Antilice lotions are available in the market, but in persistent cases a doctor's advice can be sought.

Nit picking is painstaking and requires patience. A fine toothed comb and regular monitoring can get rid of the problem. Usually when a child is given an antilice shampoo, all members of the family are advised to use it too.

**Intime Hygiene.** Women are especially prone to urethral infection. This happens when bacteria travel up the urethra and start breeding there. Chances of urinary infection are higher during pregnancy and after major surgery. This infection causes pain or a burning sensation during urination. Sometimes the urine is discoloured. Itching, frequent urination, fever and chills can also result from urinary infection. Though not a serious problem it can be rather an irritating and an awkward one. It is easy to catch this infection when toilets are not clean or when too many people share toilet facilities. To avoid this infection improve overall standards of hygiene: both, regarding toilets and personal parts. Wash or wipe front to back after urinating or defecating. It's also a general rule for wiping or washing babies. They do not recommend to wear tight fitting synthetic underwear.

**Menstrual Hygiene.** No woman feels completely comfortable when she has her periods. If it is not premenstrual tension or stomach cramps it is the problem of dealing with the menstrual flow. Technology offers sanitary pads, tampons or menstrual cups or caps to deal with the flow. The user has to decide what suits her best. Absorbent pads may be noticeable in form fitting clothes. They cause some soreness on the inner thighs. Some women prefer tampon to external pads. A plug of absorbent cotton or gauze is inserted inside. But these should not be left unchanged beyond six h. Some brands state that tampons left unchanged for more than 12–18 h increases the possibility of toxic shock. It is not clear what causes toxic shock. But there seems to be a link between tampons and toxic shock syndrome (TSS). Approximately 1% of all menstruating women carry the bacteria in question (*Staphylococcus aureus*) in their vagina. Absorbent tampons provide the medium for them to grow and spread infection. TSS cases were first reported in 1978. It is marked by high fever, severe vomiting and diarrhoea. The cases can be mild to fatal. The menstrual cup (or cap), is inserted within and collects the flow and can be emptied, cleaned and reused. Whatever the preference, washing is important. There should be no taboo about bath on these days. Some people have the problem of odour during menstruation. Cleanliness and change of pad/tampon as often as is necessary reduces this problem. It is not advisable to use perfumed pads or tampons. In fact, using powder in the genital area is not recommended.

**Intime Hygiene of Males.** Keeping the male genital area clean and free of infection is easy. Males should wash the genital area every day using a mild

soap to provide a constant cleanliness under and around the foreskin (in young boys, the foreskin may not fully retract). Men with a circumcised penis must practice genital hygiene as often as the other ones.

**Teeth Hygiene.** It's recommended to brush teeth twice a day and rinse well after every meal. Brushing before going to bed is important. While brushing, pay attention to the fact that you are getting rid of the food particles stuck in between the teeth and in the crevices of the flatter teeth at the back, the molars and premolars. Brush down on the upper teeth and brush up on the lower teeth. Use a circular motion. Pay attention to the tongue and the inner surface of teeth as well. The brush should have resilient bristles. It should be rinsed well and left to dry after use. There are no perfect toothpastes or powders. It's better to use one without harsh abrasives or strong antiseptics.

Poor oral hygiene and infection of gums often results in a bad odour emanating from the mouth. This is called halitosis. Smoking can make this worse. Proper brushing of the teeth and oral care can get rid of bad breath. There can be other reasons for bad breath. Colds, sinuses, throat infections or tonsils can cause bad breath. Diseases of the stomach, liver, intestines or uncontrolled diabetes are also possible causes. Therefore, if bad breath persists despite good dental care, you need to see a doctor.

The main way of a hygienic maintenance of hygiene in the oral cavity — daily twice (morning and evening) cleaning of teeth. The cleaning of teeth eliminates a bad odour, reduces quantity of microorganisms of the oral cavity, including conditionally pathogenic.

For cleaning teeth special denture powders and pastas are used. There are distinguished hygienic and medical-preventive pastes. In their formula there are various biologically active materials (vitamins, vegetative extracts, mineral salts, trace substances and others), rendering resolvent, fluorinating and other positive effects on teeth and gingivas.

## HYGIENE OF CLOTHES

Essential element of personal hygiene is the hygiene of clothes. The major physiological function of clothes is the support of thermal comfort in various climatic, home and workshop conditions. The clothes allow to create underclothes microclimate with necessary relative stability of temperature and humidity mode, gas composition and movement of air.

By expression of F. Erisman, the clothes are as though second (after dwelling) ring of protection from unfavorable weather conditions, mechanical effects, stings of insects and animals, dust and microbial pollution, exuberant solar irradiation, other

unfavorable factors of the home and industrial environment.

On assignment and character of usage distinguish clothes home, military, hospital, ritual and others.

Main hygienic requirements to the clothes are following:

- to provide optimal underclothes microclimate and to promote thermal comfort of a man;

- do not complicate respiration, circulation and movement of the man, do not displace and do not squeeze internal organs and constituents of the locomotors;

- to be enough strong, easy to refine from external and internal pollution;

- do not contain toxic chemical impurities, excreted in the external environment, do not have physical and chemical properties unfavorably influential on the skin and the organism as a whole;

- to have rather small mass (till 8–10% of the human body mass. A major criterion of clothes quality and their hygienic properties is so-called underclothes microclimate at an ambient temperature 18–22°C. The following parameters of underclothes microclimate are recommended: the air temperature — 32.5–34.5°C; relative humidity — 55–60%.

The hygienic properties of clothes depend on a combination of a number of the factors, e.g. the kind of a fabric, character of its manufacture. For manufacture of clothes they use textile fibers of a various origin (natural and synthetic). The hygienic advantages or disadvantages of those or other tissues first of all depend on physical and chemical properties of the fibers. Among these properties the major hygienic value have air, moisture capacity, hygroscopic features and thermal conduction.

The various components of the package of clothes fulfil various functions, accordingly to which the hygienic requirements to tissues are also various.

Some requirements are showed to children's clothes. Owing to less perfect mechanism of a thermoregulation, much greater specific ratio of the value of the body's surface to unit of mass for children, more intensive peripheral circulation children are more easy cooled in a winter season and overheat in summer. Therefore their clothes should have higher heat-insulating properties in the winter and promote thermolysis in the summer. The similar hygienic requirements are showed also to footwear.

## HEALTH PROMOTION AND HEALTHY LIFE STYLE

Major condition of a healthy way of life — refusal from harmful habits (alcohol, tobacco and drug abuse, sexual perversions, etc). The damaging influence of smoking on health is connected first of

all with chemical composition of an inhaled tobacco smoke and its high temperature. With a smoke nicotine, cyan hydric acid, white damp, ammonia, arsenic, radioactive polonium-219, lead-210, tarry and many others (more than 100) harmful substances formed at dry distillation of tobacco and a paper at temperature of 250–300°C come to the organism. When one cigarette is smoked, 3–8 mg of nicotine get in to the organism. The single lethal dose of nicotine for a man makes up 60–80 mg. Approximately such quantity of nicotine gets in to the organism during smoking of 20–25 cigarettes.

In USA, for example, at inspection of 200,000 men it is determined, that at smoking 0.5 packs of cigarettes per day the mortality by 100,000 men makes up 95.2, 1–2 packs — 229, more than 2 packs — 264.2, whereas for the non-smoker this metric reaches only 12.8. On the data of WHO, smoking — direct or oblique reason of 20% of all cases of deaths. Smoking — one of the most important risk factors of ischemic illness of heart malignant neoplasms of lungs. The direct relation between risk of death from a cancer of lungs and quantity of used during a day cigarettes is proved.

The smoking aggravates hypoxia of tissues, raises contents of carboxyhemoglobin in the blood, negatively influences a growing fetus, blood vessels, teeth, oral cavity, the function of the stomach, endocrine glands, worsens memory, attention, gradually reduces mental serviceability. Passive smoking represents a great danger (especially for children and pregnant women).

The average life expectancy of the smokers is by 5–7 years less, than of non-smokers. All these data testify to necessity of intensifying struggle with smoking (first of all among medical workers) both activation preventive and organisational measures.

One of the most acute social problems is the problem of alcohol drinking. Already in the ancient world it had come an understanding of social danger of alcohol abuse. The alcohol renders various negative influence on the organism at all stages of its development, since intrauterine. Under its influ-

ence there can be premature births, increase of perinatal mortality. The increase of developmental violations in children, alcoholic syndrome of a fetus are linked with alcohol abuse. Thousand cases of craniocerebral teratisms and defects of development of internal organs connected to alcohol abuse are described. The inherent defects of heart, anomaly of extremities, microphthalmia, low forehead, strabismus are typical.

In adults the alcohol negatively influences all organs and systems of the organism. It defeats the CNS, the liver, the digestive tube, the kidney, the heart and vessels, aggravates hypoxia, inactivates enzymes, breaks metabolic processes, color perception, reduces intelligence and serviceability, gradually resulting in a person's degradation. In the brain its contents is by 75% more, than in blood, in the spinal liquid and liver — by 50%. On the nervous tissue the alcohol has a paralyzing action from the very beginning, it weakens processes of inhibition in the cortex of the brain. The persons abusing alcohol are sick on the average 2 times as often and 4 times as long than those who don't. The probability of illness of the liver, stomach, heart and lungs for them is 2–5 times higher. On the average they live by 10–15 years less, than others.

It is necessary to remember, that alcohol dilates peripheral vessels, instead of the coronary vessels of the heart. The doctor of any speciality is obliged to survey working on prophylaxis of alcohol drinking and other harmful habits as one of major units of the professional activity.

The biological rhythm structure of vital activity of a man determines physiologic and hygienic necessity of strict keeping of the mode of day — reasonable alternation of the vigorous activity and rest, wakefulness and sleep. Thus, an effective way of rest is the change of sorts of activity.

In summary it is necessary to mark, that the keeping of mentioned rules, conditions and requirements of personal hygiene reduces the intensity of negative environmental influence on human health by 40–50%.



International and National Standards of Water Quality

Index	Units	WHO	USEPA	EC	Russia*	Ukraine
Hydrogen index	pH	–	6.5–8.5	6.5–8.5	6–9	6.5–8.5
General mineralization	mg/L	1000	500	1,500	1,000	1,000 (1,500)
General hardness	mg-eq/L	–	–	1.2	7.0	7.0 (10.0)
Oxidative capacity	mg O <sub>2</sub> /L	–	–	5.0	5.0	4.0
Temperature	°C	–	–	25	–	–
General alkaliness	mg HCO <sub>3</sub> <sup>-</sup> /L	–	–	30	–	–
Smell	Scores	–	–	–	2	2
Taste	Scores	–	–	–	2	2
Colority	Degr. by Pt-Co scale	15	15	20	20	20
Turbidity	UTF	15	15	20	20	–
	mg/L	5 (1)	0.5–1	4	2.6	0.5
Transparence	cm	–	–	–	30	30
General microbes number	CFU	–	500	10 (for 22°C)	50	100
	—	—	—	100 (for 37°C)	—	—
Total coliform bacteria	Number in 100 ml	0	5	0	0	< 3
Termotolerant coliform bacteria	Number in 100 ml	0	–	0	0	–
Fecal streptococc	Number in 100 ml	–	–	0	–	0
Colifagi	BOU	–	–	–	0	0
Clostridia spores	In 20 ml	–	0	< 1	0	0
Giardia cysts	In 50 ml	–	0	–	0	0
Total α-radioactivity	Bc/L	0.1	0.555	–	0.1	0.1
Total β-radioactivity	Bc/L	1.0	–	–	1.0	1.0
Radium-226 and radium-228	Bc/L	–	0.185	–	–	–
Effective dose	mSv/year	–	0.04	0.1	–	–
Tritium	Bc/L	–	–	100	–	–
Uranium-238	µg/L	–	30	–	–	–
Aluminium (Al)	mg/L	0.2	0.2	0.2	0.5	0.2
Nitrogen of ammonia (NH <sub>3</sub> and NH <sub>4</sub> <sup>+</sup> )	mg/L	1.5	–	0.5	–	–
Antimonium (Sb)	mg/L	0.005	0.006	0.005	0.05	–
Asbest	ppm	–	7.0	–	–	–
Barium (Ba)	mg/L	0.7	2.0	0.1	0.1	0.1
Berillium (Be)	mg/L	–	0.004	–	0.0002	–
Boron (B)	mg/L	0.3	–	1.0	0.5	–
Vanadium (V)	mg/L	–	–	–	0.1	–
Bismuth (Bi)	mg/L	–	–	–	0.1	–
Wolfram (W)	mg/L	–	–	–	0.05	–
Europium (Eu)	mg/L	–	–	–	0.3	–

