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ENVIRONMENTAL MEDICINE

Vitebsk, 2017

MINISTRY OF HEALTH CARE
OF THE REPUBLIC OF BELARUS
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THE GENERAL HYGIENE AND ECOLOGY DEPARTMENT

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The tutorial is prepared for students of medical, pharmaceutical, stomatological, medical-preventive, medical-diagnostic faculties of institutes of higher education.

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Preface

Environmental medicine is an interdisciplinary field. Because environmental disharmonies occur as a result of the interaction between humans and the natural world, we must include both when seeking solutions to environmental problems. It is important to have a historical perspective, appreciate economic and political realities, recognize the role of different social experiences and ethical backgrounds, and integrate these with the science that describes the natural world and how we affect it. Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviors. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments.

The content of the tutorial « Environmental medicine» for students of high medical educational establishments corresponds with the basic educational plan and program, proved by Ministry of Health Care of the Republic of Belarus.

One of the objectives in the teaching of ecological medicine is the desire to induce students to mastering new material, namely to see the direct link between environmental factors and the occurrence of certain diseases in humans, understand approaches to address of such phenomena. Knowledge of correlation mechanisms of human impact on the environment and diseases in humans will help to identify and implement a set of measures to prevent ecologically related diseases.

The tutorial includes 5 chapters and describes the following topics: introduction in environmental medicine, ecological and medical characteristics of biosphere, ecological and medical consequences of biosphere pollution, protection of environment from pollution, ecological and medical characteristic of residence conditions, ecological and medical problems of nutrition. When writing the tutorial the materials of the Law on health care, sanitary and epidemiological wellbeing of the population, the environment protection accepted in the Republic of Belarus were used, there are references to documentation regulating the requirements to environmental factors, populated areas, residence conditions, nutrition. The tutorial combines the scientific nature of his writing with accessibility for students.

The manual is intended for students of medical, pharmaceutical, stomatological, medical-preventive, medical-diagnostic faculties of institutes of higher education. I would like to express my deepest appreciation to the many collaborators and students who have worked with me on various projects, short courses, and workshops that we have developed over the years.

1. THEORY PART

Chapter 1.

INTRODUCTION IN ENVIRONMENTAL MEDICINE

An organism and environment, their interrelations

An **organism** is any contiguous living system (such as animal, fungus, micro-organism, or plant). In at least some form, all types of organisms are capable of responding to stimuli, reproduction, growth and development, and maintenance of homeostasis as a stable whole.

An organism may be either *unicellular* (a single cell) or, as in the case of humans, comprise many trillions of cells grouped into specialized tissues and organs. The term *multicellular* (many cells) describes any organism made up of more than one cell.

All organisms living on Earth are divided into the *eukaryotes* and *prokaryotes* based on the presence or absence of true nuclei in their cells. The prokaryotes represent two separate domains, the Bacteria and Archaea. Eukaryotic organisms are characterized by the presence of a membrane-bound cell nucleus, and contain additional membrane-bound compartmentalization called organelles (such as mitochondria in animals and plastids in plants, both generally considered to be derived from endosymbiotic bacteria). Fungi, animals and plants are examples of kingdoms of organisms that are eukaryotes.

The organism experiencing a need for inflow of matter, energy and information is entirely dependent on the environment. The unity of organisms and the environment is reflected in **the main environmental law** K.F. Rul'e – I.M. Sechenov: *the results of development of any organism are determined by the ratio of its internal characteristics and characteristics of the environment in which it is located.*

Environment is a combination of natural and changed by person's activity nature factors which show effect of influence on organism.

Abiotic environment is all forces and phenomena of nature, the origin of which is not directly related to the activity of living organisms.

Biotic environment is the forces and phenomena of nature, the origin of which is directly related to the activity of living organisms.

Human environment – is an environment of human caused by a set of objects, phenomena and factors that determine the conditions of his life. It includes ***natural and artificial***, created by the man himself.

Organisms and resources compose ecosystems which, in turn, maintain biophysical feedback mechanisms, that moderate processes acting on ***living (biotic)*** and ***nonliving (abiotic)*** components of the planet. Ecosystems sustain life-supporting functions and produce natural capital like biomass production (food, fuel, fiber and medicine), the regulation of climate, global biogeochemical cycles, water filtration, soil formation, erosion control, flood protection and many other natural features of scientific, historical, economic, or intrinsic value.

An **ecosystem** is a community of living organisms (plants, animals and microbes) in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system. These biotic and abiotic components are regarded as linked together through nutrient cycles and energy flows. As ecosystems are defined by the network of interactions among organisms, and between organisms and their environment, they can come in any size but usually encompass specific, limited spaces (although some scientists say that the entire planet is an ecosystem).

The **biosphere** is the global sum of all ecosystems. It can also be called the zone of life on Earth, a closed (apart from solar and cosmic radiation and heat from the interior of the Earth), and self-regulating system.

From the broadest biophysiological point of view, the **biosphere** is the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere, hydrosphere, and atmosphere.

The term "biosphere" was coined by geologist Eduard Suess in 1875, which he defined as: "The place on Earth's surface where life dwells."

Some life scientists and Earth scientists use biosphere in a more limited sense. For example, geochemists define the **biosphere** as being the total sum of living organisms (the "biomass" or "biota" as referred to by biologists and ecologists). In this sense, the biosphere is but one of four separate components of the geochemical model, the other three being lithosphere, hydrosphere, and atmosphere. The narrow meaning used by geochemists is one of the consequences of specialization in modern science.

Some might prefer the word ecosphere, coined in the 1960s, as all encompassing of both biological and physical components of the planet.

Biosphere boundary in lithosphere is up to 5 km, in hydrosphere - up to 11 km, in atmosphere - up to 20-40 km. The greatest life concentration is marked in a top part of hydrosphere and in border of lithosphere surface layer with ground layer of atmosphere.

Biogeocenose is an interrelated complex of living and inert components associated with each other by material and energy exchange; one of the most complex systems in nature.

Among the living components of the biogeocenose are **autotrophic organisms** (photosynthesizing green plants and chemo synthesizing microorganisms) and **heterotrophic organisms** (animals, fungi, many bacteria, and viruses), and among the inert components are the atmosphere layer around the earth, with its gas and thermal resources and solar energy; and the soil, with its water and mineral resources and, in part, the weathering crust (water in the case of an aquatic biogeocenose).

Each biogeocenose maintains both uniformity (homogeneous, or more often mosaically homogeneous) of the composition and **structure of its components** and the character of the material and energy exchange between them. The higher and lower green plants, which provide the basic mass of living matter, play a particularly important role in biogeocenose. They produce the primary organic materials - the matter and energy that are used by the plants themselves and are transmitted along food chains to all heterotrophic organisms. Through the processes of photosynthesis and respiration, green plants maintain the balance of oxygen and carbon dioxide in the air; they participate in the circulation of water through transpiration. The death of organisms or their parts results in a biogenic migration and redistribution of food elements in the soil (N, P, K, Ca, and others). Finally, green plants directly or indirectly determine the composition and spatial location of animals and microorganisms in the biogeocenose. The role of chemotrophic microorganisms in the biogeocenose is less significant. In terms of the specific features of their activities, heterotrophs in a biogeocenose can be divided into consumers, which transform and partially break down the organic matter of living organisms, and decomposers or destroyers (fungi, bacteria), which decompose compound organic substances in dead organisms or their parts to simple mineral compounds. In all conversions the initially accumulated energy is lost and is dispersed in the form of heat in the surrounding space. In the functioning of a biogeocenose, a great role is played by soil organisms such as saprophages, which

feed on the organic remains of dead plants; and also soil microorganisms (fungi and bacteria), which decompose and mineralize these remains. To a significant degree, the structure of the soil, the formation of humus, the content of nitrogen in the soil, the conversion of a number of mineral substances, and many other soil properties depend upon their activity. Without the heterotrophs, the completion of the biological circulation of matter, the existence of autotrophs, and the biogeocenose itself would not be possible. The inert components of the biogeocenose serve as a source of energy and primary materials (gases, water, and minerals).

The transition from one biogeocenotic process to another in space or time is accompanied by a change in the states and properties of all its components, and consequently by a change in the nature of biogeocenotic metabolism. The boundaries of a biogeocenose can be traced from many of its components, but more often they coincide with the boundaries of the plant communities (phytocenoses). The mass of the biogeocenose is not homogeneous either in terms of composition or the state of its components or in terms of the conditions and results of their biogeocenotic activity. This mass is differentiated into the aboveground, underground, and underwater parts which in turn are divided into elementary vertical structures—biogeohorizons, which are very specific in terms of composition, structure, and the state of the living and inert components. The concept of biogeocenotic parcels has been introduced to designate the horizontal heterogeneity or mosaic quality of a biogeocenose. Like the biogeocenose as a whole, this concept is a comprehensive one, since the vegetation, animals, microorganisms, soil, and atmosphere constitute the parcel in the capacity of participants in the exchange of matter and energy.

A biogeocenose is a dynamic system. Its continuous change and development is the result of the internal contradictory tendencies of its components. The changes in a biogeocenose can be temporary, caused by easily reversible (daily, weather, and seasonal) reactions of the components in the biogeocenose, or profound, leading to irreversible changes in the state, structure, and general metabolism of the biogeocenose and marking a change (**succession**) from one biogeocenose to another. The changes can be slow or rapid; the latter often occur under the effect of sudden changes as a result of natural causes or the economic activity of man, who not only transforms and destroys the natural biogeocenose, but also creates new cultural ones. In addition to dynamic quality, biogeocenoses are also characterized by temporal stability, which is caused by the fact that the modern natural biogeocenoses are the result of a protracted and profound adapta-

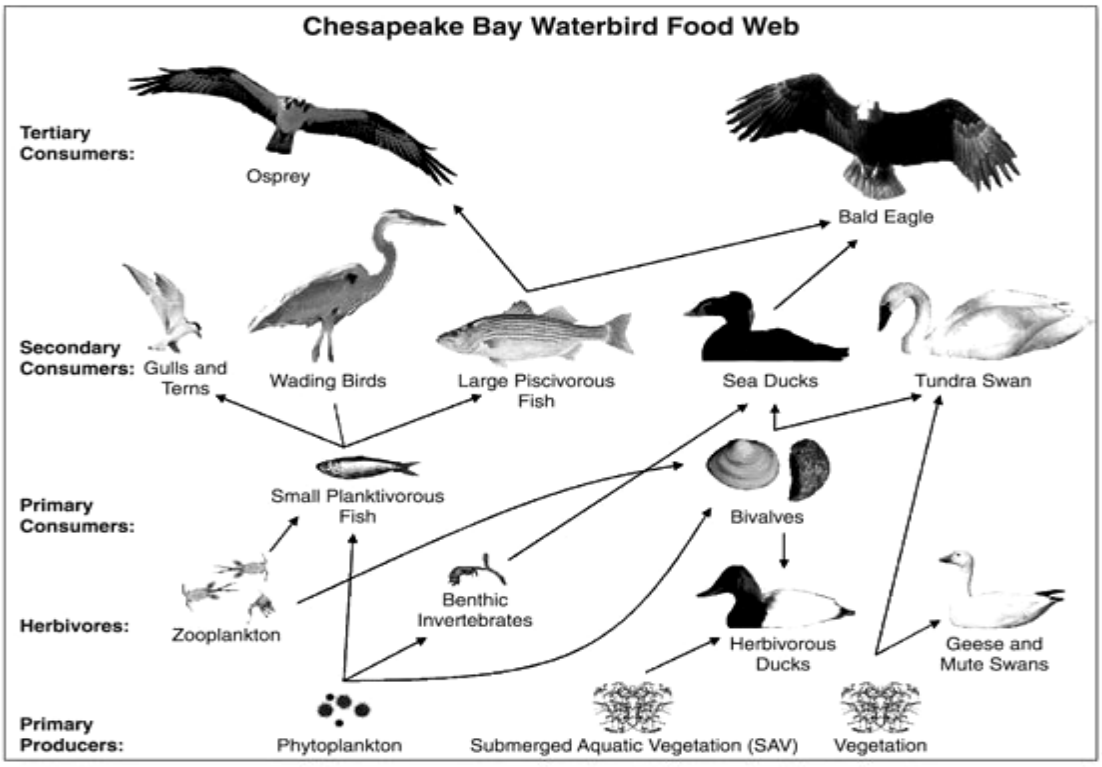
tion of the living components to each other and to the components of the inert environment. For this reason, biogeocenoses which have been removed from a stable state by one or another cause can be restored in a form close to the original after the elimination of this cause. Biogeocenoses similar in composition and structure of the components and in terms of metabolism and direction of development are classified in the same type of biogeocenose; this is the basic unit of the biogeocenotic classification. The aggregate of biogeocenoses of the entire earth forms the biogeocenotic cover, or **biogeosphere**. A study of biogeocenose and biogeosphere constitutes the subject of the science of **biogeocenology**.