Index	Units	WHO	USEPA	EC	Russia	Ukraine
Iron (Fe)	mg/L	0.3	0.3	0.2	0.3	0.3
Cadmium (Cd)	mg/L	0.003	0.005	0.005	0.001	–
Potassium (K)	mg/L	–	–	12.0	–	–
Calcium (Ca)	mg/L	–	–	100.0	–	–
Cobalt (Co)	mg/L	–	–	–	0.1	–
Silicium (Si)	mg/L	–	–	–	10.0	–
Litium (Li)	mg/L	–	–	–	0.03	–
Magnesium (Mg)	mg/L	–	–	50.0	–	–
Manganese (Mn)	mg/L	0.5 (0.1)	0.05	0.05	0.1	0.1
Copper (Cu)	mg/L	2.0 (1.0)	1.0–1.3	2.0	1.0	1.0
Molibden (Mo)	mg/L	0.07	–	–	0.25	–
Arsenic (As)	mg/L	0.01	0.05	0.01	0.05	0.01
Sodium (Na)	mg/L	200.0	–	200.0	200.0	–
Nickel (Ni)	mg/L	0.02	–	0.02	0.1	0.1
Niobium (Nb)	mg/L	–	–	–	0.01	–
Nitrates (NO <sub>3</sub> <sup>-</sup> )	mg/L	50.0	44.0	50.0	45.0	45.0
Nitrites (NO <sub>2</sub> <sup>-</sup> )	mg/L	3.0	3.3	0.5	3.0	–
Ozone residual (O <sub>3</sub> )	mg/L	–	–	–	0.3	–
Mercury (Hg)	mg/L	0.001	0.002	0.001	0.0005	–
Rubidium (Rb)	mg/L	0.001	0.002	0.001	0.0005	–
Samarium (Sm)	mg/L	–	–	–	0.024	–
Lead (Pb)	mg/L	0.01	0.015	0.01	0.03	0.01
Selenium (Se)	mg/L	0.01	0.05	0.01	0.01	0.01
Silver (Ag)	mg/L	–	0.1	0.01	0.05	–
Hydrogen sulphide (H <sub>2</sub> S)	mg/L	0.05	–	UO**	0.03	–
Strontium (Sr)	mg/L	–	–	–	7.0	–
Sulphates (SO <sub>4</sub> <sup>2-</sup> )	mg/L	250.0	250.0	250.0	500.0	250.0 (500.0)
Tallium (Tl)	mg/L	–	0.002	–	0.0001	–
Tellur (Te)	mg/L	–	–	–	0.01	–
Phosphorus (P)	mg/L	–	–	–	0.0001	–
Fluorine (F)	mg/L	1.5	2.0–4.0	1.5	1.5	1.5
Chlorine total	mg/L	0.5–5.0	–	–	–	–
Chlorine residual liberated	mg/L	–	–	–	0.3–0.5	–
Chlorine residual fixed	mg/L	–	–	–	0.8–1.2	–
Chlorides (Cl <sup>-</sup> )	mg/L	250.0	250.0	250.0	350.0	250.0 (350.0)
Chromium (Cr <sup>3+</sup> )	mg/L	–	0.1 (total)	–	0.5	–
Chromium (Cr <sup>6+</sup> )	mg/L	0.05	«	0.05	0.05	–
Cianides (CN <sup>-</sup> )	mg/L	0.07	0.2	0.05	0.035	–
Zinc (Zn)	mg/L	3.0	5.0	5.0	5.0	–
Tetrachloric carbon	µg/L	2	5	–	6	2
Dichlormethan	µg/L	20	5	–	7.5	–
1.2-dichlorethan	µg/L	30	5	3	–	–
1.1.1-trichlorethan	µg/L	2,000	200	–	10,000	–
Vinilchloride	µg/L	5	5	0.5	50	–
1.1-Dichlorethylen	µg/L	30	7	–	–	–
1.2-Dichlorethylen	µg/L	50	170	–	–	–
Trichlorethylen	µg/L	70	5	10	–	–
Tetrachlorethylen	µg/L	40	5	10	–	–
Benzene	µg/L	10	5	–	10	–

Index	Units	WHO	USEPA	EC	Russia	Ukraine
Toluol	µg/L	700	1,000	–	500	–
Xyloles	µg/L	500	10,000	–	50	–
Ethylbenzene	µg/L	300	700	–	10	–
Stirol	µg/L	20	100	–	100	–
Benz(a)pyrene	µg/L	0.7	0.2	0.01	0.5	–
Monochlorbenzene	µg/L	300	100	–	20	–
1.2-Dichlorbenzene	µg/L	1000	600	–	2	–
1.4-Dichlorbenzene	µg/L	300	–	–	–	–
Trichlorbenzene	µg/L	20	70	–	30	–
Acrolein	µg/L	–	–	–	20	–
Di(2-ethyl)adipate	µg/L	80	400	–	–	–
Di(2-ethyl)phtalate	µg/L	8	6	–	–	–
Acrilamide	µg/L	0.5	TT	–	10	–
Epichlorhydrine	µg/L	0.4	TT	0.1	10	–
Hexachlorbutadiene	µg/L	0.6	–	–	10	–
Hexachlorpentadiene	µg/L	–	50	–	1	–
EDTA	µg/L	200	–	–	–	–
Trinitrilic acid	µg/L	200	–	–	–	–
Detergents	µg/L	–	–	–	500	–
Dialkil tin	µg/L	–	–	–	2	–
Tributil tin oxide	µg/L	2	–	–	4	–
Bis.tributil tin oxide	µg/L	–	–	–	0.2	–
Tetraethyl tin	µg/L	–	–	–	0.2	–
Tin tributylmetacrilacetate	µg/L	–	–	–	0.2	–
Tetraethyl lead	µg/L	–	–	–	0	–
Total pesticides	µg/L	–	–	0.5	–	0.1
Aldrine	µg/L	0.03	–	0.03	2	–
DDT	µg/L	2	–	–	2	–
2.4-D	µg/L	30	70	–	30	–
Lindane	µg/L	2	0.2	–	2	–
Permetrine	µg/L	20	–	–	–	–

\* — according to SSanN&R 2.1.4.559-96;

\*\* — undetectable organoleptically.

## Food Value of Some Food-Things

Products	Proteins, g%	Fats, g%	Carbo- hydra- tes, g%	Salts, mg%			Vitamins, mg%			Q, kcal
				Ca	P	Fe	A or $\beta$ -ca- rotine	B <sub>1</sub>	C	
wheat	12.5	1.9	67.5	62	114	5.3		0.37		320
millet	11.2	3.8	60.7	51	131	9.6		0.67		307
peas	23	1.2	53.3	115	329	9.4	0.07	0.81		303
lentil	24.8	1.1	53.7	83	294	15.9	0.03	0.5		310
French (hari- cot) beans	22.3	1.7	54.5	150	541	12.4	0.02	0.5		309
soy-bean	34.9	17.3	26.5	348	510	11.8	0.07	0.94		395
flour (extra)	10.3	0.9	74.2	18	86	1.2		0.17		327
soy flour	48.9	1	33	212	198	9.2	0.03	1.2		328
semolina	11.3	0.7	73.3	20	84	2.3		0.14		326
buckwheat	12.6	2.6	68	70	298	8		0.53		329
rice	7	0.6	77.3	24	97	1.8		0.08		323
oatmeal	13.1	6.2	65.7	52	363	7.8		0.45		355
maize	8.3	1.2	75	20	109	2.7	0.2	0.13		325
pasta	10.4	0.9	75.2	18	87	1.2		0.17		332
white bread	7.6	0.6	52.3	20	65	0.9		0.11		233
rye bread	6.5	1	40.1	38	156	2.6		0.18		190
buns	7.6	5	56.4	25	85	1.5		0.18		288
bread with beans	8.1	1.2	42	37	218	2.8		0.21		203
pitta	7.9	1	51.6	27	88	1.6		0.17		236
sugar			99.8	2		0.3				374
honey	0.8		74.8	4		1.1		0.01	2	308
cacao	24.2	17.5	3.5	18	771	11.7		0.1		373
chocolate	5.4	35.3	47.2	5	178	2.7		0.04		540
marmalade			68.2	10	4	0.1				296
milk	2.8	3.2	4.7	121	91	0.1	0.03	0.03	1	58
baked milk	3	6	4.7	124	92	0.1	0.06	0.02	0.3	84
cream	2.8	20	3.6	90	10	0.1	0.21	0.03	0.3	205
sour cream	2.8	20	3.2	86	60	0.2	0.21	0.03	0.3	206
curd	14	18	1.3	150	217	0.4	0.16	0.05	0.5	226
kefir	2.8	3.2	4.1	120	95	0.1	0.03	0.03	0.7	59
yogurt	5	3.2	3.5	119	91	0.1	0.03	0.03	0.6	85
Ukrainian ryajenka	3	6	4.1	124	92	0.1	0.06	0.02	0.3	85
koomys (from- mare's milk)	1.6	1	5	94	60	0.1	0.04	0.02	9	39

Products	Proteins, g%	Fats, g%	Carbo-hydrates, g%	Salts, mg%			Vitamins, mg%			Q, kcal
				Ca	P	Fe	A or $\beta$ -carotene	B <sub>1</sub>	C	
condensed milk with sugar	7.2	8.5	56	307	219	0.2	0.05	0.06	1	315
butter	1.3	72.5	0.9	24	20	0.2	0.7	0.01		652
baked butter	0.3	98	0.6				0.6			887
Dutch cheese	26.8	27.3		1,040	544		0.38	0.03	2.8	361
Russian cheese ("Rossiysky")	23.4	30		1,000	544	0.6	0.43	0.04	1.6	371
Cheddar	24.9	31.8		1,100	564		0.35	0.03	1	396
Swiss cheese	24.9	31.8		1,064	594		0.44	0.04	1.5	396
Rockford	20	30.3		639	405		0.42	0.03	2	363
sheep cheese (brynza)	14.6	25.5		550	220			0.05	1	298
caw's brynza	17.9	20.1		530	210			0.04	1	260
smoked cheese	23	19		680	410					270
ice-cream	3.2	15	20.8	159	114	0.2	0.11	0.03	0.4	226
margarine	0.5	82.3	1	18	12		1.8	0.02		744
mayonnaise	3.1	67	2.6	28	50					627
refined oil (sunflower, peanut, sesame, maize, soy-bean)		99.9								899
refined olive oil		99.8								898
sunflower (un-pilled seeds)	20.7	52.9	5.0	367	530	61		1.84		578
peanut	26.3	45.2	9.7	76	350	5		0.74	5.34	548
hazelnut	16.1	66.9	9.9	47	206	4		0.2		704
eggplants	0.6	0.1	5.5	15	34	0.4	0.02	0.04	5	24
green peas	5	0.2	13.3	26	122	0.7	0.4	0.34	25	72
green cabbage	1.8		5.4	48	31	1	0.02	0.06	50	28
red cabbage	1.8		6.1	53	32	0.6	0.1	0.05	60	31
Brussels sprouts	4.8		6.7	34	78	1.3	0.3	0.1	120	46
kohlrabi	2.8		8.3	46	50	0.6	0.1	0.06	50	43
cauliflower	2.5		4.9	26	51	1.4	0.02	0.1	70	29
potatoes	2	0.1	19.7	10	58	0.9	0.02	0.12	20	83
onion	1.7		9.5	31	58	0.8		0.05	10	43
chives	1.3		4.3	121	26	1	2	0.02	30	22
leeks	3		7.3	87	58	1	0.1	0.1	35	40
red carrot	1.3	0.1	7	51	55	1.2	9	0.06	5	33
yellow carrot	1.3	0.1	7	46	60	1.4	1.1	0.1	5	33
cucumbers	0.7	1.8	17	42	0.5		0.02	0.03	7	10
Spanish paprika	1.3		5.7	8	16		2	0.1	250	27
parsley (root)	1.5		11	86	82	1.8	0.01	0.08	35	47
parsley	3.7		8.1	245	95	1.9	1.7	0.05	150	45
radish	1.2		4.1	39	44	1		0.01	25	20
white radish	1.9		4.1	39	13	44	0.02	0.03	29	34
turnip	1.5		5.9	49	34	0.9	0.1	0.05	20	28
lettuce	1.5		2.2	77	34	0.6	1.75	0.03	15	14

Products	Proteins, g%	Fats, g%	Carbohydra-tes, g%	Salts, mg%			Vitamins, mg%			Q, kcal
				Ca	P	Fe	A or $\beta$ -carotine	B <sub>1</sub>	C	
beet	1.7		10.8	37	43	1.4	0.01	0.02	10	48
celeriac (root)	1.3		6.7	63	27	0.5	0.01	0.03	8	31
celeriac			2	30	25		0.8	0.02	38	8
asparagus	1.9		3.6	21	62	0.9	0.03	0.1	20	21
swede	1.2	0.1	8.1	40	41	1.5	0.12	0.04	30	37
zucchini	0.6	0.3	5.7	15	12	0.4	0.03	0.03	15	27
tomato	0.6		2.9	8	35	0.5	0.5	0.04	20	14
fennel	2.5	0.5	4.5	223	93	1.6	1	0.03	100	32
garlic	6.5		21.2	90	140	1.5		0.08	10	106
spinach	2.9		2.3	106	83	3	4.5	0.1	55	21
water melon	0.7		9.2	14	7	1	0.1	0.04	7	38
melon	0.6		9.6	16	12	1	0.4	0.04	20	39
pumpkin	1		6.5	40	25	0.8	1.5	0.05	8	29
apricot	0.9		10.5	28	26	2.1	1.6	0.03	10	46
pine-apple	0.4		11.8	16	11	0.3	0.04	0.08	40	48
banana	1.5		22.4	8	28	0.6	0.12	0.04	10	91
cherry	0.8		11.3	37	30	1.4	0.1	0.03	15	49
pomegranate	0.9		11.8					0.04	4	52
pear	0.9		10.7	19	16	2.3	0.01	0.02	5	42
peach	0.9		10.4	20	34	4.1	0.5	0.04	10	44
plum	0.8		9.9	28	27	2.1	0.1	0.06	10	43
apple	0.4		11.3	16	11	2.2	0.03	0.01	13	46
orange	0.9		8.4	34	23	0.3	0.05	0.04	60	38
grapefruit	0.9		7.3	23	18	0.5	0.02	0.04	60	35
lemon	0.9		3.6	40	22	0.6	0.01	0.04	40	31
mandarin	0.8		8.6	35	17	0.1	0.06	0.03	38	38
grapes	0.4		17.5	45	22	0.6		0.06	6	69
strawberry	1.8		8.1	40	23	1.2	0.03	0.03	60	41
raspberry	0.8		9	40	37	1.6	0.2	0.02	25	41
gooseberry	0.7		9.9	22	28	1.6	0.2	0.02	25	41
cepe	3.2	0.7	1.6	27	89	5.2		0.02	30	25
dry cepe	27.6	6.8	10.0	184	606	35		0.27	150	209
tea	20		6.9	495	825	82	0.05	0.07	10	109
roast coffee bean	13.9	14.4	4.1	147	198	5.3		0.07		223
instant coffee	15	3.6	7	100	250	6.1				119
mutton	16.3	15.3		9	178	2		0.08		203
beef	18.9	12.4		9	198			0.06		187
pork	16.4	27.8		8	182	1.8		0.6		316
veal	16.2	14.1		11	189	1.7		0.14		192
calf	19.7	1.2		11	180	1.6		0.12		90
boiled sausage	13.7	22.8		29	178					260
scalded sausage	12.3	25.3		29	161	1.7				277
smoked meat	10.5	47.2		8	182	1.8				467
chicken	17.6	12.3		10	210	1.5	0.04	0.07		183
goose	15.2	39		12	154	3	0.02	0.08		412

Products	Proteins, g%	Fats, g%	Carbo- hydra- tes, g%	Salts, mg%			Vitamins, mg%			Q, kcal
				Ca	P	Fe	A or $\beta$ -ca- rotine	B <sub>1</sub>	C	
turkey	19.5	22		12	200	4	0.01	0.05		276
egg	12.7	11.5	0.7	55	185	2.7	0.35	0.07		157
carp	16	3.6		12	205	0.4	0.02	0.14		96
herring	17.7	19.5		102	278	0.9	0.03	0.03		242
mackerel	18	9		37	278	2.3		0.12		153
pike	19	0.8		27	225	0.4		0.08	3	83
eel	14.5	30.5		19	227		0.8	0.1		333
catfish	16.5	11.9		22	315	1		0.19	1.2	173
squid	18	0.3		43		0.9				75
shrimp	18.9	0.8		193		1.8				83
lobster	18.4	0.4								77
orange juice	0.7		13.3	18	13	0.3	0.05	0.04	40	55
apple juice	0.5	11.7	10.6	8	9	0.2		0.01	2	47
apricot jam	0.5		71.9	12	18	1	0.3		1.4	273
dry grapes	2.3		71.2	80	129	3		0.15		279

## Hygienic Characteristics of Macro- and Micronutrients

Nutrients	RDA	Sources	Content g%*/mg%**	Deficiency		Overuse	
				clinical signs	laboratory signs	clinical signs	laboratory signs
Aminoacids							
His (H)	0.5–2 g	soy bean cheese	0.9 0.9		↓Hb		
Val (V)	3–4 g	cheese curd liver soy bean	1.97 1.19 1.2 2.005				
Ile (I)	3–4 g	cheese soy bean	1.85 2.05		“–“ N balance		
Leu (L)	4–6 g	cheese liver soy bean	2.68 1.8 2.95				
Lys (K)	3–5 g	curd beef eel soy bean	1.29 1.5 1.63 2.4	anaemia	↓RBC, Hb		
Met (M)	3 g	eel cheese curd atlantic herring	0.54 0.7 0.5 0.53	fatted liver; arteriosclerosis			
Phe (F)	2–4 g	soy bean cheese	1.89 1.47				
Thr (T)	1 g	meat fish curd eggs	0.2 0.2 0.2 0.2	pellagra			
Vitamins							
A	1 mg	butter eggs cod's liver eel (red carrot)	0.5 0.35 3.45 0.8 (9.0)	xerosis, hypo- keratinization, xerophthalmia; hypogeusia; hypo- smia; hemera- lopy; Bitot's spots	↑duration of the dark adaptation	headache; vomiting; peeling (of the skin); anorexia	A <sub>1</sub> rethinol
D	100 IU age < 3: 400 IU pregnants: 500 IU	tunny's liver tunny-fish salmon eel butter yolk of egg cheese cod's liver atlantic her- ring	30,000 IU 6,000 800 500 30 300 100 1,500 1,500	rickets	↑AP ↓[Ca <sup>2+</sup> , P]	hypercalciae- mia; urolithia- sis	D <sub>3</sub> cholecalci- ferol D <sub>2</sub> ergocalci- ferol
E	12–15 mg	cotton seed oil peas corn green peas	60 3 10 6	anaemia	↓osmotic resis- tance of RBC		tocopherols (α, β, γ, δ, ε, ξ, η)



nutrients	RDA	Sources	Content g%*/mg%**	Deficiency		Overuse	
				clinical signs	laboratory signs	clinical signs	laboratory signs
K	(0.2–0.3)	spinach	4.5	hemorrhagic syndrome	↑PT	(?) jaundice	phylochinones
F*	2–6 g	benne (sesama) oil corn peanut soybean sunflowerseeds	37% 50–60% 20% 58% 60%	xerosis; alopecia; hypokeratinization; peeling; fatty liver; violation of the vision	↓platelets	(?) lipaemia	linoleic acid arachidone acid
B <sub>1</sub>	1.3–2.6 mg	oatmeal maize rye wheat rice buckwheat	0.48 0.38 0.44 0.46 0.52 0.76	beri-beri; painfulness and weakness of the muscles; (tendon and periosteal reflexes; hyperesthesia; tachycardia; cardiomegalia; cardiovascular insufficiency; encephalopathy	↑piruvates and lactates, α-ketoglutarates		thiamin
B <sub>2</sub>	1.3–3 mg	yeast cepe (boletus) spinach	0.68 0.3 0.25	angular stomatitis; heilosis; glossitis (bald tongue; angular blepharitis; seborrhea; scrotal (vulvar) dermatitis			riboflavin
PP(B <sub>3</sub> )	13–26 mg	yeast mushrooms liver	11.4 6 7	pellagra; glossitis dermatitis; diarrhea; dementia	↓N <sup>5</sup> -methylNA	dyspepsia, feverility	niacin (nicotonic acid)
B <sub>5</sub>	5–10 mg	bran yeast	9 12	sleepiness; asthenia; paresthesia	↓[K <sup>+</sup> ], [Cl <sup>-</sup> ]		panthothenic acid
B <sub>6</sub>	1.5–3 mg	yeast bran	4 2.5	(nasolabial) seborrhea; urolithiasis; polyneuritis; muscles' fasciculations; cramps; haemolytic microsphe-rocellar anaemia	↓osmotic resistance of RBC “–“ test with Trp	neuropathy	Piridoxin
H	0.15–0.3 mg	yolk of egg soybean liver mushrooms	30 60 200 16	fatiguability; depressia; nausea; mialgia			biothin
Bc (M)	200	yeast parsley liver	1080 117 160	skin paleness, glossitis, stomatitis; diarrhea; anemia	“+” test with histaminic macrocytosis, megaloblastic marrow		folacin (folic acid)
B <sub>12</sub>	3γ	liver kidneys	130 50	Addison—Biermer anemia; paleness; subicterus; anorexia; diarrhea; paresthesia; ataxia; neuritis of the optic nerve; mental disorder; tachycardia; asthenia	macrocytosis, megaloblastic punctat of medulla		cobalamin (APF-animal protein factor)

nutrients	RDA	Sources	Content g%/mg%**	Deficiency		Overuse	
				clinical signs	laboratory signs	clinical signs	laboratory signs
(B13)	500–1500	yeast					orotic acid
B15	2	brewer's yeast		muscular fatigability			pangamic acid
P	35–50	lemon orange	450 µg 300				biflavonoides: rutin, hesperin, catechin
(B4)	0.5–1	liver yolk of egg kidneys	350 1,500 100	fatty liver		hypersalivation; ↓BP, ↑Ps; mass peristalsis	choline
(B8)	1,000– 15,000	bran	1,000	inositol			
(Bx)		brewer's yeast	5,900				para-amino-benzoic acid
(Bt)		meat					carnitin
C	60–100	hips sweet pepper black currants parsley oranges lemons tangerines	470 250 200 150 60 40 38	scarvy (scurbutus, Barlow's disease): petechia, ecchimoses; alopecia; bleeding gums	↓platelets, WBC	urine stones	ascorbic acid
Minerals							
Ca2+	1500 mg (pregnants) 1,100–1,200 (children) 800 (adults)	milk cheese curd atlantic herring garlic cucumber	121 1,040 164 102 90 23	delay of the growth; rickets; spamophyllia; osteoporosis	↓[Ca2+]	hypercalcemia; mental disorder; diseases of the kidneys	decrease of absorption: (HCOOH) <sub>2</sub> sorrel, spinach, beet, rhubarb; plenty of fats, deficit of protein; rise of absorption: dairy products (lactose), citrus fruit (citric acid)
Mg2+	400 mg	pearl-barley buckwheat oatmeal bread	153 258 135 54	violation of the growth; fatigability; tremor; tetania; arrhythmia	↓[Mg2+]	diarrhea	Mg:Ca= 0.5:1.0
P	1,200 mg	haricot beans garlic bread	541 140 120	fatigability; adult rickets; heart weakness; pulmonary insufficiency	low activity of the phagocytosis ↓[P]		P:Ca=1.5:1.0 (1:1.5) age < 6 months) (1:1.3) age < 12 months
K+	3–5 g	dried apricots dried pears raising	1,717 2,043 1,280 860	languor; polyuria; paresis of the intestine; arrhythmia	↓[K+] on ECG: high P, ↑PQ	muscular hypotonia; arrhythmia	
Na+	10–12 g (of salt)	salt	37,500	muscular weakness, tonic cramps in legs; apathism; anorexia; hypotension; oliguria; mental disorder	↓[Na+]	hypertension, edema	

nutrients	RDA	Sources	Content g%*/mg%**	Deficiency		Overuse	
				clinical signs	laboratory signs	clinical signs	laboratory signs
Cl <sup>-</sup>	5–7 g	salt		cramps; apathism; anorexia	↓[Cl <sup>-</sup> ], alkalosis		
S	1 g	beef cheese haricot bean peas sea-perch	230 263 227 219 175				
Fe	12 mg (men) 18 mg (women)	fine-ground barley buckwheat lentil haricot beans liver oatmeal prunes	11.0 16.7 15.9 12.4 9.0 11.0 15.0	pale ness; weakness; Plummer — Vensant syndrome	↓[Fe], Cl, Hb, RBC, microcytosis (iron deficiency anemia)	siderosis, haemochromatosis	
Zn	10–15 mg (adults) 4–5 (children) 0.3 (newborns)	mushroom yolk of egg liver bran	150 49 45 30	rash; desquamation; delay of the growth; hypogonadism; hypogeusia; photophobia; anergia; low regeneration	↓[Zn]	febricity; sickness; nausea; diarrhea	
I	0.1–0.2	squids shrimps sea-kale (laminaria)		goiter	TSH, absorption of <sup>128</sup> I ↓T3, T4	goiter, hypothyreosis	
F	0.5–1.0	drink water		teeth decay		motted teeth (fluorosis)	
Cu	2	cacao squids liver		pale ness	neutropenia, ↓Hb, RBC, [Fe], [Cu], ceruloplasmine, microcytosis		
Cr	0.2–0.25	wholegrain bread leguminoses			tolerance to glucose, hyperglycemia		
Mo	0.5	leguminous plant				Gout, uraturia	
Co	0.1–0.2	liver oatmeal red beet	13.5 7.6 12	pale ness; asthenia			
Mn	5–7	tea liver parsley	15 0.3 1.0				

\* — for amino acids;

\*\* — for micronutrients.

## Food Poisonings and their Prevention

Disease	Cause	Toxic agent	Incubation period	Clinical signs	Prevention
<b>toxicoinfections</b>					
Escherichia coli (EPS, ETS)	all food-stuffs	endoentero -toxines	4–10 h	gastroenteritis	observance to sanitaric rules in food stuffs purchases, cooking, keeping transportation and selling
Bac.Cereus	custard and souces, meatloaf		8–16 h		
Cl perfringens A	milk		8–22 h		
Proteus	meat, fish		4–6 h		
Vibrio parahaemoliticus	fish		12–48 h		
Str.Faecalis	all food stuffs		3–18 h		
Campilobacter	milk		2–10 days		
Citrobacter					
Hafnia					
Klebsiella					
Edwardsiella					
Yersinia					
Pseudomonas					
Aeromonas					
<b>bacteriotoxicoses:</b>					
botulism	home-canned low-acid food-stuffs, vacuum-packed fish, fermented fish eggs, fish, marine mammals, sausages, etc.	exoneurotoxins A, B, E and F of Clostridium botulinum	2 h – 8 days (average 18–36 h)	vertigo; double or blurred vision; dryness of mouth; difficulty in swallowing, speaking, and breathing; descending paresis; constipation; pupils dilated or fixed; respiratory paralysis. Gastrointestinal symptoms and neurologic symptoms may precede. Frequently fatal	sanitary control on the catering organization; not use homesmoked salmon (or sturgeon) in food; adequate technology of cooking, canning of “risk products” nutrition education
staphylococcal intoxication	dairy products, cream-filled pastry, food moxture, poultry products, ham, meat	exoenterotoxines A,B,C,D and E of Staphylococcus aureus	1–8 h (mean 2–4 h)	gastroenteritis	observance to sanitaric rules in food-stuffs purchases, cooking transportation and selling
<b>mycotoxicosis:</b>					
aflotoxicosis	cereal crops, peanut, fruit	aflotoxines of Aspergillus flavus etc.;		toxic hepatitis	mycologic sanitaric control of cereals, peanuts, fruit and other products of vegetable origin
poisoning with “tipsy bread” alimentaric toxic aleukia	bread, flour bread	toxine of Fusarium graminearum toxine of Fusarium sporotrichiella		mental disorder, gastroenteritis, anaemia necrotic tonsillitis; aleukia convulsive, gangrenous and mixed clinical forms	
ergotism	flour, bread	ergotoxine and ergotamine (toxines of Claviceps pur purea)			

Disease	Cause	Toxic agent	Incubation period	Clinical signs	Prevention
<b>poisoning with pesticides</b> mercurial (Granosanum, Mercuranum, etc.) chlororganic (DDT, hexachloran) phosphororganic (carbophos, chlorophos, etc.)	plants, other food-stuffs corn	methylmercury ethylmercury		mercurialism  toxic hepatitis,  neurointoxication bronchospastic syndrome; abdominal syndrom; cramps	control of using in agriculture change of dangerous substances to safe substances control of pesticides containing in food-stuffs
<b>metalls:</b> lead zinc nickel copper iron, etc.	all food-stuffs			plumbism gastroenteritis	checking of metalls containing in food-stuffs; not using zinc-coated and untinned pans for cooking and food-keeping
<b>nitrites</b>	plants			methemoglobinemia	checking of nitrates containing in food-stuffs not using ammonia selitre for planting of mellow, water-mellows, squashes, cucumbers not using as a preservative more than 0.003–0.005% of nitrates for sausages and ham sanitary education
<b>mushroom poisoning</b>	(toadstools) an agaric amanita Satan's mushroom wooly milk cap, etc.			neuroitoxication, toxic hepatitis, gastroenteritis	sanitary education
<b>poisoning with poisonous plants</b>	aconite foxglove thorn apple deadly nightshade (belladonna) bread with admixture of Trichodesma incanum seeds	aconitine digitaline atropine, hyoscinamine		cramps, coma arrhythmiae, atropinisme: dilated pupillas, dispnoe, dryness of skin and mucouses encephalitis	sanitary education
<b>food additives</b>	chinese food	MSG (monosodium glutamate)		"chinese restaurant" syndrome: burning sensation in neck, forearms, chest, tingling, flushing, dizziness, headache, nausea	checking of additives using in food industry
<b>poisoning with poisonous products of animal origin</b>	"Fugu" — Japanese delicacies (puffer fish, porcupine fish)	tetrodotoxine		descendens paralysis, dyspnea, respiratory failure, collapse	sanitary education checking of dangerous food-stuffs using
<b>poisoning with products which is got poisonous peculiarities temporarily</b>	potatoes uncooked harricot beans stones of bitter almonds, apricot, peach scombroid fish oysters, shrimps, lobster, shellfish	solanine fazine amigdaline  histamine siguatoxines		gastroenteritis dyspepsia headache, nausea, cyanosis, unconsciousness  burning sensation in neck, forearms, chest, tingling flushing, dizziness, headache; ciguatera (paralytic, gastrointestinal and allergic forms)	sanitary education products keeping in wrong conditions are not in use  harricot bean flour is forbidden for sale

**abatement** the reduction or elimination of pollution.

**acceptable daily intake (ADI)** the highest daily amount of a substance that may be consumed over a lifetime without adverse effects.