A **niche** is a term describing the way of life of a species. Each species is thought to have a separate, unique niche. The ecological niche describes how an organism or population responds to the distribution of resources and competitors (e.g., by growing when resources are abundant, and when predators, parasites and pathogens are scarce) and how it in turn alters those same factors (e.g., limiting access to resources by other organisms, acting as a food source for predators and a consumer of prey).

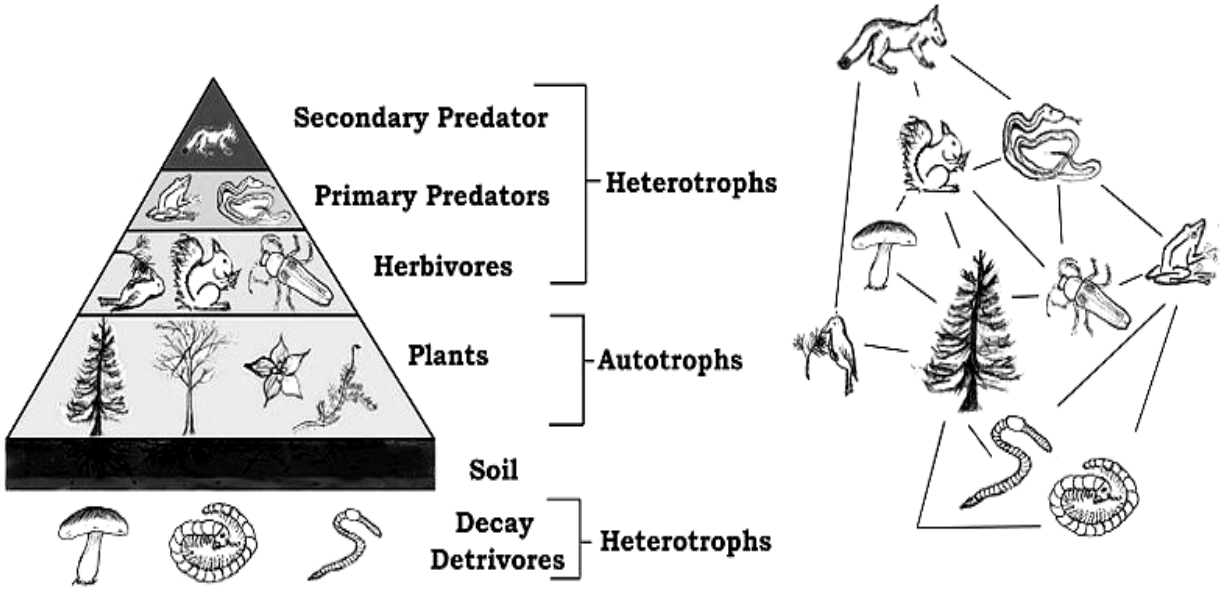
The majority of species exist in a standard ecological niche.

A **food chain** is a linear consequence of links in a food web starting from a species that eats no other species in the web and ends at a species that is eaten by no other species in the web. A food chain differs from a food web, because the complex polyphagous network of feeding relations are aggregated into trophic species and the chain only follows linear monophagous pathways. A common metric used to quantify food web trophic structure is food chain length. In its simplest form, the length of a chain is the number of links between a trophic consumer and the base of the web and the mean chain length of an entire web is the arithmetic average of the lengths of all chains in a food web (picture 1.1).

A **trophic level** (from Greek troph, meaning "food" or "feeding") is "a group of organisms acquiring a considerable majority of its energy from the adjacent level nearer the abiotic source." Links in food webs primarily connect feeding relations or trophism among species. Biodiversity within ecosystems can be organized into trophic pyramids, in which the vertical dimension represents feeding relations that become further removed from the base of the food chain up toward top predators, and the horizontal dimension represents the abundance or biomass at each level. When the relative abundance or biomass of each species is sorted into its respective trophic level, they naturally sort into a “pyramid of numbers” (picture 1.2).



Picture 1.1. Food Chain.



Picture 1.2. Categories of Species.

Species are broadly categorized as:

- **autotrophs** (or primary producers);
- **heterotrophs** (or consumers);
- **detritivores** (or decomposers).

Environmental factors, the laws of their influence on an organism

Environmental factor or ecological factor or ecofactor is any factor, abiotic or biotic, that directly or indirectly influences living organisms.

Any element or condition of environment, capable to render direct or indirect influence on a live organism at least on one of stages of its individual development and on which the organism answers with adaptive reactions, is called as **ecological factor**.

There are also ***factors of inhabitancy*** of the person - are any chemical, physical, social or biological factors of the natural or anthropogenous origin, capable to influence a human body.

Organisms and resources compose ecosystems which, in turn, maintain biophysical feedback mechanisms that moderate processes acting on ***living (biotic)*** and ***nonliving (abiotic)*** components of the planet. Ecosystems sustain life-supporting functions and produce natural capital like biomass production (food, fuel, fiber and medicine), the regulation of climate, global biogeochemical cycles, water filtration, soil formation, erosion control, flood protection and many other natural features of scientific, historical, economic, or intrinsic value.

Apart from the true monogenic genetic disorders, environmental factors may determine the development of disease in those genetically predisposed to a particular condition. Stress, physical and mental abuse, diet, exposure to toxins, pathogens, radiation and chemicals found in almost all personal-care products and household cleaners are common environmental factors that determine a large segment of non-hereditary disease.

If a disease process is concluded to be the result of a combination of genetic and environmental factor influences, its etiological origin can be referred to as having a multifactorial pattern.

As an example of an environmental trigger, a component of a human's drinking water may activate (trigger) a change in a person's body. Such changes are mainly negative ones. Using this example, what is in the

drinking water may affect one person entirely differently than another – someone may be affected greatly, whereas someone may not be at all.

Many cancers (osteosarcoma, etc.), along with a plethora of other diseases, are thought to be a result of environmental triggers.

Nitrates may be an environmental trigger for Alzheimer's, diabetes, and Parkinson's disease and methemoglobinemia.

Environmental triggers for asthma and autism have been studied too.

Ecological factors which can affect dynamic change in a population or species in a given ecology or environment are usually divided into two groups: ***abiotic and biotic***.

Abiotic factors are physical (geological, geographical, hydrological and climatological parameters), chemical (native structure of environment, chemical impurity) properties of non-living nature.

Biotic ecological factors also influence biocenose viability, these factors are considered as either intraspecific or interspecific relations.

Biotic components are contrasted to abiotic components. Biotic components are the living things that shape an ecosystem. A **biotic factor** is any living component that affects another organism, including animals that consume the organism in question, and the living food that the organism consumes. Each biotic factor needs energy to do work and food for proper growth. Biotic factors include human influence.

Anthropogenic factors (i.e. human-induced) are opposed to natural factors. Anthropogenic factor is a set of ecological factors and impacts which are caused by human activities; this is a direct effect of humans on organisms or indirect effect on organisms through a change of their habitat by humans.

The environmental factors are divided into: ***external (exogenous)*** and ***internal (endogenous)***. External environmental factors in relation to the ecosystem and to living organisms are effects. The reaction of ecosystem, ecological community, population or organisms on these effects is called as response. The ability of organism to adapt to environmental conditions and acquire resistance to the influence of various environmental factors depends on the response. Internal factors relate to the properties of the organism and form it or include in its composition (for example, abundance, biomass of populations, the number of different chemicals, the characteristics of the water and the soil mass).

Every environmental factor in relation to humans can be:

1. *favorable* - contributing to health, development and implementation;

2. *unfavorable* - leading to degradation and disease;

3. *influencing of both kinds*.

Depending on the periodicity of exposure of ecological factors are divided into ***primary and secondary periodic and nonperiodic factors***.

Primary periodic factors are the daily periodic change of illuminance, change of seasons.

Secondary periodic factors are consequences of the primary periodical factors: humidity, temperature, precipitation, dynamics of the vegetation food, the content of dissolved gases in the water.

Nonperiodic factors are factors that do not have the proper periodicity or cycling (soil and ground factors, natural disasters).

Environmental factors may be helpful or harmful for the organism, facilitate or inhibit survival and reproduction. When exposed to the organism they may act as ***irritants, limiters, signals and modifiers***.

As ***irritants***, environmental factors cause the adaptive physiological and biochemical changes, ***limiters*** - change the geographical distribution of organisms due to the impossibility of existence in the given conditions, ***modifiers*** - determine the morphological and anatomical changes, ***signals*** - indicate the change of other environment factors.

Environmental factors may be ***causal etiological factors or risk factors***.

Casual etiological factors directly cause an environmental disease. Risk factors do not directly cause disease, but increase the probability of its occurrence.

Risk factors - are potentially unsafe to health factors of physical, chemical, biological and social origin, which increase the risk of diseases and their progression and adverse outcome. The risk factor, although it is important for the development and progression of the disease, but is not able to cause disease by itself in an individual.

In ecology, there is a law of the optimum, according to which any environmental factor has the certain limits of positive impact on living organisms. ***Optimum factor*** – is the most favorable intensity of environmental factors for organisms.

Interaction of factors - the simultaneous or sequential cumulative effect on organisms of natural and anthropogenic factors, leading to weakening, enhancement or modification of a single factor.

Synergy - the combined effect of two or more factors when their joint biological activity is much higher than the effect of each component and their sum.

It should be understood that the main harm to health is caused by not single environmental factors but their total load on organisms.

There are some laws of influence of ecological factors on an organism: ***optimum, limiting factor, interaction of factors***.

The optimum law, or the tolerance law means that any ecological factor has limits of positive influence on a live organism.

The distance between minimum and maximum values of the factor is called as *tolerance of an organism*.

The law of the limiting factor means, that the factor which deviates from its optimum value in the largest degree is the most significant for an organism.

The law of interaction of ecological factors ascertains that the optimum zone and limits of endurance of organisms in relation to any factor can be displaced depending on that, in a combination to what other factors influence is carried out.

In accordance to the optimum law the factors of optimal intensity are *beneficial* for the organism, factors that go beyond the minimum or maximum intensity are *harmful or pessimal factors*.

Environmental medicine as a science, its differentiation, purpose, tasks, methods, connection with other sciences.

Recently, in the structure of the general morbidity of the population, there has been increase in the number of chronic diseases caused by habitat factors of predominantly anthropogenic origin. A well-known and accessible direction of studying of the multifaceted influence on the health of the population of the environment is the *factorial approach*, including the identification of risk factors leading to the development of environmental diseases. The diseases arising under the influence of environmental factors of the habitat are called ***environmental, or environmentally determined***, while the environmental factor is considered as the main cause of environmental disease.

Currently, almost 80% of the known more than 6 thousand human diseases are developing under the influence of environmental factors, every fourth inhabitant of the Earth suffers from allergies and autoimmune diseases. Violations of reproductive health, immune reactivity, development of secondary immune deficiency, increase in the frequency of malignant neoplasms, the appearance of new, previously unknown diseases, as well

as the development of ecopathological conditions from indistinctly expressed and not having a clear clinical symptomatology to severe forms with the lethal outcome. Among ecopathological conditions, special attention is paid to the "diseases of civilization" arising on the background and due to psycho-emotional stress, hypodynamia, biorhythm disturbances, malnutrition, excessive information loads.