**ACH, AC/H (air changes per h)** the number of times air is replaced in an h.

**acid deposition** a comprehensive term for the various ways acidic compounds precipitate from the atmosphere and deposit onto surfaces. It can include: 1) wet deposition by means of acid rain, fog, and snow; and 2) dry deposition of acidic particles (aerosols).

**acid rain** rain which is especially acidic ( $\text{pH} < 5.2$ ). Principal components of acid rain typically include nitric and sulfuric acid. These may be formed by the combination of nitrogen and sulfur oxides with water vapor in the atmosphere.

**action level (AL)** the concentration of a contaminant which, if exceeded, triggers treatment or other requirements must follow.

**additives (food additives)** are any natural or synthetic material, other than the basic raw ingredients, used in the production of a food item to enhance the final product. Any substance that may affect the characteristics of any food, including those used in the production, processing, treatment, packaging, transportation or storage of food.

**adolescence** period of time in a person's life beginning with the onset of puberty and ending with the full acceptance of adult responsibility. In years, that could be anywhere from age 10 on the low end to about age 25 on the other end.

**adolescent** one who is in the developmental period called adolescence. A young person in the midst of major biological changes leading to sexual maturity. An individual in the "in between" phase between childhood and adulthood.

**adverse health effect** health effect from exposure to contaminants that may range from relatively mild temporary conditions to permanent and serious conditions, such as birth defects, cancer.

**aerosol** particles of solid or liquid matter that can remain suspended in air.

**air monitoring** sampling for and measuring of pollutants present in the atmosphere.

**air pollutants** amounts of foreign and/or natural substances occurring in the atmosphere that may result in adverse effects to humans, animals, vegetation, and/or materials.

**air quality index (AQI)** a numerical index used for reporting severity of air pollution levels to the public. AQI incorporates five criteria pollutants — ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide — into a single index.

**air quality standard (AQS)** the prescribed level of a pollutant in the outside air that should not be exceeded during a specific time period to protect public health.

**alpha tocopherol (Vitamin E)** essential fat soluble vitamin. Only chain-breaking lipid-soluble antioxidant which protects the cells from damage caused by free radicals and peroxides — reinforced by the selenium enzyme — glutathione peroxidase. Reduces oxygen needs of muscles, blood vessel dilator, maintains healthy blood vessels. An essential nutrient: supplemented for its effects as an antioxidant, in problems of low fertility, immune enhancement, joint and muscle complaints and applied locally on scar tissue and burns.

**alternative fuels** fuels such as methanol, ethanol, natural gas, and liquid petroleum gas that are cleaner burning and help to meet ARB's mobile and stationary emission standards.

**amino acids** amino acids function as the building blocks of proteins. Chemically, amino acids are organic compounds containing an amino ( $-\text{NH}_2$ ) group and a carboxyl ( $\text{COOH}$ ) group. Amino acids are classified as essential and nonessential. If body synthesis is inadequate to meet metabolic need, an amino acid is classified as essential and must be supplied as part of the diet. Essential amino acids include leucine, isoleucine, valine, tryptophan, phenylalanine, methionine, threonine, lysine, histidine and possibly arginine. Nonessential amino acids can be synthesized by the body in adequate amounts, and include alanine, aspartic acid, asparagine, glutamic acid, glutamine, glycine, proline and serine.

**analytical epidemiology** the design, execution and analysis of studies in groups to evaluate potential associations between risk factors and health outcomes.

**anorexia nervosa** an eating disorder characterized by refusal to maintain a minimally normal weight for height and age. The condition includes weight loss leading to maintenance of body weight 15 percent below normal; an intense fear of weight gain or becoming fat, despite the individual's underweight status; a disturbance in the self-awareness of one's own body weight or shape; and in females, the absence of at least three consecutive menstrual cycles that would otherwise be expected to occur.

**anticyclone** a large area of high pressure around which the winds blow clockwise in the Northern Hemisphere.

**antioxidants** any substance that delays or inhibits oxidative damage (the attack upon biological molecules of oxygen containing “free radicals”). All molecules in living organisms are potential targets of oxidative damage: lipids, proteins, nucleic acids, connective tissue and carbohydrates. Antioxidants work primarily by donating or “sacrificing” an electron to the free-radical thereby stabilizing the free-radical. Found in: many plants — especially those rich in bioflavonoids. Vitamins A, C and E, super oxide dismutase (SOD), glutathione peroxidase, selenium, zinc, copper, manganese have antioxidant activity.

**aquatic integrity** the overall condition of a waterbody including chemical, physical and biological components. The integrity condition is generally based on a comparison to a reference which is a relatively undisturbed system and represents the best quality to be expected for the ecoregion.

**aquifer** a natural underground geologic layer that is capable of storing water and may be used as a source of water supply.

**arginine** essential amino acid. Stimulates growth hormone (GH) which stimulates immune function, accelerates wound healing, enhances fat metabolism and involved in insulin production. In blood vessels arginine converts to the amino acid citrulline which releases nitric oxide which has a potent vasodilator effect.

**ascorbic acid (vitamin C)** known to be involved in at least 300 biochemical pathways within the mammalian system. Provides an important role in — the absorption of dietary iron and its incorporation into haemoglobin; collagen formation; neurotransmitter substances; the biosynthesis of carnitine. A powerful antioxidant. Provides resistance to infection.

**aspartic acid** amino acid with protective functions for the liver, promotes uptake of trace elements from the gut. Assists in the cellular transport of magnesium and potassium.

**atmosphere** the gaseous mass or envelope of air surrounding the Earth. From ground-level up, the atmosphere is further subdivided into the troposphere, stratosphere, mesosphere, and the thermosphere.

**benthic macroinvertebrate** an animal lacking a backbone or internal skeleton which lives on or near the bottom of water reservoirs (for example, crayfish, mayflies, and nymphs). Because they spend their entire lifecycle in water, they are good indicators of the health of that waterbody.

**big five of adolescent development** the five developmental areas are critical in the life of a growing adolescent. Picture a bar graph with five bars — physical development, mental (cognitive) development, social development, emotional development, and spiritual development.

**bioflavonoids** see **flavonoids**

**biogenic source** biological sources such as plants and animals that emit air pollutants such as volatile organic compounds. Examples of biogenic sources include animal management operations, and oak and pine tree forests.

**biological integrity** the condition of the biological components (usually benthic macroinvertebrates and/or fish) of a waterbody. The integrity condition is generally based on a comparison to a reference which is a relatively undisturbed system and represents the best quality to be expected for the ecoregion.

**biotic** pertaining to life or living organisms.

**biotin** vitamin of the B complex group. Participates in the carbohydrate, protein and fat metabolisms. Maintains healthy skin, hooves and functions as a co-enzyme. Normally produced by healthy intestinal bacteria.

**BOD (biochemical oxygen demand)** the oxygen required for the biochemical degradation of organic material (carbonaceous) and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron. In other words, a measure that indicates the degree to which dissolved oxygen levels would change in a stream based on the contributions of organic matter.

**bovine spongiform encephalopathy (BSE)** is also known as “mad cow disease”. It is a rare, chronic degenerative disease affecting the brain and central nervous system of cattle. Meat borne disease.

**bromelain** a complex mixture of proteolytic enzymes extracted from the pineapple. Reported in over 200 scientific studies to exert a wide variety of beneficial effects, including reducing the inflammation specifically encountered in sporting injuries. Attributed to activating compounds which break down fibrin (whose role in promotion of the inflammatory response is to wall off the area of inflammation which results in blockage of blood vessels, inadequate tissue drainage and oedema (swelling)).

**bulimia nervosa** an eating disorder characterized by rapid consumption of a large amount of food in a short period of time, with a sense of lack of control during the episode and self-evaluation unduly influenced by body weight and shape. There are two forms of the condition, purging and non-purging. The first type regularly engages in purging through self-induced vomiting or the excessive use of laxatives or diuretics. Alternatively, the non-purging type controls weight through strict dieting, fasting or excessive exercise.

**butter** is made of pasteurized cream. It has 72,5–82% of milk fat.

**buttermilk** all commercially sold buttermilk is cultured. This means that a safe lactic acid — producing bacterial culture is added to freshly pasteurized skim or lowfat milk to produce the buttermilk. It is much thicker than skim milk and is higher in sodium than other milk. Buttermilk is a good thirst quencher.

**caffeine** is a naturally-occurring substance found in the leaves, seeds or fruit of over 63 plant species worldwide and is part of a group of compounds known as methylxanthines. The most commonly known sources of caffeine are coffee and cocoa beans, cola nuts and tea leaves.

**Calcium** the most abundant mineral in the body. Required for teeth and bones. An essential electrolyte. Assists in various biochemical functions. Intimately associated with the parathyroid glands which, in conjunction with Vitamin D, mobilise calcium from the bones into the bloodstream.

**calorie** the amount of heat required to raise 1 g of water 1°C (based on a standard temperature of 16.5 to 17.5°C).

**carbon monoxide (CO)** a colorless, odorless gas resulting from the incomplete combustion of hydrocarbon fuels. CO interferes with the blood's ability to carry oxygen to the body's tissues and results in numerous adverse health effects. Over 80% of the CO emitted in urban areas is contributed by motor vehicles.

**carbon dioxide (CO<sub>2</sub>)** a colorless, odorless gas that occurs naturally in the Earth's atmosphere. Significant quantities are also emitted into the air by fossil fuel combustion. CO<sub>2</sub> is a criteria indoor air pollutant.

**carnitine** amino acid synthesized in the liver from lysine and methionine. Vitamin C being essential for its conversion. Concentrated in heart and skeletal muscle — it serves to transport fatty acids across the cell membrane which allows them to be burnt for energy. Specifically enhances energy metabolism at the mitochondrial level.

**child abuse** may include not only physical assault of a child but also malnourishment, abandonment, neglect, emotional abuse, and sexual abuse.

**chloramination** the process of treating drinking water by applying chlorine before or after ammonia. This creates a persistent disinfectant residual.

**chlorofluorocarbons (CFCs)** substances consisting of chlorine, fluorine, and carbon. CFCs are used for refrigeration, foam packaging, solvents, and propellants.

**cholecalciferol/ergocalciferol** vitamin D is fat soluble. Substantial amounts are produced in the skin by sunlight. From the diet or the skin it is converted into a biologically active form in the liver and kidneys. Promotes absorption of calcium and phosphate from feed which is metabolized for mineralisation of the bones. Uniquely for a vitamin it has hormone like functions. Causes release of calcium from the bone.

**cholesterol** a chemical compound manufactured in the body. It is used to build cell membranes and brain and nerve tissues. Cholesterol also helps the body make steroid hormones and bile acids.

**choline** vitamin like function. Structural component of lecithin. Functions in the maintenance and integrity of the liver, kidney and blood vascular system. Deficiency can result in fatty liver and cirrhosis.

**chromium** essential micro-trace element. When bound to nicotinic acid and glutathione; it forms a compound known as Glucose Tolerance Factor (GTF) which plays an active role in the insulin metabolism; lean muscle deposition; and certain athletic performance characteristics. Animal studies have shown that organically bound chromium can reduce the blood levels of the well recognised hormone of stress — cortisol. Stimulates enzymes of the energy metabolism; involved in the synthesis of fatty acids, cholesterol and protein. Highly bioavailable when organically bound as the polynicotinate.

**climate** is the composite or generally prevailing weather conditions of a region. Climate refers to the weather situation over a long period of time, usually 30 years or more.

**climatology** the scientific study of climate. Part of meteorology which studies processes of climate formation, distribution of climates over the globe, analysis of the causes of differences of climate (physical climatology),

and the application of climatic data to the solution of specific design or operational problems (applied climatology). Climatology may be further subdivided according to purpose or point of view: agricultural climatology, air-mass climatology, aviation climatology, bioclimatology, dynamic climatology, medical climatology, macroclimatology, mesoclimatology, microclimatology, paleoclimatology, synoptic climatology and others.

**clinical epidemiology** the application of the logical and quantitative concepts and methods of epidemiology to problems (diagnostic, prognostic, therapeutic, and preventive) encountered in the clinical delivery of care to individual patients. The population aspect of epidemiology is present because these individual patients are members of conceptual populations. "A basic science for clinical medicine" (Sackett et al.).

**coenzyme** usually contains phosphorus and some form of vitamin. A coenzyme and an apoenzyme (the protein component of an enzyme) must unite in order to function.

**coliform** a group of bacteria commonly found in the environment. They are an indicator of potential contamination of water. Adequate and appropriate disinfection effectively destroys coliform bacteria.

**collagen** the most abundant protein of the body. Responsible for maintaining the integrity of "ground substance" — which holds together the tissues of the body. Found in tendons, ligaments, and cartilage. Collagen is destroyed during certain inflammatory conditions that involve bones, joints, cartilage, and other connective tissue.

**colony forming units (CFU)** a measurement used to count the number of bacteria colonies found in the medium (air, water, soil, etc.).

**condensation** the cooling of water vapor so that it becomes liquid.

**conduction** movement of heat between two solid objects in physical contact; heat moves from warmer to colder object. Conduction is the transfer of heat between materials that contact each other. Heat passes from the warmer material to the cooler material. For example, a worker's skin can transfer heat to a contacting surface if that surface is cooler, and vice versa.

**contaminant** any natural or man-made physical, chemical, biological, or radiological substance or matter in water, which is at a level that may have an adverse effect on public health, and which is known or anticipated to occur in public water systems.

**convection** process of heat flow between a solid body and a moving air (e.g. wind). Air flowing past the body can cool the body if the air temperature is cool. On the other hand, air that exceeds 35°C (95°F) can increase the heat load on the body.

**copper** required for haemoglobin formation. Important in many enzymatic reactions that involve metabolic function. Requirements can vary with age, sporting activity and stress. The antioxidant copper-zinc-superoxide dismutase is severely affected by copper deficiency.

**corrosion** a dissolving and wearing away of metal caused by a chemical reaction, usually between water and metal pipes, or between two different metals. In a water system, corrosion can cause structural failure, leaks, loss of capacity, and deterioration of chemical and microbiological water quality.



**cream** dairy product containing 15–40% of milkfat.

**creatine** most of the creatine in the body is found in skeletal muscle, where it exists both as free creatine and as high-energy creatine phosphate. During the anaerobic phase of muscular contractions this high-energy creatine phosphate reacts with ADP (adenosine diphosphate) to form creatine and ADP (adenosine triphosphate — the cellular fuel source for muscular contractions) and makes this energy available for the contractile phase of the muscle. Supplementation (creatine monohydrate) results in significant increase in the creatine content of skeletal muscle and can delay the development of fatigue during maximal exercise.