Environmental medicine is a science about etiology, pathogenesis, clinical picture, diagnostics, treatment and prevention of environmental diseases in humans.

It should be noted that the pathogenesis, clinic, diagnosis and treatment of environmental diseases are considered in detail by the clinical departments of the therapeutic profile. The environmental diseases caused by biological factors and pollutants are studied in the course of medical parasitology, medical microbiology, dermatology and venereology, phthisiology and infectious diseases.

Environmental or environmentally caused diseases are diseases caused by abiotic chemical, physical and biotic environmental factors, in this case the environmental factor is considered as the main cause of environmental diseases.

Environmental medicine, along with aviation, military, space, sports, judicial, accidents, labor and others, is a separate area of medicine - a system of scientific knowledge and practical measures aimed at the detection, treatment and prevention of diseases, the preservation and strengthening of health, capability to work and extension of people's lives.

Environmental medicine is divided into the ***general*** and ***private***.

General environmental medicine studies the theoretical foundations, methodology, main etiological and risk factors of environment, environmental pathogenesis of diseases, common clinical manifestations, diagnostics, principles of treatment, prevention and risk assessment of environmental pathology.

Private environmental medicine studies the natural caused diseases under the influence of physical, chemical and biological factors of air, water, soil, and human caused diseases under the influence of physical, chemical and biological pollutants of air, water and soil.

The **purpose** of environmental medicine – is prevention of environmental diseases and reduction of environmental morbidity.

The **tasks** of environmental medicine are:

- identification of the nature of interaction between man and environment, the reasons and causal relationships between the quality of the environment and morbidity;

- study of the mechanisms of development, clinical manifestations, diagnostic features;

- development of diagnostics, treatment schemes and prophylactic actions on prevention of human diseases, arising under the influence of environmental factors.

For deciding of the main problems in environmental medicine *chemical, physical, microbiological, parasitological methods* for studying of the environment conditions and *morphological, physiological, biochemical, clinical, statistical methods* for studying of the disease in field, model and laboratory studies are used.

Study of the influence of environmental factors on human activity includes *clinical methods* - methods which allow revealing of the changes in organisms in response to environmental factors in the process of medical examinations, *laboratory experiment* - which allow reproducing of various conditions artificially and studying of the changes in the reactions of the organism (animals or human volunteers).

Methods of statistical data give an idea of the positive or negative shifts in public health under the influence of environmental factors.

Environmental medicine is associated with chemistry, physics, mathematics, microbiology, anatomy, physiology, biochemistry, anthropoecology, hygiene, medical ecology, introduction into internal medicine, therapy, pediatrics. The elements of applied immunology, allergy and toxicology are also used in environmental medicine.

Environmental medicine is of great importance for the prevention of environmental diseases, maintenance and improving of population health, engineering of health organizations and training of medical personnel.

The doctor should carry out individual and population prevention of environmental related diseases and pathological conditions and effectively work towards valeological training and education of healthy and sick people living in conditions of high environmental risk. Only in this case the possibility of successful treatment of the patient and health of the human population are possible.

The brief outline of history of environmental medicine development

Traditionally the state of health of the population is characterized by ***demographic indicators, physical development indicators and morbidity indicators***.

Demographic indicators define the characteristics of reproduction, physical development indicators characterize reserve of physical strength or capacity and morbidity indicators reflect the peculiarities of adaptation to environmental conditions. All these indicators are reflection of the results of interaction of current and previous generations, characterized by a multiplicity of individual features and the environment.

The ecological approach to medicine which is considered as close relationship of health and illness with the environment has been developed for a long time. By definition of S.P. Botkin medicine - is a branch of human knowledge, dedicated to the study of man and surrounding nature in their interaction aimed at disease prevention, treatment and improving of people status. As can be seen from this definition, the term "medicine" bears the ecological approach.

However, in an age of scientific and technological revolution, when a combination of natural and artificial factors leads to the creation of biotechnosphere, there is a need for a detailed study of the influence of environmental factors on human health. According to WHO experts the public health depends on the state of the environment on the average on 38-44%. Man-caused air pollution in 43-45% of cases is the cause leading to the deterioration of health.

The term «environmental medicine» was introduced into the science and practice in 1985 and is associated with the name of Theron Randolph, a professor of allergy and immunology of the Nosvestern University (USA). In 1950, Theron Randolph was the first who described food allergy. He was also the first to put forward the concept of chemical sensitivity. Environmental medicine was proclaimed as independent scientific discipline in 1986 at the conference in Cleveland (USA). Thus, taking the beginning from the food allergy and chemical hypersensitivity Environmental Medicine has evolved into a separate branch of medicine in the last 30 years.

Before the advent of the term "environmental medicine" in Western Europe and the United States there was the term "clinical ecology», as well

as the direction of "environmental illness" and "environmental health". Clinical ecology establishes environmental nature of the etiological factors. Her research focuses on the study of relationship of the diseases with the environmental factors. It is known that the nature of certain health problems corresponds to certain type of environment. Many diseases which are related to endemic are called as the localities where they are distributed: taiga encephalitis, Japanese encephalitis, Omsk hemorrhagic fever, mountain sickness, etc. In the north frostbite, colds, caused mainly by physical factors are dominated, in the tropics infectious and parasitic diseases, poisoning by poisonous animals and plants take the leading role.

At the present stage, Environmental Medicine has been fully formed at the junction of Preventive and Clinical Medicine, and Anthropology.

Preventive medicine aims to prevent diseases, maintain and improve health, ability to work and life of people.

Clinical medicine is aimed at identifying and treating sick people and prevents a recurrence of diseases of the same patient.

Anthropoecology is an integrated science about laws of person's mutual relations as biosocial beings with environment. Its **purpose** is optimization of person's mutual relations with environment, decision of environment problems management, development of rational wildlife management's ways, optimization of people's life conditions in different antropoecosystems.

It develops issues of optimization of the relationship between man, the individual groups and populations with the environment, solves the problem of environmental management, and works out the ways of rational wildlife management, optimization of the living conditions of people in different anthropoecosistems.

In anthropoecology sociological, philosophical, geographical, natural-science, medical and biologic problems are converging.

Recently in medicine *a principle of environmental integrity of health* is formed, consisting in the fact that human health and the health of the biosphere is a single organism, depending on the status of all its parts, and to ensure the health and prevent the human diseases it is necessary to promote to the optimal mode of biosphere functioning.

Etiology of environmental diseases

Environmental or environmentally caused diseases are diseases caused by abiotic chemical, physical and biotic environmental factors, in this case the environmental factor is considered as the main cause of environmental diseases.

Environmental diseases are caused by *etiological environmental factors*, including natural chemical, physical, biological factors of atmospheric air, water and soil of pessimal intensity. Water, air and soil often contain neuro-, nephro-, hepato-, pulmotoxins, mutagens, carcinogens, pathogens of infectious diseases. Food contains pesticides, endocrine system effectors, pathogenic and opportunistic microorganisms. Therefore, physical, chemical and biological air, water, soil, habitation, food products of anthropogenic nature pollutants is also etiological factors. Pollutants can also be as triggers of the most common chronic diseases. Genetic defects of the hereditary apparatus can be as inducers of environmentally caused diseases in combination with the environmental factors.

Potentially hazardous to health factors of physical, chemical, biological and social origin, increasing the likelihood of development, progression and adverse outcome of disease are *risk factors*. The risk factor is an important for the development and progression of the disease, but they are not capable of causing disease in a particular person by themselves.

The development of environmental diseases can be induced by prolonged exposure to chemical, physical and biological factors at home, outdoors, at work on low, even sub threshold level.

External risk factors include lifestyle, social and economic life. Internal inherent and acquired risk factors include hypertension, hypercholesterolemia, excess body weight, heredity, the constitution and others. *Risk factors* for health are lifestyle (49-53%), heredity (18-22%) and environment (17-20%).

In large cities the impact on health of social factors and lifestyle is 30.2%, biological factors - 11%, urban and residence environment - 16.5%, industrial environment - 18.5%.

The basis for the suspicion of environmental etiology of the disease is:

• identification of the characteristic symptoms in clinical picture that are not found in other nosological forms and non-professional activity of the persons;

• the group nature of noninfectious diseases in the area of residence for not related to the overall profession or place of employment persons;

• the presence of harmful and dangerous environmental factors in the area of residence of the person;

• the possibility of disease of the environmental etiology after cessation of exposure to harmful factors.

Recently, there is found an increase in the risk of environment-related diseases of the *circulatory system, nervous, endocrine, urogenital system, skin and subcutaneous fat, senses, respiration, blood, metabolic disorders, congenital anomalies, pregnancy pathology, tumors of the digestive organs, urogenital organs, allergic diseases* under the influence of the natural pessimal factors, as well as chemical, physical and biological pollutants of air, water, soil, food stuffs, residence conditions.

The environmentally induced diseases, the causes of which are finally not investigated are:

- *chronic xenogenic intoxication,*
- *multiple chemical sensitivity,*
- *chronic allergic diseases,*
- *autoimmune diseases,*
- *eczema,*
- *asthma,*
- *chronic fatigue syndrome,*
- *chronic neurological disease,*
- *multiple sclerosis,*
- *Alzheimer's disease,*
- *impaired attention and hyperactivity syndrome,*
- *headaches of all types,*
- *depression,*
- *panic attacks,*
- *autism,*
- *chronic insomnia,*
- *Crohn's disease,*
- *ulcerative colitis,*
- *irritable bowel syndrome,*
- *chronic recurrent infections,*
- *chronic arthritis,*
- *chronic pathology of upper respiratory tract,*
- *depression conditions.*

At the present time the competence of environmental medicine includes environmentally induced pathology, the causes of which are known (table 1.1).

Table 1.1. The basic natural and man-caused environmental pathology.

Pathology	Etiological factors
natural-caused:	
endemic goiter	iodine deficiency
dental caries	fluorine deficiency
endemic molibdenosis	excess of molybdenum
hyperselenosis	excess of selenium
hemosiderosis	excess of iron
methemoglobinemia	excess of nitrates
Kashin-Beck disease	excess of strontium on the background of calcium deficiency
Prasad's disease	zinc deficiency
Keshan disease	selenium deficiency
endemic fluorosis	excess of fluorine
man-caused:	
fluorosis	excess of man-made fluorine
Minamata disease	excess of methylmercury
molybdenum gout	excess of anthropogenic molybdenum
lead encephalopathy	excess of anthropogenic lead
itai-itai disease	excess of cadmium
cobalt cardiomyopathy	excess of man-made cobalt
Yusho disease	excess of polihlorbifenilov and dioxins

The general laws in the formation of environmentally caused diseases are:

• man-made environment;

• a long impact of environmental pathogenic factors of low intensity on the certain area;

• a long latency period during which there is an increase in non-specific morbidity at population;

• an increase in frequency of occurrence of non-specific diseases with a predominance of one or more syndromes predominantly at the persons with genetically determined high sensitivity to environmental factors;

• polisyndrome character and development of disease of various severity at one causal factor;

• resistance to standard treatment against the background of the continuing impact of the environmental factor.

Environmental disease development is connected with exhaustion of organism's adaptable systems and treatment can be long.

There are some **factors** playing important role in development of ecological diseases:

1. heredity (defects of immune system, ability to detoxicate toxic connections);

2. food status (incorrect diet, imperfect digestion, infringement of adsorption);

3. toxic effects (action of the combustion products of natural gas, exposure to lead in the exhaust gases of vehicles, exposure to microorganisms in cooling, air conditioning systems and chemical compounds);

4. action of allergens (due to metabolic products of house dust mites);

5. effect of physical factors (free radical stress is caused due to the effect of physical factors and organic compounds, heavy metals in organism;

6. effect of psychosocial factors.