**cyanocobalamin** vitamin B<sub>12</sub> is water soluble. Functions as a co-enzyme, required in the synthesis of DNA (deoxyribonucleic acid). Maintains healthy myelin sheaths (nerve insulators). Intimately associated with folic acid. Therapeutic for certain anaemias.

**cyclone** a large-scale circulation of winds around a central region of low atmospheric pressure, counterclockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere. Also the term used for a hurricane in the Indian Ocean and in the Western Pacific Ocean.

**descriptive (observational) epidemiology** the most basic form of epidemiology, which is the description of the patterns of occurrence of health-related states or events in groups; answering the questions of “Who?”, “What?” “Where?”, and “When?”. Descriptive epidemiology is usually one of the first things done at the scene of any disease outbreak.

**dew** moisture that has condensed on objects near the ground, whose temperatures have fallen below the dew-point temperature.

**dewpoint** the temperature to which the air must be cooled for water vapor to condense.

**dietary fibre** is that part of whole grains, vegetables, fruit and nuts which resists digestion in the gastrointestinal tract: it consists of carbohydrate (cellulose, etc.) and lignin.

**dilution ventilation (general exhaust ventilation)** a form of exposure control that involves providing enough air in the workplace to dilute the concentration of airborne contaminants to acceptable levels.

**disinfectant** a chemical (commonly chlorine, chloramine, or ozone) or physical process (e.g. ultraviolet light) that kills microorganisms such as bacteria, viruses, and protozoa.

**distribution system** a network of pipes that distribute potable water to customers’ plumbing systems.

**DMG (dimethyl glycine)** a “branch form” of the amino acid glycine. Reputed to boost athletic performance. Recent studies demonstrate that it lowers the levels of lactate in the blood. Also used to enhance immune system functioning.

**docosahexanoic acid (DHA)** essential (omega-3) fatty acid. Has a beneficial influence on the prostaglandin and leukotriene metabolism alleviating circulatory problems, skin disease and inflammation.

**dose** the amount of a pollutant that is absorbed. A level of exposure which is a function of a pollutant’s concentration, the length of time a subject is exposed, and the

amount of the pollutant that is absorbed. The concentration of the pollutant and the length of time that the subject is exposed to that pollutant determine dose.

**dry air** exists when all of the contaminants and water vapor have been removed from atmospheric air. By volume, dry air contains about 78% of nitrogen, 21% of oxygen, and 1% of other gases. Dry air is used as the reference in psychrometrics.

**dry bulb (DB) temperature** is measured by a thermal sensor, such as an ordinary mercury-in-glass thermometer, that is shielded from direct radiant energy sources.

**dry whole milk** is pasteurized whole milk with the water removed. It has limited retail distribution — mainly for use in infant feeding and for people without access to fresh milk, such as campers. Dry whole milk is usually sold to chocolate and candy manufacturers.

**dust** solid particulate matter that can become airborne.

**dwelling unit** any building, addition, extension, or any portion thereof, which is designated or intended for occupancy by one family or persons living together or by a person living alone.

**early adolescence** period between the ages of 11 and 13, generally junior high school, beginning with puberty. Characterized by changing gender roles, more autonomous relationships with parents. Beginning to develop personal identity, though still rooted in parent expectations. Most significant relationships are still same-sex, emotions are a roller coaster. Physical changes are dramatic and sometimes painful. Girls mature physically about one and a half to two years ahead of boys. May struggle with inability to live up to biblical standards.

**early maturers** adolescents who begin pubescence earlier than is average for their gender.

**ecoclimate** is the climate inside vegetation.

**ecological entity** in ecological risk assessment, a general term referring to a species, a group of species, an ecosystem function or characteristic, or a specific habitat or biome.

**ecological epidemiology** a branch of epidemiology which views disease as a result of the ecological interactions between populations of hosts and parasites.

**ecological impact** the effect that a man-caused or natural activity has on living organisms and their non-living (abiotic) environment.

**ecological indicator** a characteristic of an ecosystem that is related to, or derived from, a measure of biotic or abiotic variable, that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability.

**ecological risk assessment** the application of a formal framework, analytical process, or model to estimate the effects of human actions(s) on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each component of the assessment process. Such analysis includes initial hazard identification, exposure and dose-response assessments, and risk characterization.

**ecological/environmental sustainability** maintenance of ecosystem components and functions for future generations.

**ecology** is the branch of biology concerned with studying the interrelationships of living organisms, specifically their relationships to each other and to the environment.

**ectotherm** an organism that relies mainly on external sources of energy for regulating body temperature (includes invertebrates, amphibians, fish, reptiles).

**eicosapentaenoic acid (EPA)** essential (omega-3) fatty acid. Has a beneficial influence on the prostaglandin and leukotriene metabolism alleviating circulatory problems, skin disease and inflammation.

**electrolytes** the maintenance of normal body function is dependant upon the interplay of many systems — central to all is the fluid and electrolyte medium (plasma, cations and anions) in which all cells are bathed and which constitutes the body's transport medium. The principal cations in the plasma are sodium, potassium, calcium and magnesium. The principal anions are chloride, bicarbonate, phosphate, sulphate, organic acids (lactate, citrate) and protein. It is essential for the body to keep these ions in perfect balance as a loss or imbalance can cause severe problems to all systems. Such an imbalance is caused during strenuous athletic exercise, disease, heat exposure and other stressful conditions.

**electrostatic precipitator (ESP)** an air pollution control device that removes particulate matter from an air stream by imparting an electrical charge to the particles for mechanical collection at an electrode.

**emission rate** the weight of a pollutant emitted per unit of time (e.g. tons/year).

**emission standard** the maximum amount of a pollutant that is allowed to be discharged from a polluting source such as an automobile or smoke stack.

**endotherm** an organism that relies heavily on internally-derived metabolic heat energy to regulate body temperature (includes birds, mammals; some fish and insects selectively heat critical organs).

**environment** the sum of all external conditions affecting the life, development and survival of an organism.

**environmental audit** an independent assessment of the current status of a party's compliance with applicable environmental requirements or of a party's environmental compliance policies, practices, and controls.

**environmental equity/justice** equal protection from environmental hazards for individuals, groups, or communities regardless of race, ethnicity, or economic status. This applies to the development, implementation, and enforcement of environmental laws, regulations, and policies, and implies that no population of people should be forced to shoulder a disproportionate share of negative environmental impacts of pollution or environmental hazard due to a lack of political or economic strength levels.

**environmental exposure** human exposure to pollutants originating from facility emissions. Threshold levels are not necessarily surpassed, but low-level chronic pollutant exposure is one of the most common forms of environmental exposure.

**environmental indicator** a measurement, statistic or value that provides a proximate gauge or evidence of the effects of environmental management programs or of the state or condition of the environment.

**environmental site assessment** the process of determining whether contamination is present on a parcel of real property.

**environmental sustainability** long-term maintenance of ecosystem components and functions for future generations.

**environmental/ecological risk** the potential for adverse effects on living organisms associated with pollution of the environment by effluents, emissions, wastes, or accidental chemical releases; energy use; or the depletion of natural resources.

**enzymes** non living protein catalysts (capable of greatly accelerating chemical reactions and the breakdown of biological substances) which are secreted by virtually every living plant and animal cell. Made up of two parts — a protein molecule and a coenzyme. Inside cells these catalysts facilitate thousands of chemical reactions which enable the cell to live, repair itself, and dispose of waste products. Present in digestive fluids and in many tissues; enzymes perform their function without being destroyed or altered.

**EPT** a group of three orders of insects (*Ephemeropter* [mayflies], *Plecoptera* [stoneflies], and *Trichoptera* [caddisflies]) generally considered as sensitive to pollution and used in some cases as primary indicators of stream aquatic integrity.

**epidemiology** “epi” — upon, “demos” — the people, “logos” — study of. The logical, systematic approach to understanding the complexities of disease (Torrence, 1997). The logic of observation and the methods to quantify these observations in populations (groups) of individuals. Epidemiology is the study of the distribution of health-related states or events in specified populations and the application of this study to the control of health problems (CDC). Epidemiology includes:

— the methods for measuring the health of groups and for determining the attributes and exposures that influence health;

— the study of the occurrence of disease in its natural habitat rather than the controlled environment of the laboratory;

— the methods for the quantitative study of the distribution, variation, and determinants of health-related outcomes in specific groups (populations) of individuals, and the application of this study to the diagnosis, treatment, and prevention of these states or events (Last, 1995).

**equinox** the time when the sun crosses the earth's equator, making night and day of approximately equal length all over the earth and occurring about March 21 (the spring or vernal equinox) and September 22 (autumnal equinox).

**essential fatty acids** precursors to the hormone like prostaglandins: necessary for cells (all cell membranes consist of fatty acids) and need to be consumed via the diet. They consist of linoleic acids, gamma-linolenic acid, arachidonic acid, eicosapentaenoic acid and docosahexanoic acid. Used as nutritional adjuncts in the treatment of skin problems, allergic respiratory disease, circulatory problems, arthritis and inflammatory problems.

**eutrophication** over-enrichment of a waterbody with nutrients resulting in excessive growth of organisms and depletion of oxygen concentration.

**evaporated milk** evaporated milk is prepared by heating homogenized whole milk under a vacuum to remove half its water, sealing it in cans, and thermally processing it. When evaporated milk is mixed with an equal amount of water, its nutritive value is about the same as whole milk. Evaporated skim milk is also available.

**evaporation** the transformation of liquid water to a gas or vapor. This process is accelerated by heat or wind (see hydrologic cycle).

**evaporative cooling** takes place when sweat evaporates from the skin. High humidity reduces the rate of evaporation and thus reduces the effectiveness of the body's primary cooling mechanism.

**evaporative emissions** emissions from evaporating gasoline, which can occur during vehicle refueling, vehicle operation, and even when the vehicle is parked. Evaporative emissions can account for two-thirds of the hydrocarbon emissions from gasoline-fueled vehicles on hot summer days.

**evapotranspiration** is a measure of the amount of water vapor that returns to the air in a given area. It combines the amount of water vapor returned through evaporation (water leaving the earth) with the amount of water vapor returned through transpiration (water leaving plants) to arrive at a total for the area.

**exceedance** a measured level of an air pollutant higher than the national or state ambient air quality standards.

**exhaust gas recirculation (EGR)** an emission control method that involves recirculating exhaust gases from an engine back into the intake and combustion chambers. This lowers combustion temperatures and reduces NO<sub>x</sub>.

**expected peak day concentration (EPDC)** a calculated value that represents the concentration expected to occur at a particular site once per year, on average. The calculation procedure uses measured data collected at the site during a three-year period. Measured concentrations that are higher than the EPDC are excluded from the state area designation process.

**exposure assessment** measurement or estimation of the magnitude, frequency, duration and route of exposure to a substance for the populations of interest.

**exposure** the concentration of the pollutant in the air multiplied by the population exposed to that concentration over a specified time period.

**fat** a chemical compound containing one or more fatty acids. Fat is one of the three main constituents of food (the others are protein and carbohydrate). It is also the principal form in which energy is stored in the body.

**fatty acid** a molecule composed mostly of carbon and hydrogen atoms. Fatty acids are the building blocks of fats.

fecal coliform bacteria that forms in the colon of humans or animals and is transmitted through fecal material. The presence of fecal coliform bacteria in water, while not threatening to human health, is often used to indicate the presence of other harmful pathogens.

**fermented food** a food preserved by the growth of acid-producing microorganisms in the food which lowers the pH to 4.6 or less.

**filtration** a series of processes that physically removes particles from water.

**flavonoids** appear to be involved in modifying the body's reaction to compounds such as allergens, viruses, and carcinogens as evidenced by their anti-inflammatory, anti-allergic, antiviral, and anticancer properties. Flavonoid molecules are quite unique in that they are active against a wide variety of oxidants and free radicals. Among their effects is an ability to increase vitamin C levels within the cells, decrease the leakages and breakage of small blood vessels, protect against free radical damage (antioxidants), and support joint structures.

**flexible fuel vehicle (FFV)** vehicles that can use a combination of fuels such as alcohol fuel and unleaded gasoline.

**fly ash** air-borne solid particles that result from the burning of coal and other solid fuel.

**folic acid** pteroyl-glutamic acid water soluble vitamin of the B complex group. Essential growth factor. Functions as an enzyme. Deficiency can lead to anaemia. Recent scientific evidence in human medicine demonstrates essentiality of additional supplementation during pregnancy to prevent specific birth defects (spina bifida).

**food allergen** a food allergen is the part of a food (a protein) that stimulates the immune system of food allergic individuals. A single food can contain multiple food allergens. Carbohydrates or fats are not allergens.

**food allergy** a food allergy is any adverse reaction to an otherwise harmless food or food component (a protein) that involves the body's immune system. To avoid confusion with other types of adverse reactions to food-stuffs, it is important to use the terms "food allergy" or "food hypersensitivity" only when the immune system is involved in causing the reaction.

**Food and Drug Administration (FDA)** is part of the Public Health Service of the U. S. Department of Health and Human Services. It is the biggest national environmental regulatory agency responsible for ensuring the safety and wholesomeness of all food-stuffs sold in interstate commerce except meat, poultry and eggs (which are under the jurisdiction of the U. S. Department of Agriculture). FDA develops standards for the composition, quality, nutrition, safety and labeling of food stuffs including food and color additives. It conducts research to improve detection and prevention of contamination. It collects and interprets data on nutrition, food additives and pesticide residues. The agency also inspects food plants, imported food products and feed mills that make feeds containing medications or nutritional supplements that are destined for human consumption. And it regulates radiation-emitting products such as microwave ovens. FDA also enforces pesticide tolerances established by the Environmental Protection Agency for all domestically produced and imported food stuffs, except for food-stuffs under USDA jurisdiction.

**fossil fuels** fuels such as coal, oil, and natural gas; so-called because they are the remains of ancient plant and animal life.

**free radicals** consist of "electrically charged compounds of oxygen" that exist within the body and which are damaging to normal physiological functioning.

**front** the transition zone between two distinct airmasses. The basic frontal types are cold fronts, warm fronts and occluded fronts.

**fugitive dust** dust particles that are introduced into the air through certain activities such as soil cultivation, or vehicles operating on open fields or dirt roadways. A subset of fugitive emissions.

**fugitive emissions** emissions not caught by a capture system which are often due to equipment leaks, evaporative processes, and windblown disturbances.

**fume** solid particles under 1 micron in diameter formed as vapors condense, or as chemical reactions take place.

**furnace** a combustion chamber; an enclosed structure in which fuel is burned to heat air or material.

**gale** wind speeds from 39 to 54 mph (17–24 m/s).

**gamma-linolenic acid (GLA)** fatty acid. Involved, as a precursor, in the production of the prostaglandin “PGE1”; improves the activity of the immune system (specifically the T-lymphocytes). Found in borage (25%), blackcurrant seed oil (14%) and evening primrose (7 to 9%).

**gap winds** strong winds channeled through gaps in the Pacific coastal ranges, blowing out into the Pacific Ocean or into the waterways of the Inside Passage. The winds blow through low passes where major river valleys issue onto the seaways when strong east-west pressure gradients exist between the coast and the inland areas, with low pressure over the ocean.

**gastronomy** the study and appreciation of good food and good eating, and a culture’s culinary customs, style and lore. Any interest or study of culinary pursuits as relates essentially to the kitchen and cookery, and to the higher levels of education, training and achievement of the chef apprentice or professional chef.

**global warming** an increase in the temperature of the Earth’s troposphere. global warming has occurred in the past as a result of natural influences, but the term is most often used to refer to the warming predicted by computer models to occur as a result of increased emissions of greenhouse gases.

**globe temperature** the temperature inside a blackened, hollow, thin copper globe.

**glucose** monosaccharide found in food-stuffs especially fruit. Source of energy for living organisms, its utilization being controlled by insulin.

**glucose tolerance factor (GTF)** consists of a complex of nicotinic acid, glutathione (which consists of the amino acids — glutamic, cysteine and glycine) bound to the essential trace element chromium. Only active form of chromium to function physiologically. Functions as a binding factor for insulin on the cell wall. Athletic stress and trauma has been seen in humans to cause abnormal chromium losses and deficiency which in turn negatively affects glucose tolerance.

**glutamic acid** amino acid — precursor of gamma-amino butyric acid (GABA), a natural calming agent produced by the central nervous system. Vitamin B<sub>6</sub> is also essential in the production of GABA.

**grains** are the seeds or fruit of various food plants including cereal grasses. The examples of wheat, corn, oats, barley, rye and rice provide a partial list. Grain food-stuffs include such food-stuffs as bread, cereals, rice and pasta.

**greenhouse effect** atmospheric heating caused by solar radiation being readily transmitted inward through the

earth’s atmosphere but longwave radiation less readily transmitted outward, due to absorption by certain gases in the atmosphere.

**greenhouse gases** atmospheric gases such as carbon dioxide, methane, chlorofluorocarbons, nitrous oxide, ozone, and water vapor that slow the passage of re-radiated heat through the Earth’s atmosphere.

**ground water** the water that comes from an aquifer via wells.

**growth spurt** a sudden increase in the velocity of physical growth; an important feature of adolescent development, occurring approximately two years earlier for girls than for boys, resulting in dramatic changes in height and weight.

**habitat integrity** the condition of the physical habitat (banks, sediment) of a water body, particularly with respect to its suitability for aquatic life. The integrity condition is generally based on a comparison to a reference which is a relatively undisturbed system and represents the best quality to be expected for the ecoregion.

**hail** precipitation in the form of balls or irregular lumps of ice.

**half-and-half** is made by homogenizing a mixture of milk and cream. It must contain at least 10.5 percent of milk-fat, but no more than 18%.

**haze (hazy)** a phenomenon that results in reduced visibility due to the scattering of light caused by aerosols. Haze is caused in large part by man-made air pollutants.

**Health Risk Assessment (HRA)** a document that identifies the risks and quantities of possible adverse health effects that may result from exposure to emissions of toxic air contaminants. A health risk assessment cannot predict specific health effects; it only describes the increased possibility of adverse health effects based on the best scientific information available.

**Health-Based Standard (primary standard)** a dosage of air pollution scientifically determined to protect against human health effects such as asthma, emphysema, and cancer.

**hesperidin bioflavonoid (vitamin P)** found in citrus fruits. Vitamin like in activity. Enhancing co-factors in vitamin C activity and bioassimilation. Reduces small blood vessel fragility.

**heterotrophic plate count (HPC)** formerly known as the standard plate count, this is a procedure for estimating the number of live heterotrophic bacteria in water. It is a measure of a broad spectrum of bacteria. This test can provide useful information about water quality and supporting data on the significance of coliform test results. The lower the HPC, the better the biological water quality.

**humidity** the amount of water vapor in the atmosphere.

**hurricane** a severe tropical cyclone with wind speeds in excess of 74 mph (64 knots).

**HVAC (heating, ventilation and air conditioning)** technical systems designed primarily to control temperature, humidity, odors, and air quality.

**hydrogen sulfide (H<sub>2</sub>S)** a colorless, flammable, poisonous compound having a characteristic rotten-egg odor. It is used in industrial processes and may be emitted into the air.

**hydrologic cycle** the process in which water evaporated from rivers, lakes, and oceans rises and condenses into clouds, and then falls back to earth as rain, hail, sleet or snow.

**industrial ventilation (IV)** the equipment or operation associated with the supply or exhaust of air by natural or mechanical means to control occupational hazards in the industrial setting.

**impervious surface** a surface which does not allow water or other liquids to pass through. Examples include asphalt, roof-tops and concrete. Impervious surfaces greatly increase the volume and velocity of runoff and, therefore, the amount of pollution and sediment that enters streams or lakes.

**incineration** the act of burning a material to ashes.

**incremental reactivity (IR)** the additional ozone formed in the atmosphere with the incremental addition of a certain amount of a volatile organic compound.

**indirect source of pollution** any facility, building, structure, or installation, or combination thereof, which generates or attracts mobile source activity that results in emissions of any pollutant (or precursor) for which there is a state ambient air quality standard. Examples of indirect sources include employment sites, shopping centers, sports facilities, housing developments, airports, commercial and industrial development, and parking lots and garages.

**individual cancer risk** the probability, expressed as chances in a million, that a person experiencing 70 years of continuous area-wide outdoor exposure to a toxic air contaminant will develop cancer.

**indoor air pollution** air pollutants that occur within buildings or other enclosed spaces, as opposed to those occurring in outdoor, or ambient air. Some examples of indoor air pollutants are nitrogen oxides, smoke, asbestos, formaldehyde, and carbon monoxide.

**industrial premise** is ondoor space in the specially intended buildings and structures, in which is constant (on changes) or periodically (within a working day) the labour activity of the people is carried out.

**industrial source** any of a large number of sources — such as manufacturing operations, oil and gas refineries, food processing plants, and energy generating facilities — that emit substances into the atmosphere.

**infectious disease epidemiology** classical epidemiology; the study of epidemics; the study of the dynamic factors involved in the transmission of infectious agents in populations. Some include the products of the application of the methods of this discipline, the natural history of disease (information about how each disease spreads through groups and how a case of that disease develops in an individual).

**inorganic contaminants** such as salts and metals, which can be naturally occurring or result from urban storm runoff, industrial or domestic wastewater discharges, oil and gas production, mining or farming.

**intake** an opening strainer or grating through which water enters, and is then conveyed, usually by gravity, to a reservoir.

**integrated sampling device** an air sampling device that allows estimation of air quality components over a peri-

od of time through laboratory analysis of the sampler's medium.

**inversion** a layer of warm air in the atmosphere that prevents the rise of cooling air and traps pollutants beneath it.

**intermittent** a stream that flows only periodically throughout the year.

**irrigation** use of water for grazing and agricultural purposes. ITCZ: Inter-tropical.

**jus** a natural liquid extract from meat.

**kelp** a source of alginic acid, which is used to produce the gum, alginate. Used as a water control agent, as a flavor enhancer and as a source of iodine.

**key food stuffs** identification of food-stuffs most highly consumed and also best sources of nutrients deemed important to national dietary health. Key food stuffs are identified as those food stuffs contributing up to 75% of any one nutrient.

**kola nut** the seed of the cola plant that contains 1. 5% caffeine. Used primarily in beverages.

**kwashiorkor (infantile pellagra)** is a form of protein-energy malnutrition in countries of South-East Asia, Africa, Central and Latin America.

**lactates** any salt of lactic acid. Minerals, such as iron and copper bound to lactates are better assimilated physiologically.

**lactobacillus** one of a group of commensal (friendly) bacteria which populate the gastrointestinal tract. Probiotic. Stress, gastrointestinal imbalance (eg. diarrhoea) and treatments using antibiotics can cause a negative imbalance that necessitates supplementation.

**lactose** constituent of milk. A sugar which is broken down (by acids or enzymatically) to yield glucose and galactose.

**late adolescence** generally ages 16 to 19 (and occasionally beyond), organized around the central task of achieving an identity, in which adolescents integrate their sexuality into their relationships, prepare for a vocation, and fashion a personal set of beliefs. Physical changes have slowed down, but late growth spurts are not uncommon. Likely to test spiritual issues. Judgment shows promise of development.

**late maturers** individuals who undergo physical changes leading to sexual maturity at a later age than is average for their gender.

**limit of detection (LOD)** the lowest concentration of a substance that can reliably measured.

**linoleic acid** essential dietary fatty acid. Biologically inactive before it is catalysed into gamma-linoleic acid (GLA). Used as nutritional adjunct in the treatment of skin problems, allergic respiratory disease, circulation, arthritis and inflammatory problems.

**lipid** a chemical compound characterized by the fact that it is insoluble in water. Both fat and cholesterol are members of the lipid family.

**lipic acid** growth factor found in potatoes, liver and yeast.

**local exhaust ventilation** an industrial ventilation system that captures and removes emitted contaminants before dilution into the ambient air of the workplace.

**low NO<sub>x</sub> burners** one of several combustion technologies used to reduce emissions of nitrogen oxides.

**low-calorie sweetener** low-calorie sweeteners are non-nutritive sweeteners, also referred to as intense sweeteners. Low-calorie sweeteners can replace nutritive sweeteners in most food-stuffs at a caloric savings of approximately 16 calories per teaspoon. Thus, caloric reduction may be achieved when low-calorie sweetened food-stuffs and beverages are substituted for their full-calorie counterparts. Examples of low-calorie sweeteners in use in the U. S. food supply are saccharin, aspartame and acesulfame K.

**low-level jet** a regular, strong, nighttime, northward flow of maritime tropical air over the sloping Great Plains of the central United States, in which the wind increases to a peak in the lowest kilometer and then decreases above.

**lysine amino acid** essential for optimal growth and development. Low levels in feeds of non-meat origin. Involved in formation of antibodies (immune system). Involved in synthesis of carnithine.

**macroclimate** is the weather situation over a long period of time, usually the average of 30 years or more. Macroclimate is independent of local topography, soil type and vegetation and may extend for hundreds of kilometers. Typically, macroclimate temperatures are measured 1.5 meters above the ground and wind speed is determined at 10 meters above ground. Macroclimate considerations are important for the study of biogeography.

**marine climate** climate of regions adjacent to the sea characterized by small diurnal or annual, or both, amplitudes of temperature, and by high relative humidities.

**maturity** the age or state when the person is considered fully developed emotionally, socially, intellectually, and spiritually.

**maximum contaminant level (MCL)** the maximum allowable level of a contaminant that federal or state regulations allow in a public water system. If the MCL is exceeded, the water system must treat the water so that it meets the MCL.

**maximum contaminant level goal (MCLG)** the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

**maximum drained weight** weight of the solid portion of the product after it has been processed and after draining the covering liquid for a specified time with the appropriate sieve.

**maximum incremental reactivity (MIR)** a measure of the increase in ozone formation per unit weight of a hydrocarbon when added to the atmosphere.

**medical climatology** study of the influence of climate on the health of human beings.

**mediterranean cuisine** a blend of more than a dozen nations in and around the region of southern Europe, the Middle East and North Africa. The dishes from this area usually utilize the bounty of fresh produce available in these regions, in combination with some of the following herbs and spices: garlic, thyme, rosemary, cinnamon, saffron, paprika, oregano, ginger, cumin, marjoram, turmeric and mint.

**menarche** a girl's first menstrual period, occurring during pubescence.

**mesoclimate or topoclimate** is a local variant of macroclimate caused by topography and sometimes by vegetation or human action. Mesoclimates are found in ravines, over large lakes, and in big cities. The focus of mesoclimate studies is usually horizontal surfaces which may extend from kilometers to hectometers. Typically, mesoclimate temperatures are measured at 1.5 meters and/or at 0.5 meters above the ground, humidity is measured at 0.5 meters above the ground, and wind speed is determined at 1–2 meters above the ground. Mesoclimate considerations are important for the study of urban ecology and bioclimatology.

**metabolic heat** energy released within an organism during the process of cellular respiration.

**MFL** million fibers per liter.

**MGD** million gallons per day.

**microclimate** is the climate of the lower two meters of the atmosphere and the upper 0.5 to 1 meter of the soil. Vegetation has considerable influence on microclimate. Other important considerations are aspect (compass direction) and inclination. A microclimate typically extends over meters to hectometers. Typically, microclimate temperatures are measured at 1.5 meters and/or at 0.5 meters above the ground, humidity is measured at 0.5 meters above the ground, and wind speed is determined at 1–2 meters above the ground. Microclimate considerations are important for studies of vegetation ecology and population dynamics of plants and animals.

**middle adolescence** generally 14–15 years old. Movement toward interpersonal relationships with peers (particularly toward opposite sex), more comfortable with body changes. At first, marked differences in development between genders, but boys are beginning to catch up physically. Capable of more abstract thought. Tends to be introspective and searching, particularly in spiritual matters.

**migration** also affects the growth of cities. "Rural-urban migration" takes place when people from the countryside move, or migrate, to the city. This was the main contributor to urban growth after industrialization and all the way up to the 1970s. Today, international migration, or the movement of people from one country to another, adds a large number of people to the world's major cities.

**millibar** a unit of atmospheric pressure. 1 mb = 100 Pa (pascal). Normal surface pressure is approximately 1013 millibars.

**minimum net weight** the weight of all the product in the container, including brine or sauce, but not including the weight of the container.

**mobile sources** sources of air pollution such as automobiles, motorcycles, trucks, off-road vehicles, boats, and airplanes.

**monitoring** the periodic or continuous sampling and analysis of air pollutants in ambient air or from individual pollution sources.

**monounsaturated fatty acid** a fatty acid that is missing one pair of hydrogen atoms in the middle of the molecule. The gap is called an "unsaturation." Monounsaturated fatty acids are found mostly in plant and sea food-stuffs. Monounsaturated fat: fat made of monounsaturated fatty acids. Olive oil and canola oil are monounsaturated.

rated fats. Monounsaturated fats tend to lower levels of LDL-cholesterol in the blood.