The **etiological environmental factors** which can cause the environmental pathology include the following.

Among the ***physical factors*** of air - the visible and ultraviolet parts of solar radiation spectrum, weather and climate conditions, the Earth's magnetic field; among the physical factors of water - smell, taste, color, transparency and turbidity; among the physical factors of soil - porosity, water and air permeability, moisture capacity, temperature.

Among the ***chemical components*** of air - oxygen, carbon dioxide, nitrogen, ozone; among the chemical components of water - chlorides, sulfates, phosphates, carbonates, calcium, magnesium, sodium, fluoride, strontium, iodine, iron, manganese; among the chemical components of soil - fluoride, iodine, iron, strontium, manganese, selenium, molybdenum, cobalt, zinc.

Biological factors of air are represented by airplankton, water - by hydrobionts, soil - by edaphobionts.

Anthropogenic factors, or pollutants of the physical nature of air - noise, infrasound, electromagnetic field, water - heat, sand, clay, floating impurities, soil - dust, radionuclides.

Pollutants of the chemical nature of air - oxides of carbon, sulfur, nitrogen, ammonia, hydrogen sulphide, dioxins, water - heavy metals, surfac-

tants, hydrocarbons, volatile organic compounds, fertilizers, pesticides, acids, alkalis, soil - pesticides, fertilizers, heavy metals, oil, hydrocarbons.

Pollutants of the biological nature of air - pathogenic viruses, bacteria, fungi, water - pathogenic bacteria, viruses, protozoan cysts, fungi and helminthes eggs, soil - pathogenic viruses, bacteria, protozoan cysts, helminthes eggs, fungi.

The ***internal pollutants of dwelling*** such as:

A) Pollutants of chemical nature:

– compounds released from the structures of buildings and the soil under them;

– the products of degradation of polymeric materials used in construction and finishing of the premises;

– the products of incomplete combustion of domestic gas;

– anthropotoxins allocated in the process of human life;

– the products produced by tobacco smoking;

– substances formed during cooking;

– substances released from household chemicals;

– pesticides used in everyday life;

– compounds formed in the process of self-employment;

– pollutants of shoes and outdoor clothing, primarily labor;

– hydrogen sulfide, radon and other volatile substances contained in tap water.

B) Pollutants of physical nature (electric and magnetic fields (electrosmog), air ions).

C) Pollutants of biological nature (bioaerosols).

The ***external pollutants of dwelling*** such as:

A) pollutants of physical nature (noise, dust).

B) pollutants of chemical nature (oxides of sulfur, nitrogen, carbon, products of photochemical reactions (photo-oxidants), the products of vehicle exhaust, lead and other metals).

C) pollutants of biological nature (pollen, fungal spores).

Xenobiotics or xenobiotic compounds which pollute the foodstuffs are also can be as etiological environmental factors. The foodstuffs are polluted with *xenobiotics of natural origin* such as oxalic acid, anthraquinones, essential oils, mint oil, theophylline, caffeine, serotonin; *xenobiotics which enter in foodstuffs as a result of reception of initial raw food material* such as metals, pesticides, medical preparations such as biostimulators, antibiotics, sexual hormones, tireostatics, sedatives, glucocorticoids, vitamins, nitrates; *xenobiotics which enter in foodstuffs from raw materials*

and food products, received by chemical and microbiological synthesis such as tyramine, histamine, recombinant growth hormone - somatotropin, enzyme preparations; *xenobiotics which enter in foodstuffs as a result of processing and cooking of food* of a sort of food additives (dyes, preservatives, antioxidants) and the compounds which are formed at influence of culinary processing and chemical interaction (at cooking of meat in alkaline water - lizilalanin, at smoking - benzo (a) pyrene and nitrosamines); *xenobiotics which enter in foodstuffs at contact to polymeric and other materials* such as utensils, container such as heavy metals, plasticizers, polyvinyl chloride).

Biological pollutants, in particular pathogens, in contrast to chemical contaminants, are discrete organisms, which are often collected in conglomerates or adsorbed on suspended solid particles and they form a different infectious dose. They have a certain invasiveness and virulence, proliferate in the host or water, food products. They are not cumulated.

Many of the factors and environmental pollutants are ***mutagenic*** and have a ***genotoxic effect*** on the human genotype, leading to changes (mutations) of the genes and chromosomes of the genome as a whole.

Mutation - is a sudden change in hereditary, caused by sharp structural and functional changes in the genetic material.

Mutagens or mutagenic factors - a substance and impact, leading to mutations. They cause disturbances in human hereditary unit, reflecting on his offspring. A **mutagen** is a physical, chemical or biological agent that changes the genetic material, usually DNA, of an organism and thus increases the frequency of mutations above the natural background level. As many mutations cause cancer, mutagens are therefore also likely to be carcinogens. Not all mutations are caused by mutagens: so-called "spontaneous mutations" occur due to spontaneous hydrolysis, errors in DNA replication, repair and recombination.

Mutagens are classified into ***physical, chemical or biological***. They may act directly on the DNA, causing direct damage to the DNA, and most often result in replication error. Some however may act on the replication mechanism and chromosomal partition. Many mutagens are not mutagenic by themselves, but can form mutagenic metabolites through cellular processes. Such mutagens are called **promutagens**.

Mutagens cause changes to the DNA that can affect the transcription and replication of the DNA, which in severe cases can lead to cell death. The mutagen produces mutations in the DNA, and deleterious mutation

can result in aberrant, impaired or loss of function for a particular gene, and accumulation of mutations may lead to cancer.

Different mutagens act on the DNA differently. Powerful mutagens may result in chromosomal instability, causing chromosomal breakages and rearrangement of the chromosomes such as translocation, deletion, and inversion. Such mutagens are called **clastogens**.

Mutagens may also modify the DNA sequence; the changes in nucleic acid sequence by mutations include substitution of nucleotide base-pairs and insertions and deletions of one or more nucleotides in DNA sequences. Although some of these mutations are lethal or cause serious disease, many have minor effects as they do not result in residue changes that have significant effect on the structure and function of the proteins. Many mutations are silent mutations, causing no visible effects at all, either because they occur in non-coding or non-functional sequences, or they do not change the amino-acid sequence due to the redundancy of codons.

Some mutagens can cause aneuploidy and change the number of chromosomes in the cell.

The process of occurrence of mutations, their accumulation, distribution and elimination is called as *mutation process*. It has as a hardly noticeable and catastrophic influence on the viability of carriers of mutations. Versatile effect of mutagenic factors results in sum up of additive effects and the development of unpredictable long-term consequences.

The accumulated mutations contribute to the formation of the genetic load, which is defined as the accumulated *variability in the genome*.

Thus factors and pollutants of environment lead to appearance of mutations, which in turn cause the development of *hereditary diseases*. However, it should be noted that not all mutations cause hereditary pathology due to the existence of reparation and the factors of the internal environment.

Physical mutagens are:

- Ionizing radiations such as X-rays, gamma rays and alpha particles may cause DNA breakage and other damages.
- Ultraviolet radiations with wavelength above 260 nm are absorbed strongly by bases, producing pyrimidine dimers, which can cause error in replication if left uncorrected.
- Extreme heat.
- Microwave radiation.

The action of ionizing radiation results in DNA breaks: *single* (under the influence of gamma rays, X-rays) or *multiple* (under the influence of

alpha particles, neutron radiation). This is an universal mechanism of chromosomal rearrangements in all stages of the cell cycle.

In contrast to ionizing radiation ultraviolet rays do not cause ionization of molecules, but only excite the electron shells of an atom, which is reflected in their reactivity and may lead to mutations.

UV irradiation present in sunlight is an environmental human carcinogen. The toxic effects of UV from natural sunlight and therapeutic artificial lamps are a major concern for human health. The major acute effects of UV irradiation on normal human skin comprises of sunburn inflammation *erythema, tanning*, and local or systemic *immunosuppression*.

As a defense against UV radiation, the type and amount of the brown pigment melanin in the skin increases when exposed to moderate (depending on ***skin type***) levels of radiation; this is commonly known as a sun tan. The purpose of melanin in the skin is to absorb UV radiation and dissipate the energy as harmless heat, blocking the UV from damaging skin tissue, thus to protect the body by absorbing solar radiation. The more the melanin there is in the skin, the more solar radiation can be absorbed. Excessive solar radiation causes direct and indirect DNA damage to the skin. With the production of the melanin, the skin color darkens, but can also cause sunburn. The tanning process can also be created by artificial UV radiation.

A person's natural *skin color* has an impact on their reaction to exposure to the sun. Generally, those who start out with darker skin colour and more melanin have better abilities to tan. Individuals with very light skin and albinos have no ability to tan. The biggest differences resulting from sun exposure are visible in individuals who start out with moderately pigmented brown skin: the change is dramatically visible as tan lines, where parts of the skin which tanned are delineated from unexposed skin.

For practical purposes, such as exposure time for sun tanning, six skin types are distinguished following Fitzpatrick (1975), listed in order of decreasing lightness (table 1.2).

Dark skin with large concentrations of melanin protects against ultraviolet light and skin cancers, light-skinned people have about a tenfold greater risk of dying from skin cancer, compared with dark-skinned persons, under equal sunlight exposure.

Table 1.2. Skin types on Fitzpatrick scale.

Type	Also called	Sunburning	Tanning	Von Lus-

			behavior	chan's chromatic scale
I	light, pale white	often	occasionally	1–5
II	white, fair	usually	sometimes	6–10
III	medium, white to light brown	rarely	usually	11–15
IV	olive, moderate brown	rarely	often	16–21
V	brown, dark brown	very rarely	sometimes darkens	22–28
VI	very dark brown to black	extremely rarely	naturally black-brown skin	29–36

Sunscreen prevents the direct DNA damage that causes sunburn, by blocking of UVB. As such, most of these products contain an SPF rating that indicates how well they block UVB as a measure of their effectiveness (SPF is therefore also called UVB-PF, for "UVB protection factor"). This rating, however, offers no data about protection against UVA, exposure to which does not lead to sunburn but is still harmful since it causes indirect UV DNA damage and is also (along with UVB and UVC) considered carcinogenic. In the US, the Food and Drug Administration is considering adding a star rating system to show UVA protection (also known as UVA-PF). A similar system is used in some European countries. Some sunscreen lotions now include compounds such as *titanium dioxide*, which helps protect against UVA rays. Other UVA blocking compounds found in sunscreen include *zinc oxide and avobenzone*.

Extreme heat possesses by minor mutagenic effect. The mutagenic effect of this factor is most pronounced in organisms with a constant body temperature. Extreme temperatures increase the effect of other mutagens, because it reduces the enzymatic activity of repair systems.

Chemical mutagens.

A large number of chemicals may interact directly with DNA. However, many such as PAHs, aromatic amines, benzene are not necessarily mutagenic by themselves, but through metabolic processes in cells they produce mutagenic compounds.

- **Reactive oxygen species (ROS).** These may be superoxide, hydroxyl radicals and hydrogen peroxide, and large numbers of these highly reactive species are generated by normal cellular processes, for example as by-products of mitochondrial electron transport, or lipid peroxidation. A number of mutagens may also generate these ROS. These ROS may result in the production of many base adducts, as well as DNA strand breaks and crosslinks.
- **Deaminating** agents, for example nitrous acid which can cause transition mutation by converting cytosine to uracil.

- **Polycyclic aromatic hydrocarbon** (PAH), when activated to diol-epoxides can bind to DNA and form adducts.
- **Alkylating** agents such as ethylnitrosourea. The compounds transfer methyl or ethyl group to bases or the backbone phosphate groups. Guanine when alkylated may be mispaired with thymine. Some may cause DNA crosslinking and breakages. Nitrosamines are an important group of mutagens found in tobacco, and may also be formed in smoked meats and fish via the interaction of amines in food with nitrites added as preservatives. Other alkylating agents include mustard gas and vinyl chloride.
- **Aromatic amines and amides** have been associated with carcinogenesis since 1895 when German physician Ludwig Rehn observed high incidence of bladder cancer among workers in German synthetic aromatic amine dye industry. 2-Acetylaminofluorene, originally used as a pesticide but may also be found in cooked meat, may cause cancer of the bladder, liver, ear, intestine, thyroid and breast.
- **Alkaloid** from plants, such as those from Vinca species, may be converted by metabolic processes into the active mutagen or carcinogen.
- **Benzene**, an industrial solvent and precursor in the production of drugs, plastics, synthetic rubber and dyes.
- **Base analog**, which can substitute for DNA bases during replication and cause transition mutations.
- **Intercalating agents**, such as ethidium bromide and proflavine, are molecules that may insert between bases in DNA, causing frameshift mutation during replication. Some such as daunorubicin may block transcription and replication, making them highly toxic to proliferating cells**.**
- **Metals**. Many metals, such as arsenic, cadmium, chromium, nickel and their compounds may be mutagenic; they may however act via a number of different mechanisms. *Arsenic, chromium, iron, and nickel* may be associated with the production of ROS, and some of these may also alter the fidelity of DNA replication. Nickel may also be linked to DNA hypermethylation and histone deacetylation, while some metals such as cobalt, arsenic, nickel and cadmium may also affect DNA repair processes such as DNA mismatch repair, and base and nucleotide excision repair.

Biological mutagens.

- **Virus** - Virus DNA may be inserted into the genome and disrupts genetic function (viruses of measles, rubella, influenza).

- **Bacteria** - some bacteria such as Helicobacter pylori cause inflammation during which oxidative species are produced, causing DNA damage and reducing efficiency of DNA repair systems, thereby increasing mutation.
- **Helminths and the products of their metabolism**, have clastogenic and aneugennym effects on somatic and generative host cell, disrupting the process of chromosome segregation at anaphase of mitosis and meiosis. Helminths parasitism is accompanied by a genotoxic and cytotoxic effects in somatic, generative and embryonic host cells leading to increased damage of nuclear DNA.

Pathogenesis of environmental diseases

The organism reacts to the influencing factors by specific adaptive reactions, adapting to them. **Adaptation** is an adaptation of organisms to the environment, having the relative character.

An **adaptation**, also called an adaptive trait, in biology is a trait with a current functional role in the life history of an organism that is maintained and evolved by means of natural selection. Adaptation refers to both the current state of being adapted and to the dynamic evolutionary process that leads to the adaptation. Adaptations contribute to the fitness and survival of individuals. Organisms face a succession of environmental challenges as they grow and develop and are equipped with an adaptive plasticity as the phenotype of traits develops in response to the imposed conditions. The developmental norm of reaction for any given trait is essential to the correction of adaptation as it affords a kind of biological insurance or resilience to varying environments.

All adaptations help organisms survive in their ecological niches. These adaptive traits may be **structural, behavioral or physiological**.

Structural adaptations are physical features of an organism (shape, body covering, armament; and also the internal organization).

Behavioral adaptations are composed of inherited behavior chains and/or the ability to learn: behaviors may be inherited in detail (instincts), or a tendency for learning may be inherited. Examples: searching for food, mating, vocalizations.

Physiological adaptations permit the organism to perform special functions (for instance, making venom, secreting slime, phototropism); but also more general functions such as growth and development, temperature

regulation, ionic balance and other aspects of homeostasis. Adaptation, then, affects all aspects of the life of an organism.

Populations differ in their phenotypic plasticity, which is the ability of an organism with a given genotype to change its phenotype in response to changes in its habitat, or to move to a different habitat. **Flexibility** deals with the relative capacity of an organism to maintain themselves in different habitats: their degree of specialization.

To a greater or lesser extent, all living things can adjust to circumstances. The degree of flexibility is inherited, and varies to some extent between individuals. A highly specialized animal or plant lives only in a well-defined habitat, eats a specific type of food, and cannot survive if its needs are not met. Many herbivores are like this; extreme examples are koalas which depend on eucalyptus, and pandas which require bamboo. A generalist, on the other hand, eats a range of food, and can survive in many different conditions. Examples are humans, rats, crabs and many carnivores. The tendency to behave in a specialized or exploratory manner is inherited – it is an adaptation.

The nutritional adaptation is done by the increase in the activity of single elements of the functional system (*the process of actualization* - energy support), and the inclusion of the new elements into the structure of the functional system (*the process of mobilization* - substrate support).

According to the WHO definition, adaptation - is a true ability of an organism to adapt to the changing of environmental conditions, which occurs without any breach of this biological system and exceeding of normal (homeostatic) ability to respond. As a result, adaptation resistance or non-adaptation with the followed pathological conditions may develop. The final result depends on the extremity of alien influence and functional state of adaptation and protection systems. The essence of adaptive resistance is to increase the resistance of the stress factor, extending the range of protective and adaptive capacity of the organism. This is possible only at the deficit-free uptake of full set of nutrients in a diet.

Factors of the environment of the lower or upper normal limits, influencing on an organism, trigger a functional reorganization of the biochemical, physiological and biophysical processes of the organism, as a result of which adaptation to new conditions occurs. A person can also adapt to factors out f the normal limits, or be in a state of resistance to a factor. Some functional disorders of the body caused by environmental factors can be compensated. If the body's defenses are not enough to restore the impaired functions, a state of decompensation develops, leading to pathology.

Thus, the disease occurs when the adaptation is disturbed and its formation is associated with the depletion of the organism's adaptive systems.

An environmental disease is associated with depletion of the adaptation systems of the body. It does not develop immediately, it can take years and even decades. An important role in the development of environmental diseases belongs to hereditary defects in the immune system and detoxication, inadequate or excessive nutritional status, digestion and absorption of nutrients, the physical, chemical and biological effects of harmful factors, and the content of pollutants in the body.

The pathological process begins with damage of immune, nervous and endocrine mechanisms of regulation, followed by violations of biochemical processes, physiological functions, morphological structures, causing the damage of certain organs and systems, which leads to disease and possibly death.

Chronic exposure to environmental factors is able to initiate the pathological process by turning of decompensation mechanisms of processes of neutralization, immune system damages, other organs and systems damages, direct damage of the target organ. In this case chronic exposure to biological factors leads, first and foremost, to damage of immune mechanisms, to physical - mainly of neuroendocrine regulation mechanisms. For individuals with hypersensitivity to certain environmental factors chronic exposure, even in small doses, can lead to disease.

There are three major target of genotoxic lesions: ***somatic, germinal and embryonic cells***.

Lesions of *somatic cells* on the nuclear level are carcinogenesis; on the mitochondrial level are mitochondrial diseases.

Induction of mutations in the *germinal cells* is the source of many inherited diseases and infertility.

Genotoxic effects on *embryonic cells* are the cause of miscarriage and teratogenesis.

The mechanism of genotoxicity of xenobiotics is that they penetrate into the cell nucleus, alter the structural and functional organization of the nuclear genome.

Mutations resulting in a genotype under the influence of external factors or internal environment are called as **induced**.

By the nature of changes in the genotype mutations are classified into **genetic, chromosomal, genomic, and cytoplasmic**.

Molecular mechanisms of **gene (point) mutations** are manifested in changing of the order of nucleotide pairs in the nucleic acid molecule.

Intragenic changes occur in the following types of nucleotide mutations: *replacement* of a pair of nucleotide, *deletion (loss) or insertion* of one pair or group of nucleotides in the DNA molecule.

Gene mutations can lead to the appearance of retinoblastoma, Langer-Giedion syndrome, Prader-Willi syndrome, sickle-cell anemia.

Chromosomal mutations are associated with changes in the structure of chromosomes and are caused by a violation of the process of crossing over.

There are *intrachromosomal and interchromosomal rearrangements*.

Intrachromosomal rearrangements result from the losing of part of chromosome (*deletions*), doubling or multiplication of certain chromosomal regions (*duplication*), turning the individual sections of the chromosome by 180^0 (*inversion*).

The most common syndromes are Wolf-Hirschhorn, "cat cry", Orbell, antimongolizm.

Interchromosomal rearrangements are *translocations*, which involve exchange of segments between non-homologous chromosomes, the merger of two residues of chromosomes with formation of dicentric chromosomes, exchanging portions of two arms with formation of ring chromosomes. The most frequent translocation is Down syndrome.

When **genomic mutation** there is a change in chromosome numbers by reducing or increasing of the number of haploid sets or individual chromosomes. The increase in the number of chromosomes multiple to the haploid set is called *polyploidy*, the change in the number of chromosomes, not multiple to the haploid set - *aneuploidy or geteroploidiey*.

Cytoplasmic mutation – is a change of plazmogenes, leading to changes in characteristics and properties of the organism. These mutations are associated with changes in the DNA structure of plastids and mitochondria. Examples of cytoplasmic mutations in man are certain types of myopathies, anencephaly, Albright syndrome.

Somatic mutations occur in the genotype of somatic cells, which can mutate during embryogenesis.

In multicellular organisms with dedicated reproductive cells, mutations can be subdivided into **germ line mutations**, which can be passed on to descendants through their reproductive cells, and **somatic mutations** (also called as **acquired mutations**), which involve cells outside the dedicated reproductive group and which are not usually transmitted to descendants.

A change in the genetic structure that is not inherited from a parent, and also not passed to offspring, is called a "somatic cell genetic mutation" or "acquired mutation". Cells with heterozygous mutations (one good copy of gene and one mutated copy) may function normally with the unmutated copy until the good copy has been spontaneously somatically mutated. This kind of mutation happens all the time in living organisms, but it is difficult to measure the rate. Measuring this rate is important in predicting the rate at which people may develop cancer.

Somatic mutation, genetic alteration acquired by a cell that can be passed to the progeny of the mutated cell in the course of cell division. Somatic mutations differ from germ line mutations, which are inherited due to genetic alterations that occur in the germ cells (i.e., sperm and eggs). Somatic mutations are frequently caused by environmental factors, such as exposure to ultraviolet radiation or to certain chemicals.

Somatic mutations may occur in any cell division from the first cleavage of the fertilized egg to the cell divisions that replace cells in a senile individual. The mutation affects all cells descending from the mutated cell. A major part of an organism, such as the branch of a tree or a complete tissue layer of an animal, may carry the mutation; it may or may not be expressed visibly. Somatic mutations can give rise to various diseases, including *cancer*.

Many DNA damages are corrected by repair enzymes. The process of restoring of the damaged natural DNA structures is called as **reparation**.

There are three ways of DNA reparation: ***photoreactivation, excision repair, postreplicative reparation*.**

Photoreactivation is carried out by the enzymes which are activated by photons of visible light. The damage caused by ultraviolet radiation is eliminated.

Excision repair allows eliminating the damage caused by ionizing radiation, chemicals, etc.

Postreplicative reparation is carried out through the exchange by fragments between two newly formed double helix of DNA. If the amount of damages of DNA in the cell structure remains high, replication processes are blocked, the cell stops dividing, the changes are not transmitted to posterity.