**monsoon** a persistent seasonal wind, often responsible for seasonal precipitation regime.

**mrem/year** millirems per year, a measure of radiation absorbed by the body.

**MSLP** mean sea level pressure.

**multimedia exposure** exposure to a toxic substance from multiple pathways such as air, water, soil, food, and breast milk.

**natural sources of pollution** non-manmade emission sources, including biological and geological sources, wildfires, and windblown dust.

**natural wet bulb (NWB) temperature** is measured by exposing a wet sensor, such as a wet cotton wick fitted over the bulb of a thermometer, to the effects of evaporation and convection.

**nature versus nurture** the interaction of heredity and environment, the discussion of which is more influential — genetics or environment. An old psychological argument concerning whether genetics or environment is more responsible for determining development.

**nitrates** a dissolved form of nitrogen found in fertilizers and sewage by-products which may leach into groundwater and other water sources. Nitrates may also occur naturally in some waters. Over time, nitrates can accumulate in aquifers and contaminate groundwater.

**nitric oxide (NO)** precursor of ozone,  $\text{NO}_2$ , and nitrate; nitric oxide is usually emitted from combustion processes. Nitric oxide is converted to nitrogen dioxide ( $\text{NO}_2$ ) in the atmosphere, and then becomes involved in the photochemical processes and/or particulate formation.

**nitrogen oxides (oxides of nitrogen,  $\text{NO}_x$ )** a general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide ( $\text{NO}_2$ ), and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes, and are major contributors to smog formation and acid deposition.  $\text{NO}_2$  is a criteria air pollutant, and may result in numerous adverse health effects.

**nitrosamines** are a digestive reaction-product of nitrite, a food additive used to preserve meats, fish and poultry.

**non-industrial source** any of a large number of sources, such as mobile, area-wide, indirect, and natural sources which emit substances into the atmosphere.

**non-methane hydrocarbon (NMHC)** the sum of all hydrocarbon air pollutants except methane. NMHCs are significant precursors to ozone formation.

**non-methane organic gas (NMOG)** the sum of non-methane hydrocarbons and other organic gases such as aldehydes, ketones, and ethers.

**non-point sources of pollution** diffuse pollution sources that are not recognized to have a single point of origin.

**non-road emissions** pollutants emitted by a variety of non-road sources such as farm and construction equipment, gasoline-powered lawn and garden equipment, and power boats and outboard motors.

**no-observed-adverse-effect-level (NOAEL)** a term used in risk assessment. An exposure level at which there are

no statistically or biologically significant increases in the frequency or severity of adverse effects between an exposed population and a comparable non-exposed population.

**no-observed-effect-level (NOEL)** a term used in risk assessment. An exposure level at which there are no statistically or biologically significant difference or severity of any effect between an exposed population and a comparable non-exposed population.

**NTU (nephelometric turbidity unit)** a measure of the clarity of water. NTU measures suspended particles in water. High quality water has a low NTU.

**nutraceuticals** one term used to describe substances in or parts of a food that may be considered to provide medical or health benefits beyond basic nutrition, including disease prevention. Research indicates this term might not appeal to consumers.

**occluded front** a complex frontal system that occurs when a cold front overtakes a warm front. Also known as an occlusion.

**offshore breeze** a wind that blows from the land towards a body of water. Also known as a land breeze.

**onshore breeze** a wind that blows from a body of water towards the land. Also known as a seabreeze.

**opacity** the amount of light obscured by particle pollution in the atmosphere. Opacity is used as an indicator of changes in performance of particulate control systems.

**outdoor air (OA)** is the “fresh” air mixed with return air (RA) to dilute contaminants in the supply air.

**ozone depletion** the reduction in the stratospheric ozone layer. Stratospheric ozone shields the Earth from ultraviolet radiation. The breakdown of certain chlorine and/or bromine-containing compounds that catalytically destroy ozone molecules in the stratosphere can cause a reduction in the ozone layer.

**ozone layer** a layer of ozone in the lower portion of the stratosphere — 12 to 15 miles above the Earth’s surface — which helps to filter out harmful ultraviolet rays from the sun.

**ozone precursors** chemicals such as non-methane hydrocarbons and oxides of nitrogen, occurring either naturally or as a result of human activities, which contribute to the formation of ozone, a major component of smog.

**ozone** strong smelling, pale blue, reactive toxic chemical gas consisting of three oxygen atoms. It is a product of the photochemical process involving the sun’s energy and ozone precursors, such as hydrocarbons and oxides of nitrogen. Ozone exists in the upper atmosphere ozone layer (stratospheric ozone) as well as at the Earth’s surface in the troposphere (ozone).

**particulate matter (PM)** any material, except pure water, that exists in the solid or liquid state in the atmosphere. The size of particulate matter can vary from coarse, wind-blown dust particles to fine particle combustion products.

**pathogen** (disease-causing pathogens, waterborne pathogen) is a bacterium, virus or parasite that causes or is capable of causing disease. Pathogens may contaminate water and cause waterborne disease.

**peak height velocity (PHV)** maximal height rising (cm/year)

**peak levels** a level of airborne pollutants that is much higher than average. They can occur over a short period of minutes or h in response to sudden releases, or they can occur due to a longer term build-up over several days.

**peer pressure** experienced pressure to think and act like one's friends; often associated with risk behavior.

**peroxyacyl nitrate** a group of compounds formed from the photochemical reactions of nitrogen and organic compounds. PANs are components of smog and known to cause eye irritation.

**persistence** refers to the length of time a compound stays in the atmosphere, once introduced. A compound may persist for less than a second or indefinitely.

**perspiration** heat loss by evaporation of sweat. Excessive perspiration can lead to the scaling of the skin or inflammation (dermatitis). Usually this is no cause for worry. Some people sweat more, some less due to hereditary and body composition factors. Excessive perspiration is also a symptom of diabetes, anaemia and hyperthyroidism.

**pesticides** is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest.

**photochemical reaction** a term referring to chemical reactions brought about by the light energy of the sun. The reaction of nitrogen oxides with hydrocarbons in the presence of sunlight to form ozone is an example of a photochemical reaction.

**plume** a visible or measurable discharge of a contaminant from a given point of origin that can be measured according to the Ringelmann scale.

**poikilotherm** an organism whose body temperature varies directly with environmental temperatures (commonly called cold-blooded)

**point source pollution** originates at one location, usually a pipe, tank or ditch; examples include discharges from industrial facilities, water reclamation facilities and collected storm water runoff that is directed through a pipe.

**pollutant standards index (PSI)** a numerical index formerly used for reporting severity of air pollution levels to the general public. The PSI incorporated the five criteria pollutants — ozone, PM10, carbon monoxide, sulfur dioxide, and nitrogen dioxide — into one single index. The PSI was based on the 1-hour ozone standard. PSI levels ranged from 0 (Good air quality) to 500 (Hazardous air quality). The higher the index, the higher the level of pollutants and the greater likelihood of health effects.

**pollution prevention** the use of materials, processes, or practices to reduce, minimize, or eliminate the creation of pollutants or wastes. It includes practices that reduce the use of toxic or hazardous materials, energy, water, and/or other resources.

**polycyclic aromatic hydrocarbons (PAHs)** organic compounds which include only carbon and hydrogen with a fused ring structure containing at least two benzene (six-sided) rings. PAHs may also contain additional fused rings that are not six-sided. The combustion of organic substances is a common source of atmospheric PAHs.

**polyunsaturated fatty acid** a fatty acid that is missing more than one pair of hydrogen atoms.

**positive crankcase ventilation (PCV)** an emission control system for a reciprocating internal combustion engine that involves recirculating gases that blow by the piston rings during combustion from the crankcase back into the intake manifold so they can be more completely burned.

**potable water** water that is safe to drink.

**ppb** parts per billion. One part per billion corresponds to approximately 1 second in 31.7 years. Also the same as micrograms per liter ( $\mu\text{g/L}$ ).

**ppm** parts per million. One part per million corresponds to 1 second in 11.5 days. Also the same as milligrams per liter ( $\text{mg/L}$ ).

**ppq** parts per quadrillion, or picograms per liter.

**ppt** parts per trillion, or nanograms per liter.

**precipitation** the formation of a liquid or solid from a gas, as in the formation of rain, hail, sleet or snow from gaseous moisture in clouds; in the hydrologic cycle, precipitation describes the formation of rain or snow and their subsequent falling to earth.

**precipitator** pollution control device that collects particles from an air stream.

**premises** the parcel of land, lot or lots, on which the development, improvement, or service is planned.

**primary particles** particles that are directly emitted from combustion and fugitive dust sources.

**propellant** a gas with a high vapor pressure used to force formulations out of aerosol spray cans. Among the gases used are butanes, propanes and nitrogen.

**private water system** a water system constructed, owned, operated, and maintained by private individuals, corporations, or organisations.

**ptomaine food poisoning** the dictionary defines ptomaine poisoning as "food poisoning caused by bacteria or bacterial products". Ptomaine poisoning is not a special kind of food poisoning and it is not a deadlier type of food poisoning. Ptomaine is an old-fashioned general term for any type of food poisoning caused by bacteria. The term "ptomaine food poisoning" is not used medically anymore.

**puberty** broad term used to describe the onset of adolescence. Specifically, puberty is the sum of the physical growth processes, including the growth spurt and hormonal activity that result in maturity or the ability to reproduce and bear offspring.

**public water supply** any system that pipes water to at least 25 people or 15 connections for a minimum of 60 days per year.

**radioactive contaminants** can be naturally-occurring or be the result of oil and gas production and mining activities.

**radon** a colorless, naturally occurring, radioactive, inert gaseous element formed by radioactive decay of radium atoms in soil or rocks.

**raw (source) water** water that has not been treated in any way; it is generally considered to be unsafe to drink.

**reactive organic gas (ROG)** a photochemically reactive chemical gas, composed of non-methane hydrocarbons, that may contribute to the formation of smog. Also sometimes referred to as non-methane organic gases (NMOGs).



**reciprocating internal combustion engine** an engine in which air and fuel reintroduced into cylinders, compressed by pistons, and ignited by a spark plug or by compression. Combustion in the cylinders pushes the pistons sequentially, transferring energy to the crankshaft, causing it to rotate.

**residual risk** the quantity of health risk remaining after application of emission control.

**riffle pool** a section of stream that has shallow, fast-flowing water followed by deep, slow-flowing water.

**Ringelmann chart** a series of charts, numbered 0 to 5, that simulate various smoke densities by presenting different percentages of black. A Ringelmann N 1 is equivalent to 20 percent black; a Ringelmann N 5 is 100 percent black. They are used for measuring the opacity or equivalent obscuration of smoke arising from stacks and other sources by matching the actual effluent with the various numbers, or densities, indicated by the charts.

**risk assessment** an evaluation of risk which estimates the relationship between exposure to a harmful substance and the likelihood that harm will result from that exposure.

**risk management** an evaluation of the need for and feasibility of reducing risk. It includes consideration of magnitude of risk, available control technologies, and economic feasibility.

**runoff** rain or melted hail, sleet, or snow that finds its way to a lake or stream by flowing over land.

**sample** the water that is analyzed for the presence of EPA-regulated drinking water contaminants. Depending on the regulation, EPA requires water systems and states to take samples from source water, from water leaving the treatment facility, or from the taps of selected consumers.

**saturated fatty acid** a fatty acid that has the maximum possible number of hydrogen atoms attached to every carbon atom. It is said to be "saturated" with hydrogen atoms. Saturated fatty acids are mostly found in animal products such as meat and whole milk.

**scrubber** an air pollution control device that uses a high energy liquid spray to remove aerosol and gaseous pollutants from an air stream. The gases are removed either by absorption or chemical reaction.

**secondary particles** particles that are formed in the atmosphere. Secondary particles are products of the chemical reactions between gases, such as nitrates, sulfur oxides, ammonia, and organic products.

**secular trend** a trend that can be seen only by observing several generations, such as the trend toward earlier attainment of adult height and sexual maturity, which began a century ago puberty has been occurring earlier by 3 to 4 months per decade since mid 1800s. In mid 1800s, average age for menarche was 15.5–16.5. Now the average age in U.S. is 12.5. Another effect is that people grow larger. Males average an inch and 10 pounds heavier than their fathers. Females grow 1/2 inch to an inch more than their mothers and weigh about 2 pounds more on average.

**sediment basin** a man-made basin or intentional ponding area designed to hold storm water for a period of time to allow sediment and other suspended material to settle.

The water eventually flows out of the basin to downstream waterways, evaporates into the atmosphere or infiltrates the ground.

**sedimentation** deposition of solids carried by storm water which accumulate in channel beds, flood plains and the bottoms of lakes and rivers.

**sensitive groups** identifiable subsets of the general population that are at greater risk than the general population to the toxic effects of a specific air pollutant (e.g. infants, asthmatics, elderly people).

**sherbet** made from milk, fruit or fruit juice, stabilizers, and sweeteners, has about twice as much sweetener as ice cream. It must have 1 to 2% of milkfat.

**siltation** may be used synonymously with "sedimentation" and generally refers to the accumulation of soil that has eroded from another source and been carried into a body of water by storm water runoff.

**smog** a combination of smoke and other particulates, ozone, hydrocarbons, nitrogen oxides, and other chemically reactive compounds which, under certain conditions of weather and sunlight, may result in a murky brown that causes adverse health effects.

**smoke** a form of air pollution consisting primarily of particulate matter (i.e. particles released by combustion). Other components of smoke include gaseous air pollutants such as hydrocarbons, oxides of nitrogen, and carbon monoxide. Sources of smoke may include fossil fuel combustion, agricultural burning, and other combustion processes.

**soot** very fine carbon particles that have a black appearance when emitted into the air.

**source of pollution** any place or object from which air pollutants are released. Sources that are fixed in space are stationary sources and sources that move are mobile sources.

**spermarche** a boy's first ejaculation of seminal fluid.

**standard air** dry air at 20°C, 760 mm Hg.

**stationary sources** non-mobile sources such as power plants, refineries, and manufacturing facilities which emit air pollutants (see also mobile sources).

**storm** in marine usage, winds 48 knots (55 mph) or greater.

**strum and drang** a German expression sometimes used as a description of adolescence, meaning literally "storm and stress", descriptive of the turbulence, turmoil, and frustrated idealism sometimes assumed to be characteristic of adolescents.