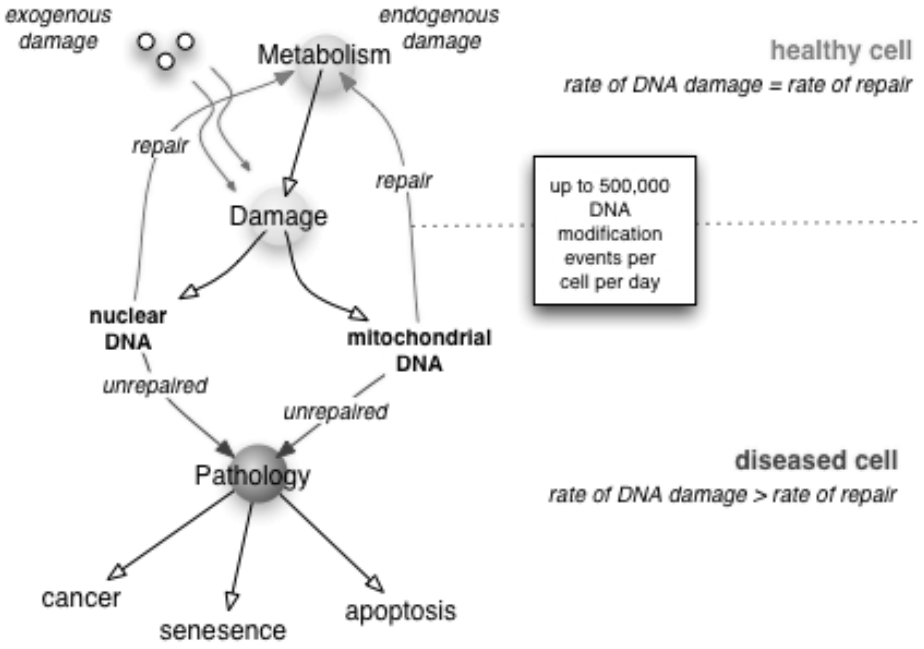
DNA repair is a collection of processes by which a cell identifies and corrects damage to the DNA molecules that encode its genome. In human cells, both normal metabolic activities and environmental factors such as

UV light and radiation can cause DNA damage, resulting in as many as 1 million individual molecular lesions per cell per day. Many of these lesions cause structural damage to the DNA molecule and can alter or eliminate the cell's ability to transcribe the gene that the affected DNA encodes. Other lesions induce potentially harmful mutations in the cell's genome, which affect the survival of its daughter cells after it undergoes mitosis. As a consequence, the DNA repair process is constantly active as it responds to damage in the DNA structure. When normal repair processes fail, and when cellular apoptosis does not occur, irreparable DNA damage may occur, including double-strand breaks and DNA crosslinkages (interstrand crosslinks or ICLs).

The rate of DNA repair is dependent on many factors, including the cell type, the age of the cell, and the extracellular environment. A cell that has accumulated a large amount of DNA damage, or one that no longer effectively repairs damage incurred to its DNA, can enter one of three possible states:

- an irreversible state of dormancy, known as senescence;
- cell suicide, also known as apoptosis or programmed cell death;
- unregulated cell division, which can lead to the formation of a tumor that is cancerous.

The DNA repair ability of a cell is vital to the integrity of its genome and thus to its normal functioning and that of the organism. Many genes that were initially shown to influence life span have turned out to be involved in DNA damage repair and protection. Failure to correct molecular lesions in cells that form gametes can introduce mutations into the genomes of the offspring and thus influence the rate of evolution (picture 1.3).



Picture 1.3. DNA repair rate is an important determinant of cell pathology.

Clinical picture of environmental diseases

The clinical picture of environmental disease is very diverse and usually has no specific symptoms. Furthermore, evaluating the effects of environmental factors on health status it should be noted that only a part of lesions are manifested as clinical symptoms, and other changes are manifested in the form of hidden disorders which do not appear at the organism level.

Therefore, the study of environmental influences on the state of the body should be complex and include biochemical, physiological, immunological and other studies to obtain a complete characteristic of the research state in the form of *information complex index*.

The clinic of environmental diseases is characterized by a latent period lasting up to tens of years. In the clinical picture, there are ***asthenic, asthenic and neurotic, vegetative, asthenic and vegetative, cerebral*** and other syndromes. If the harmful factors possesses by pulmotoxicity, hematotoxicity, nephrotoxicity, hepatotoxicity, gonadotoxicity, cardiotoxicity, the certain organs can be damaged with the appearance of the clinical symptoms.

Only a part of the lesions are manifested in the form of clinical symptoms, the other changes are expressed as disorders in a hidden form, which are not manifested at the organism level. It should be taken into account when assessing the effect of environmental factors on the state of health.

Asthenic syndrome, or chronic fatigue syndrome, is a painful condition, manifested by increased fatigue and exhaustion with extreme mood instability, intolerance, insomnia, decreased mental and physical stress, intolerance to loud sounds, bright light, sharp odors. Asthenia, which develops due to nervous overstrain, anxiety, difficult and often prolonged experiences and conflicts, is called *neurasthenia*.

Vegetal and vascular, or neuro and circulatory, dystonia, - is a violation of the cardiovascular, respiratory, digestive, vestibular, excretory, thermoregulatory systems. At the vegetal and vascular dystonia, vegetative disorders are necessarily combined with emotional disorders.

Asthenic and vegetative syndrome is characterized by a combination of asthenia with vegetative disorders mainly of the vagotonic character: decrease in working capacity, fatigue, sweating and emotionality, mood swings, insomnia, phobias, depression, headache, tachycardia, hand tremors, vomiting, nausea, shortness of breath.

Cerebral syndrome (encephalopathy) is accompanied by the symptoms: memory and consciousness disorder, headache, desire to die, dizziness, head noise, depression.

Diagnostic of environmental diseases

The modern official medicine is focused to establish an accurate diagnosis in accordance with the current International Classification of Diseases (ICD) through the collection of anamnesis, physical, laboratory, instrumental studies in acute diseases, to establish the symptoms in chronic diseases. In contrast to the modern official medicine environmental medicine is not intended the accepted diagnoses according to ICD, it evaluates and corrects numerous factors, which are signs of the disease.

The direct doctor-patient communication, individual medical examination allows to reveal the individual health problems and the impact of specific factors or conditions. For the diagnosis of environment-related conditions (phenomena of discomfort, disease, and death) the use of both traditional and special techniques is required.

The process of **diagnostics** of an environmental pathology includes:

• an anamnesis (history) of the disease;

• establishment of prior factors (genetic, stress, infectious, toxic, physical);

• identification of the role of triggers (chemical, physical, biological and physiological factors, medications, physical activity, social interaction);

• revealing of mediators (hormones, lymphokines, cytokines, free radicals, neurotransmitters);

• definition of pathological process, deficiencies, excesses, intoxication and the reasons that caused these phenomena.

To clarify the diagnosis, clinical, biochemical, physiological, immunological, bacteriological, genetic, parasitological and other studies are conducted, allowing to obtain a complete picture of the patient's condition as a single complex indicator.

We must also consider the possibility of developing of the disease of environmental etiology after the termination of contact to the harmful factors.

To reveal the environmental pathology the following criteria are taken into account:

- ✓ duration of residence in the contaminated area;
- ✓ professional and general anamnesis;
- ✓ the characteristic clinical symptoms which are not associated with work production;
- ✓ the presence of nonspecific clinical signs which are characteristic of the disease;
- ✓ the group character of diseases in the area of residence;
- ✓ complications and long-term effects of the pathological process;
- ✓ the presence of elimination and re-exposure phenomena.

To confirm the environmental pathology the following aspects are taken into account:

- anthropogenic environmental pollution;
- prolonged circulation of a pathogenic environmental factor of low intensity in a specific area;
- long latency period with an increase in non-specific diseases;
- increase in the frequency of non-specific diseases in individuals with genetically determined susceptibility to environmental factors;

- polisyndrome character and the development of the pathology of varying degrees of severity at the same etiological factor;
- resistance to standard treatment on the background of ongoing impact of environmental factors.

To prove the environmentally related diseases the ***correlation factor*** of morbidity with the environmental indicators is calculated and the force and character of correlation is determined.

Diagnosis of environment-related conditions is based on its retrospective analysis with the searching of the cause-and-effect relations and the making of the probable diagnostic models based on them. One important direction of investigation in this area is considered the determining factors or their combinations, provoking, promoting or supporting the emergence of these states that is later used for the purposes of prediction and prevention.

Treatment of environmental diseases

Treatment of the disease within the framework of modern medicine is carried out according to the developed standards, including the list of medical procedures without the use of individual approach with the appliance of pharmacological, surgical techniques, radiotherapy, physiotherapy, diet therapy, psychotherapy. However, this approach provides a positive effect only in case of acute, but not chronic disease.

Treatment is carried out after a complete diagnosis taking into account the scheme of developing of the disease and included:

1. detoxication to remove heavy metals and toxic xenobiotics (in vitro methods, peroral detoxification, including by means of food, phytotherapy);
2. elimination of violations of nutritional status (the treatment of maldigestion and maladsorbtion syndromes, irritable bowel, elimination of nutrients deficiency (proteins, amino acids, minerals, etc.);
3. immunocorrection depending on the disease;
4. treatment of allergies (specific desensitization, etc.);
5. antioxidant therapy;
6. treatment by the introduction of mediator precursors;
7. elimination of dysfunctions in the organs and systems.

Prevention of environmental diseases

Prevention of environmental diseases is carried out by:

- individual and public health prevention;
- environmental monitoring;
- environmental education and training of the population.

Almost all cases of environmental diseases induced by exposure to the environment can be prevented.

The representatives of environmental prevention approach in medicine believes that providing people with clean air, water, normal adequate nutrition and timely utilization of industrial and household waste are more important than the construction of new hospitals, the search for new highly efficient medical products. Many of the most effective preventive measures are carried out outside the traditional clinical framework. For this purpose the intervention in non-medical risks, in particular, legislation, technology, sanitary devices, organizational and planning decisions is used and appropriate measures, including treatment and prophylactic, are developed.

Prevention of environmental diseases includes **public and individual prevention.**

Individual prevention includes:

- formation of healthy lifestyle with a focus on rational and preventive nutrition;
- protection by time, distance, quantity, screen;
- reception of phytopreparations, adaptogens.

The healthy lifestyle is the realized necessity of constant performance of rules and ways of health preservation and strengthening, combined with the reasonable relation to environment.

The person can live till 150 years and more under the condition that will get rid of the scornful relation to health and will profess and conduct a healthy way of life.

The leading components of healthy lifestyle are:

- refusal of bad habits;
- regular physical and impellent activity, optimum impellent mode;
- high-grade work, rational mode of work, productive leisure;
- balanced diet;
- the arranged well life;
- personal hygiene;

- ability to be self-controlled, positive emotions, psychological comfort and psychophysiological satisfaction;
- correct sexual behaviour, a strong family;
- an active vital position, economic and material independence, conformity of biological and psychological possibilities of the person to conditions and requirements of the natural and social environment.

Formation of healthy lifestyle – is a prompting of the person to inclusion of rational forms of his or her behaviour during a daily life directed on preservation of health and preservation of the environment.

Formation of healthy lifestyle is performed through training, education, culture.

Balanced and preventive nutrition is applied to ensure the adaptive resistance to the stress factor, extending the range of protective and adaptive capacity of the organism. This is possible only at the deficit-free uptake of full set of nutrients in a diet.

Nutritional ensuring of the development of adaptation resistance is performed in two main directions:

- reduction of alimentary alien load;
- provision of the necessary amount of nutrients.

The first is control for the quality of food and the use of *elimination diet therapy* principles: inclusion of the diet that prevents the absorption of xenobiotics and ensures their rapid clearance from the body without disturbing of functions of the excretory system. Particular attention should also be given to the opportunity of alimentary normalization (stabilization) of allergy status - *allergen diet therapy* and intestinal microbiocenosis - *probiotic diet therapy*.

Currently, the special series of ***preventive products*** with protective properties or increasing the resistance of the body due to the enrichment of them with dietary fiber, vitamins, minerals, animal protein are developed. Increase in the amount of dietary fiber is achieved by introducing them into the recipes of bakery, confectionery, meat and fish products, processed in various ways carrots, apples, beets, and so on. At the same time due to the herbal ingredients food is enriched with vitamins and minerals.

Normalization of mineral composition of a wide range of products is made by the introduction into the appropriate nutritional composition of meat mass, finely crushed fish mass, eggshell powder, preparations of slaughtering blood and liver.

Intensification of alien nutritional load is caused by adverse environmental conditions and has a negative effect on the function of homeo-

static systems with the development of stress variant of metabolism, in which a special mode of life support in the process of adaptation develops.

In terms of environmental load diet in addition to traditional functions must ensure:

- reduction of speed of absorption of xenobiotics in the gastrointestinal tract;
- weakening of adverse influence of alien factors at cellular and organ levels;
- reduction of the level of contaminants deposition in tissues;
- acceleration of removal of contaminants and products of their metabolism from the body.

Assimilation of xenobiotics in the gastrointestinal tract depends on how long food stay in the intestine, state of enterocytes membranes, activity of enzymatic digestion, microbiocenosis nature and chemical composition of the diet. The latter implies the possibility of existence of different types of interaction of xenobiotics and nutrients (competitive, synergistic or neutral), proceeding as in cavernous spaces, and on biological membranes and in the cytosol of cells.

The food substances blocking absorption of xenobiotics are natural sorbents such as fiber, alginates, collagen, zeolites, chitin. They also enhance intestinal motility, thereby reducing the effective period of absorption.

Some nutrients come to conformational interaction with the alien agent, thereby forming the indigestible complexes or competitively inhibiting the transmembrane delivery and connection to the active carriers on membranes and fluids (mineral elements, vitamins, amino acids). Nutritional deficiency of most nutrients is registered at large populations, it requires the correction of the primary dietary imbalances.

There are some principles of non-specific nutritional support of the processes of xenobiotics biotransformation:

- ensuring of adequate supply of nutrients, which are cofactors or substrates, as well as regulators of protective metabolic processes;
- decrease to the minimum uptake of substrates of pathochemical reactions;
- ensuring of optimal balance of nutrients, given the availability of nutrients with unidirectional or inhibition properties.

In the situation of high environmental risk, poor nutrition should be considered not only from the point of view of the possible development of a number of common nutrition-related pathologies, but also as a factor that

reduces the protective-adaptive capabilities of the organism. In the alien impact conditions in stress mode an organism uses all the functionality to maintain normal homeostasis, while experiencing the need for deficit-free uptake of the basic nutrients in diet in the physiologically reasonable quantities.

The daily norm of each nutrient uptake in the specific environmental conditions should be determined taking into account the individual physiological needs and consumption of the nutrients in the adaptation mechanisms.

A number of nutrients can exacerbate the pathochemical processes induced by one or another kind of alien influence. Thus, unsaturated and particularly polyunsaturated fatty acids are substrates for the formation of lipid radicals and endogenous peroxides under potentiation of free radical reactions, thereby increasing the damage at the cellular level. Thus, on the conditions of alien prooxidant load it is necessary not only to increase the nutritional intake of antioxidant nutrients, but to also reduce the amount of polyunsaturated fatty acids in the diet to the lower border of physiological need.

Balanced diet - is a physiologically balanced diet of healthy people, which corresponds to the energy, plastic and biochemical needs of the organism, provides and maintains homeostasis of the functional activity of organs and systems, resistance to adverse environmental factors at optimal levels in different conditions of life.

Rational diet should be adequate, balanced, safe and diverse.

The daily diet and recommended quantity of food intake of men and women of 18-29 years old in favorable ecological conditions are listed in the table 2. The recommended quantity of food intake is 4 (breakfast - 25%, lunch - 35 %, afternoon tea - 15%, dinner - 25%).

The need for sulfur amino acids, dietary fibers, calcium and iron increases in the conditions of toxic (lead) load. Simultaneously, we need to reduce the intake of fats.

Objective indicators of the nutrient lack are data of studying of the specific parameters of nutritional status.

Drugs, alcohol (thiamine, riboflavin), smoking (vitamin C and β-carotene) and environmentally caused xenobiotic load can have a negative effect on the degree of nutrients assimilation.

The daily diet of men and women of 18-29 years old in favorable ecological conditions are presented in the table 1.3.

Table 1.3. The daily diet of men and women of 18-29 years old in favorable ecological conditions.

Dietary components	men	women
proteins, g	72	61
fats, g	81	67
carbohydrates, g	358	269
energy, kcal	2450	2000
calcium, mg	1000	1000
phosphorus, mg	800	800
magnesium, mg	400	400
iron, mg	10	18
vitamin B_1, mg	1.5	1.5
vitamin A, mkg	900	900
vitamin C, mg	90	90

In the situation of high ecological risk poor nutrition should be considered not only from the point of view of the possible development of a number of common nutrition-related diseases, but also as a factor that reduces the protective-adaptive capabilities of the organism.

Organization of p***reventive nutrition*** in conditions of the environmental load includes:

- justification of daily nutrient composition of the diet;
- definition of the product set, providing the necessary amount of nutrients and energy;
- choice of the optimal regime and nutrition conditions.

Currently the nutritional standards for different groups of the population living in the radioactive load in areas affected by the Chernobyl accident are developed. These guidelines can be used as a basis for optimization of nutrition in areas with a predominance of *prooxidant load* under adverse environmental impact.

The main principles of construction of a diet in terms of environmental load are:

1. increase in proteins receipt till 15 % from the caloric content of a diet, basically at the expense of proteins of animal origin (60 % from the general receipt);
2. restriction in fats receipt till 30 % from the caloric content of a diet at relative reduction of receipt of vegetable oil and cod-liver oil (polyunsaturated fatty acids - 3 % from the general caloric content of a diet);
3. increase in vitamins-antioxidants (E, C, A, β-carotin) receipt on 20

- 50 % in comparison with the recommended age norms;

4. increase in dietary fibers receipt on 20-30 %;

5. increase in mineral substances and microelements (Ca, Fe, Mg, K, Zn, Se, I, Mn, Cu) receipt on 20 - 50 %.

The regime of nutrition is of essential value. The optimal daily diet will provide adaptive and protective function only when the uniform receipt of food and, consequently, nutrients in day will be.

Food intake should be at least 4 times a day (preferably 5 - 6 times).

The distribution of meals on caloric value at four food intake regime is:

- breakfast - 25%;
- lunch - 35 - 40%;
- afternoon tea - 10 - 15%;
- dinner - 25%.

Thus, it is recommended to use at least 60% of the total daily volume of food in the morning (before 3 p.m.).

The normal function of protective and adaptive systems depends on the availability of the organism by the substrates of synthesis of *enzymes, cofactors* (iron, selenium, copper, zinc, manganese) and *coenzyme* (riboflavin, niacin) of the working enzyme systems, *antioxidant vitamins* (E, A, β-carotene, C, bioflavonoids), *calcium*, *dietary fiber*. At the same time, nutritional deficiency of the most above listed so-called "working nutrients", are marked in large populations and required the priority correction among the dietary imbalances.

Antioxidants are important group of anticarcinogenic compounds that may help remove ROS or potentially harmful chemicals. These may be found naturally in fruits and vegetables. Examples of antioxidants are *vitamin A* and its carotenoid precursors, *vitamin C, vitamin E, polyphenols,* and various other compounds.

β-Carotene is the red-orange colored compound found in vegetables like carrots and tomatoes.

Vitamin C may prevent some cancers by inhibiting the formation of mutagenic N-nitroso compounds (nitrosamine).

Flavonoids, such as EGCG in green tea, have also been shown to be effective antioxidants and may have anti-cancer properties.

Epidemiological studies indicate that a diet rich in fruits and vegetables is associated with lower incidence of some cancers and longer life expectancy, however, the effectiveness of antioxidant supplements in cancer prevention in general is still the subject of some debates.

Other chemicals may reduce mutagenesis or prevent cancer via other mechanisms, although for some the precise mechanism for their protective property may not be certain. *Selenium*, which is present as a micronutrient in vegetables, is a component of important antioxidant enzymes such as gluthathione peroxidase. Many phytonutrients may counter the effect of mutagens; for example, *sulforaphane* in vegetables such as broccoli has been shown to be protective against prostate cancer. Others that may be effective against cancer include *indole-3-carbinol* from cruciferous vegetables and resveratrol from red wine.

Public prevention includes medical measures for the population exposed to harmful environmental factors, as well as measures to protect the environment from pollution, the most significant of which are legislative.

Treatment and prophylactic measures mean the medical examination and clinical examination of the population, sanatorium treatments and other activities.

According to medical measures, doctors conduct prophylactic medical examinations of the population, send people for sanitation to sanatorium-and-spa treatment, participate in environmental education and training, social and hygienic monitoring, and assessment of the health risks of environmental factors.

Environmental protection from pollution - is a system of the actions directed toward the elimination of negative influence on humans in the form of emissions in air, dumps in water and garbage in soil containing new agents or exceeding their natural level.

Groups of actions for environmental protection are presented by the following:

1. ***legislative***: working out of hygienic standards (maximum permissible concentration for chemical substances and dust, maximum permissible level/dose for physical and biological pollutants);
2. ***technological***: working out and creation of the closed technological processes, technologies without waste, replacement of harmful substances of less harmful ones;
3. ***planning***: zoning of territory of a city, planning of residential area, its gardening, sanitary-protective areas (50-1000 m according to the damage class of the enterprises);
4. ***sanitary-engineering***: clearing of atmospheric emission, hydrospheric dumping, litospheric garbage by means of clearing devices, effective clearing of the occupied places from garbage, its gathering, removal, neutralization and recycling;

5. ***organizational***: dumps at various time of day, monitoring.

For assessment of harm and level of safety in chemical factors and pollutants in atmospheric air, water or soil **maximum permissible concentration (MPC)** - maximum concentration limit is standardized, which is maximum single. The maximum permissible concentration of a gas, vapour, impurity, spray or substance, is the maximal concentration in atmospheric air, water or soil which, according to the present state of our knowledge, in general, remains without harmful effects on human health and their offspring, even after repeated exposure, during a long period of time up to an entire life, including long-term both health and environment effects.

For physical and biological factors and pollutants in atmospheric air, water or soil **maximum permissible level (MPL)** is standardized. Levels of exposure to factors and pollutants are normalized to the maximum permissible level, whose values are listed in appropriate standards of safety and hygiene rules.

In the absence of the standardized value of maximum concentration limit, **approximate safety level of influence** is used temporarily.

MPC values are regularly adapted as a result of new insights. Although you cannot determine the concentration of a particular substance, the MPC indicates how you should handle a particular substance**.**

Environmental training and education – is a comprehensive educational, training and upbringing activity aimed at formation of hygienic health of individuals, social groups and society as a whole.

Ecological education has public, planned character, its carrying out is the responsibility of all medical and teaching staff.

The population should be raised in optimism. There must be the belief that all necessary conditions for prevention of communicable and non-communicable diseases, health promotion, preservation of optimal living conditions, active longevity, high capacity for work are created in the country. Work on ecological training and education should be carried out in cooperation with non-health agencies and non-governmental organizations and has a massive, nationwide character.

In wildlife management business, ecological and nature protection training and education, this should be carried out concerning all population and began from preschool institutions, get special value nowadays. Propagation of knowledge on wildlife management by means of the *speaking, printing, pictorial and combined methods* is an important point of ecological and nature protection training and population education.

The ***method of speaking propagation*** is simpler in organizational terms, does not require large material expenditures, and enables the preparation of the material taking into account the specificity of audience and direct contact to audience.

The ***method of printing of propagation*** enables large duplicating of literature and wide population coverage.

The ***method of pictorial propagation*** possesses visualization and contributes to a better memorization.

The ***combined propagation*** is the most effective due to the simultaneous exposure to visual and auditory analyzers and coverage of great number of people.

The *ways of method of speaking propagation* are lectures, agitation and information presentations, evenings of questions and answers, discussions, quiz, conference, club and courses.

The *ways of method of printing propagation* are books, brochures, newsletters, magazines, leaflets, slogans, memos, newspaper, recipes, pamphlets and articles.

The *ways of method of pictorial propagation* are **planar** (posters, drawings, diagrams, tables, plans, drawings, chart, cartogram, photograph, slide, slide), **volume** (dummy, model, layout diagram phantom, sculpture, effigy) and **natural** (slides, macropreparations, sample) objects.