**sulfur dioxide (SO<sub>2</sub>)** a strong smelling, colorless gas that is formed by the combustion of fossil fuels. Power plants, which may use coal or oil high in sulfur content, can be major sources of SO<sub>2</sub>. SO<sub>2</sub> and other sulfur oxides contribute to the problem of acid deposition. SO<sub>2</sub> is a criteria air pollutant.

**sulfur oxides** pungent, colorless gases (sulfates are solids) formed primarily by the combustion of sulfur-containing fossil fuels, especially coal and oil. Considered major air pollutants, sulfur oxides may impact human health and damage vegetation.

**surface water** the water that exists above ground, including lakes, rivers, streams, and oceans.

**sweetened condensed milk** this concentrated canned milk is prepared by removing about half the water from whole milk. Often used in candy and dessert recipes, sweetened condensed milk has at least 40% sugar by weight.

**taxonomic category (taxon, taxa)** a classification or group of organisms (i.e. kingdom, phylum, class, order, family, genus, species).

**TCE, trichloroethylene** a solvent and degreaser used for many purposes; it is a common groundwater contaminant.

**temperature-humidity index (THI)** commonly called heat stress, uses temperature and relative humidity to determine how hot the air temperature actually “feels”. When humidity is high the apparent temperature is higher than the air temperature.

**TMDL (total maximum daily load)** the maximum amount of point and non-point source pollutants a stream can take in during a single day and still support its designated uses.

**total organic gases (TOG)** gaseous organic compounds, including reactive organic gases and the relatively unreactive organic gases such as methane.

**total suspended particulate (TSP)** particles of solid or liquid matter — such as soot, dust, aerosols, fumes, and mist — up to approximately 30 microns in size.

**toxic air contaminant (TAC)** an air pollutant which may cause or contribute to an increase in deaths or in serious illness, or which may pose a present or potential hazard to human health. Health effects to TACs may occur at extremely low levels, and it is typically difficult to identify levels of exposure which do not produce adverse health effects.

**toxic hot spot** a location where emissions from specific sources may expose individuals and population groups to elevated risks of adverse health effects — including but not limited to cancer — and contribute to the cumulative health risks of emissions from other sources in the area

**trace elements** chemical elements that are distributed throughout the tissues in very small amounts and are essential to nutrition such as cobalt, copper, magnesium, manganese, zinc, selenium, vanadium, chromium, silicon, boron, nickel and tin. Others can be considered as toxic such as mercury, cadmium and lead.

**trans fatty acid** a polyunsaturated fatty acid in which some of the missing hydrogen atoms have been put back in a chemical process called hydrogenation. Trans fatty acids are the building blocks of hydrogenated fats.

**transportation control measure (TCM)** any control measure to reduce vehicle trips, vehicle use, vehicle miles traveled, vehicle idling, or traffic congestion for the purpose of reducing motor vehicle emissions. TCMs can include encouraging the use of carpools and mass transit.

**treated water** disinfected and/or filtered water served to water system customers. It must meet or surpass all drinking water standards to be considered safe to drink.

**treatment technique (TT)** a required process intended to reduce the level of a contaminant.

**trihalomethanes (THM)** four separate compounds including chloroform, dichlorobromomethane, dibromochloromethane, and bromoform.

**troposphere** the layer of the Earth’s atmosphere nearest to the surface of the Earth. The troposphere extends outward about 10 km at the poles and about 20 km at the equator.

**tsunami** an ocean wave generated by a submarine earthquake, volcano or landslide. (Also known as a seismic seawave, and incorrectly as a tidal wave.)

**turbidity** a measure of the cloudiness of water caused by suspended particles.

**typhoon** a hurricane that forms in the Western Pacific Ocean.

**unit risk number** the number of potential excess cancer cases from a lifetime exposure to one microgram per cubic meter ( $\mu\text{m}^3$ ) of a given substance. For example, a unit risk value of  $5.5 \times 10^{-6}$  would indicate an estimated 5.5 cancer cases per million people exposed to an average concentration of  $1 \mu\text{m}^3$  of a specific carcinogen for 70 years.

**upwelling** the rising of cold water from the deeper areas of the ocean to the surface.

**urban areas** the formal definition of urban areas describes them as concentrations of nonagricultural workers and nonagricultural production sectors.

**urban growth** absolute increase in the physical size and total population of urban areas.

**urbanism** the tendency for people to lead urban ways of life.

**urbanisation** an increasing proportion of the total population of regions and nations to live in places defined as urban. In other words a process of relative concentration of population in urban areas.

**visibility reducing particles (VRP)** any particles in the atmosphere that obstruct the range of visibility.

**vitamin** a general term for micronutrients essential for normal metabolic function. Vitamins cannot be synthesized in sufficient amounts by the animal or human body. Occur in the multiple and diverse source of food-stuffs found in nature. An intimate interrelationship exists between minerals, trace elements and vitamins which, when combined together in certain specific groupings, provide a maximal bioassimilation and functioning within the body.

**volatile organic compounds (VOCs)** carbon-containing compounds that evaporate into the air (with a few exceptions). VOCs contribute to the formation of smog and/or may themselves be toxic. VOCs often have an odor, and some examples include gasoline, alcohol, and the solvents used in paints.

**water cycle** the process in which water evaporated from rivers, lakes, and oceans rises and condenses into clouds, and then falls back to earth as rain, hail, sleet, or snow.

**water reclamation (wastewater treatment)** a process in which water used in houses and businesses goes down the drain and becomes wastewater, which is then cleaned using biological and chemical processes so the water can be returned to the environment.

**water system** a network of pipelines, storage, pumps, and other appurtenances, wells, or other sources which furnishes a supply of water to the consumer.

**watershed** the area of land that slopes or drains toward or into a lake, river, stream, or wetland.

**weather** refers to the conditions of a certain moment as opposed to climate, the long-term average of weather conditions.

**welfare-based standard (secondary standard)** an air quality standard that prevents, reduces, or minimizes injury to agricultural crops and livestock, damage to and the deterioration of property, and hazards to air and ground transportation.

**wind chill equivalent temperature** the apparent temperature felt on the exposed human body owing to the combination of temperature and wind speed.

**working zone** the space limited on height above a level of a floor or a platform, on which there are workplaces of constant or changeable (temporary) stay of the workers.

**workplace** the place of constant or temporary stay of the worker during labour activity.

**zero emission vehicle (ZEV)** vehicles which produce no emissions from the on-board source of power (e.g. an electric vehicle).

**zone of breath** is space in radius up to 50 cm on behalf of working.

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## REFERENCES

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1. *Control of hospital infection. A practical handbook.* — 3rd ed. / Ayliffe G. A. J. et al. — London: Chapman & Hall, 1992. — 488 p.
2. *Barsi M. E. Human Nutrition* Cardiff. — 1997. — 334 p.
3. *Barton N. Human nutrition.* — N. Y., 1990. — 765 p.
4. *Bender A. E., Bender D. A. Food Tables and Labelling.* — London, 1999. — 110 p.
5. *Blaxter M. Health and Lifestyles.* — London, 1990. — 288 p.
6. *Bowling A. Research Methods in Health — Investigating Health and Health Services.* — London, 2002. — 501 p.
7. *Burridge R., Ormandy D. Unhealthy Housing.* — London, 1993. — 480 p.
8. *Darby M. L. Mosby's Comprehensive Review of Dental Hygiene.* — London, 2002. — 230 p.
9. *DuPont HL, Steffen R. Textbook of Travel Medicine and Health.* — 2nd ed. — Oxford: Blackwell Science, 2001. — 500 p.
10. *Rom W. N. Environmental and Occupational Medicine.* — Boston, 1990. — 1890 p.
11. *Evaluation of Human Work: A Practical Ergonomics Methodology.* — London, 1990. — 500 p.
12. *Galan A. The project on Environmental Health indicators of European Centre for Environment and Health // Гігієнічні проблеми півдня України: Матеріали наук.-практ. конф. присв. 100-річному ювілею кафедри загальної гігієни Одеського державного медичного університету (1993-2003 pp.).* — Одеса, 2003. — С. 116-123.
13. *Ganley Y. Handbook of travel medicine.* — London: Science Press, 1996. — 90 p.
14. *Garrow J. S., James W. P. T. Human Nutrition & Dietetics.* — 10th ed. — London, 1999. — 780 p.
15. *Garrow J. S. Human Nutrition and Dietetics.* — London, 1999. — 880 p.
16. *Hall D., Alliman D. Health for All Children.* — London, 2003. — 428 p.
17. *Hart M. World Travel Health Guide.* — 1997 worldwide edition. — London: Columbus Press, 1996. — 244 p.
18. *Health for All — An Alternative Strategy.* New Delhi and Pune: Indian Institute of Education, 1981. — 120 p.
19. *Health information for international travel 2001-2002.* — Atlanta: Centers for Disease Control (CDC), 2001. — 257 p.
20. *Howarth J. W. Healthy travel.* — London: Cadogan Books, 1995. — 228 p.
21. *Hunt S. M., Holbrook J. M., Croff J. L. Nutrition: Principles and Clinical Practice.* — London: Mosby, 1980. — 506 p.
22. *Krause M. V., Mahan L. K. Food, Nutrition and Diet Therapy.* — Philadelphia, W. B. Sanders Company, 1984. — 1010 p.
23. *Last J. M. A Dictionary of Epidemiology.* — 4th ed. — N.Y.: Oxford University Press, 2001. — 320 p.
24. *Latham M. C. Human nutrition in tropical Africa: A textbook for health workers: with special reference to community health problems in East Africa, Rome, FAO.* — 1979. — 286 p.
25. *Lucas A. O., Gilles H. M. A new short textbook of preventive medicine in the tropics* — 3rd ed. — London: Edward Arnold, 1990. — 322 p.
26. *Mayhall C. G. Hospital epidemiology and infection control.* — Baltimore: MD, Williams & Wilkins, 1996. — 800 p.
27. *Mehtar S. Hospital infection control. Setting up with minimal resources.* — Oxford: Oxford Medical, 1992. — 487 p.
28. *Naidoo J., Wills J. Health Promotion.* — London, 2000. — 420 p.
29. *Nutrition and Reproduction* London, 1998. — 460 p.
30. *Occupational Health and Hygiene.* — London, 1999. — 251 p.
31. *Oxford Handbook of Public Health Practice.* — London: Lippincot — 2001. — 632 p.
32. *Park's Textbook of Preventive and Social Medicine / ed. by K. Parks* — Jabalpur, 1997. — 680 p.
33. *Plog B. A., Quinlan P. J. Fundamentals of Industrial Hygiene: Study Guide.* — 5th ed. — 2001. — 670 p.

34. *Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation.* — London, 2002. — 286 p.

35. *Last J. M.* Public health and human ecology. — Stamford, 1998. — 486 p.

36. *Seedhouse D.* Health. — London, 2001 — 160 p.

37. *The 2004 Hospital Infection Control Yearbook.* — N.Y., 2003. — 367 p.

38. *Unwin N., Carr S. Leeson J.* Introductory Study Guide to Public Health and Epidemiology. — London, 1997. — 160 p.

39. *Wenzel R. P.* Prevention and control of nosocomial infections. — 3rd ed. — Baltimore: MD, Williams & Wilkins, 1997 — 620 p.

40. *Willan J.* Hospital Management in the Tropics and Subtropics. — London, 1990. — 448 p.

41. *Бардов В. Г., Сучков Б. П.* Методические указания по самоподготовке студентов лечебного факультета по курсу «Гигиенические аспекты профилактики тропических болезней». — К.: КМИ, 1988. — 32 с.

42. *Бардов В. Г.* Гигиена климата. — К., 1990. — 136 с.

43. *Гигиена водоснабжения и питания в условиях жаркого климата / Под ред. Н. Ф. Кощелева.* — Л.: Военно-мед. акад., 1975. — 35 с.

44. *Даценко І. І., Габович Р. Д.* Основи загальної і тропічної гігієни. — К.: Здоров'я, 1995. — С. 22-31, 333-336.

45. *Даценко І. І., Габович Р. Д.* Профілактична медицина. Загальна гігієна з основами екології. — К.: Здоров'я, 1999. — С. 97-124, 296-298, 465-471.

46. *Новожилов Г. Н., Березин А. А.* Методы комплексной оценки микроклимата и наружных метеоусловий. — Л.: Военно-мед. акад., 1980. — С. 3-17, 27-30, 35-37, 42-43.

47. *Общая гигиена / Г. И. Румянцев, М. П. Воронцов, Е. И. Гончарук и др.* — М.: Медицина, 1990. — С. 64-67, 169-172, 208.

48. *Общая гигиена. Пропедевтика гигиены: Учеб. для иностр. студентов / Е. И. Гончарук, Ю. И. Кундиев, В. Г. Бардов и др.* — К.: Вища шк., 2000. — С. 163-241.

49. *Руководство по тропическим болезням / Под ред. А. Я. Лысенко.* — М.: Медицина, 1983. — С. 5-52.

50. *Тропические болезни: Учебник / Под ред. Е. П. Шуваловой.* — М.: Медицина, 1989. — С. 6-7.

51. *Факторы, влияющие на здоровье в условиях работы при высоких температурах: Доклад науч. группы ВОЗ // Сер. техн. докладов № 412.* — Женева: ВОЗ, 1970. — 38 с.

## INTERNET RESOURCES

<http://www.who.int> World Health Organisation

<http://www.fao.org> Food and Agriculture Organisation

<http://www.unicef.org> United Nations Children Foundation

<http://www.ilo.org> International Labor Organisation

<http://www.epa.gov> Environmental Protection Agency (USA)

<http://www.cdc.gov> Center of Disease Control (USA)

<http://www.fda.gov> Food and Drug Administration (USA)

<http://www.aiha.org> American Industrial Hygiene Association

<http://www.osha.org> Occupational Safety and Health Administration (USA)

<http://www.eurasiahealth.org> Eurasia Health Network

<http://www.pubmed.com> National Library of Medicine

[http://europa.eu.int/comm/environment/index\\_en.htm](http://europa.eu.int/comm/environment/index_en.htm) European Commonwealth resources on Environmental Health

<http://www.lshtm.ac.uk> London School of Hygiene & Tropical Medicine

<http://www.m-w.com> Mirriam Webster Thesaurus and Glossary

<http://www.waterhistory.org> Prehistoric and historic water projects worldwide

<http://www.nau.kiev.ua> Ukrainian Laws and Sanitary Standards. English version is available

<http://www.chernobyl.info/en/Resources/Glossary?letter=A> Chernobyl Information Center

<http://www.rnreference.mod.uk/09/medhist.htm> Royal Naval Medical Service

<http://www.google.com> the best search machine

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