The *ways of method of combined propagation* are television, movies, videos, exhibitions, museums, health holidays.

The principles of environmental education – are the basic, proven by practices, provisions guiding the activity in the field of environmental education.

These include actuality, scientificity, accessibility, positive orientation of information, the unity of theory and practice, the unity of teaching, a differential and individual approach, illustrativity, sequence of environmental education, promotion of awareness and activity of the population.

1. The principle of actuality focuses on the provision of individuals, groups of individuals, social community by important and timely health information. Actuality is determined by the modern objectives of health maintaining, including public health objectives, as well as problems of the local (regional, urban) character.

The principle of actuality reflects the urgent problems related to human health, the environment, hygienic culture, social norms and values,

etc. It is realized at satisfaction of interest and needs of the population in some hygienic health information.

2. The principle of individual approach provides for the implementation of environmental education, taking into account the individual characteristics of the person to whom it is directed (health, character traits, temperament, profession, gender, age, working and living conditions). It is essential every person to have the opportunity to receive individual advice on health promotion, disease prevention.

3. The principle of unity of training and education involves mastering by an individual or group of individuals not only the content of the information but also the methods of its processing, relationship to it, how it is used.

4. The principle of illustrativity provides for a combination of presentation of theoretical information with examples and demonstrations. It helps lucidly and convincingly presenting of the material, improves its perception.

In practice there are 3 types of illustrativity:

• *verbal and figurative* (examples from medical practice, everyday life);

• *sign* (natural and artificial objects, posters, diagrams, drawings, photographs);

• *action* (actions on providing of self-help and self-learning the rules of the mammary glands).

5. The principle of consistency provides allocation of the basic stages and their logical continuity in the implementation process. Environmental education is carried out at all stages of human life, and the study of new material should be supported in the previously acquired knowledge.

6. The principle of systematicity provides for a permanent, regular character of implementation of environmental education, which allows providing the knowledge related to health, in the form of an integrated system.

Its implementation is possible only in conditions of coordination between all agencies and organizations involved in hygiene education (preschool institutions, schools, vocational schools, secondary specialized educational institutions, higher educational institutions, health facilities, parents, youth organizations, sports organizations).

7. The principle of stimulation of awareness and activity in ecological education expresses the aim to increase the activity of an individual,

group of individuals, social community in matters of health. This activity is only possible if there is a sense of responsibility for their health and the health of others. It is extremely important as it is a foundation to change the behaviors and lifestyles.

The importance of training and education, especially in the development of habits and skills, has the personal example of those who conduct the propagation.

Environmental monitoring is a system of planned long-term systematic observations over the environment, evaluation of its state, analysis and forecast of its changes due to the impact of natural and man-caused factors, and also biological responses to environment changes under the influence of natural and technogenic factors.

The Natural Resources and Environmental Protection Ministry of the Republic of Belarus is a national state administration body in charge of exploitation of natural resources and environmental protection, pursuing the state ecology policy.

Environmental monitoring is being conducted under the ***National Environmental Monitoring System*** *(NEMS)* established in 1993.

Now NEMS includes 11 independent environmental monitoring types based on the same principles:

1. land monitoring;
2. surface water monitoring;
3. underground water monitoring;
4. air monitoring;
5. ozone layer monitoring;
6. flora monitoring;
7. forest monitoring;
8. fauna monitoring;
9. radiation monitoring;
10. geophysical monitoring;
11. local environmental monitoring.

NEMS has an information system that ensures information exchange between all the monitoring types, analysis and generalization of information about the environment state and forecast of its changes due to natural and man-made factors as well as its provision to governmental agencies, entities and individuals and international organizations in accordance with international agreements.

The organization of work as a part of NEMS is carried out in accordance with the provisions of the Council (Cabinet) of Ministers:

- "On the establishment of the National Environmental Monitoring System in the Republic of Belarus (NEMS)" from 20.04.1993, № 247;

- "On the program of the National Environmental Monitoring System in the Republic of Belarus" from 20.06.1995, № 311;

- "On the implementation of the National Environmental Monitoring System in the Republic of Belarus" from 08.27.1998, № 1344;

- "On the local environmental monitoring in the Republic of Belarus" from 08.02.1999, № 201;

- "On the National Environmental Monitoring System in the Republic of Belarus" from 14.07.2003, № 949.

Work on the environmental monitoring is carried out under the supervision of the Ministry of Natural Resources and Environmental Protection of Belarus.

In connection with presence of global problems of environment and natural resources the international cooperation has great value for wildlife management. According to this plan Belarus has signed Paris convention on world and cultural heritage protection, Viennese convention on ozone layer protection, Geneva convention on pollution of atmosphere, etc., cooperates in UNEP (The United Nations Environment Program), UNESCO (The United Nations Educational, Scientific and Cultural Organization).

The **UNEP** is an agency of the UN that coordinates United Nations environmental activities, assisting developing countries in implementing environmentally sound policies and practices. It was founded as a result of the United Nations Conference on the Human Environment in June 1972 and has its headquarters at the Gigiri neighborhood of Nairobi, Kenya. UNEP also has six regional offices and various country offices.

Its activities cover a wide range of issues regarding the atmosphere, marine and terrestrial ecosystems, environmental governance and green economy. It has played a significant role in developing international environmental conventions, promoting environmental science and information and illustrating the way those can be implemented in conjunction with policy, working on the development and implementation of policy with national governments, regional institutions in conjunction with environmental Non-Governmental Organizations (NGOs). UNEP has also been active in funding and implementing environment related development projects.

UNEP has aided in the formulation of guidelines and treaties on issues such as the international trade in potentially harmful chemicals, transboundary air pollution, and contamination of international waterways.

The World Meteorological Organization and UNEP established the Intergovernmental Panel on Climate Change (IPCC) in 1988. UNEP is also one of several Implementing Agencies for the Global Environment Facility (GEF) and the Multilateral Fund for the Implementation of the Montreal Protocol, and it is also a member of the United Nations Development Group. The International Cyanide Management Code, a program of best practice for the chemical's use at gold mining operations, was developed under UNEP's agency.

The **UNESCO** is a specialized agency of the United Nations (UN).

Its purpose is to contribute to peace and security by promoting international collaboration through education, science, and culture in order to further universal respect for justice, the rule of law, and human rights along with fundamental freedom proclaimed in the UN Charter. It is the heir of the League of Nations' International Commission on Intellectual Cooperation.

UNESCO has 195 member States (it recently added Palestine in November 2011) and nine Associate Members. Most of the field offices are "cluster" offices covering three or more countries; there are also national and regional offices. UNESCO pursues its objectives through five major programs: education, natural sciences, social and human sciences, culture, and communication and information.

Projects sponsored by UNESCO include literacy, technical, and teacher-training programs; international science programs; the promotion of independent media and freedom of the press; regional and cultural history projects; the promotion of cultural diversity; translations of world literature; international cooperation agreements to secure the world cultural and natural heritage (World Heritage Sites) and to preserve human rights, and attempts to bridge the worldwide digital divide. It is also a member of the United Nations Development Group.

UNESCO's aim is "to contribute to the building of peace, the eradication of poverty, sustainable development and intercultural dialogue through education, the sciences, culture, communication and information".

Other priorities of the organization include attaining quality Education For All and lifelong learning, addressing emerging social and ethical challenges, fostering cultural diversity, culturing peace and building inclusive knowledge societies through information and communication.

The control over a natural condition is carried out in the course of monitoring.

Monitoring – is a system of continuous supervision, assessment and forecast of environment conditions. It is carried out at constant supervision of sources and factors of anthropogenous influences and arising effects in environment.

Monitoring purpose – is a revealing of anthropogenous pollution and its ecological estimation.

There are the following ***levels of monitoring***:

Local monitoring encompasses tens of kilometers. Local monitoring is generally carried out in relation to specific objects, such as forest, water, mountain, which are often subjected to intense anthropogenic influences. Its ultimate goal is to provide a strategy of management, in which the concentration of priority pollutants of anthropogenic origin falls within the tolerance limits.

This type of local monitoring is an ***impact*** monitoring (impact - influence). It is carried out, as a rule, especially in hazardous areas and places, for example, territories near to the radiochemical enterprises, places where radioactive wastes are buried, chemical plants.

Regional monitoring encompasses thousands of square kilometers. It is monitoring of the processes and phenomena in the range for large areas, which usually differs from neighboring natural conditions, for example, natural areas, landscape complexes, recreational areas around cities.

Global monitoring is conducted to obtain information about the biosphere as a whole or of individual biosphere processes, in particular, climate change, ozone monitor, etc. Specific objectives of the global monitoring are defined in the international cooperation in the framework of various international agreements and declarations. This type of global monitoring is called ***background or base***.

There are **types of monitoring** based on:

- on research methods (chemical, biological, physical);
- on components of biosphere (monitoring of atmosphere, hydrosphere, lithosphere);
- on influence factor (ingredient monitoring - the control over polluting substances and agents including electromagnetic radiation, thermal pollution, noise, toxic substances).
- on types of pollution sources (*dot stationary* (factory pipes, concentrated dumps of the industrial enterprises, cattle-breeding farms), *dot mobile* (transport), *linear or vulgar* (drain from agricultural fields, loss of atmospheric precipitation, dispersion of fertilizers and their washout).

Monitoring is carried out in a zone of possible essential anthropogenous influence, in a zone of an average level of impurity and at background level in biosphere reserves. Results of monitoring are a basis for ecology-economic modeling, calculation of admissible anthropogenous loadings, forecast of environment changes, working out of rational ways of use, protection and reproduction of natural resources and development of uniform system of laws and rules in the field of wildlife management.

In Belarus there are two systems of air environment monitoring (hydrometeorology and sanitary and epidemiological services), three systems of water monitoring (hydrometeorology, sanitary and epidemiological services, Belarusgeology), three systems of monitoring of radiation pollution of air, soil, water (hydrometeorology, sanitary and epidemiological services, the Ministry of Agriculture and Foodstuffs), system of social and hygienic monitoring (sanitary and epidemiological services).

Biological monitoring is the use of the properties of an organism to obtain information on certain aspects of the biosphere.

Bioindication methods are:

- ***passive monitoring*** (the visible or physiological and biochemical damages or abnormalities are signs of stress and are studied in free-living organisms);

- ***active monitoring*** (the same changes as in free-living organisms are detected in the test-organisms in standardized conditions at study area).

Passive methods observe plants growing naturally within the area of interest.

Active methods detect the presence of air pollutants by placing test plants of known response and genotype into the study area.

Biological monitoring determines the status of biota, its response to anthropogenic impacts, as well as a function of the states and deviations from the normal natural functions at different levels - molecular, cellular, organism, population, community.

A **biological monitor**, or **biomonitor**, can be defined as an organism that provides quantitative information on the quality of the environment around it. Therefore, a good biomonitor will indicate the presence of the pollutant and also attempt to provide additional information about the amount and intensity of the exposure.

Bioindicators are used for the purpose of biogeocenoses monitoring. Bioindicators – are organisms or their communities, vital functions of which are closely associated with certain environmental factors. **Biological indicators** are species that can be used to monitor the health of an environment or

ecosystem. They are many biological species or group of species whose function, population, or status can reveal what degree of ecosystem or environmental integrity is present. Bioindicators can tell us about the cumulative effects of different pollutants in the ecosystem and about how long a problem may have been present, which physical and chemical testing cannot.

A bioindicator is an organism or biological response that reveals the presence of the pollutants by the occurrence of typical symptoms or measurable responses, and is therefore more qualitative. These organisms (or communities of organisms) deliver information on alterations in the environment or the quantity of environmental pollutants by changing in one of the following ways: *physiologically, chemically or behaviorally*.

The information can be deduced through the study of:

1. their content of certain elements or compounds;
2. their morphological or cellular structure;
3. metabolic-biochemical processes;
4. behaviour;
5. population structure(s).

Ecological monitoring – is a detection of condition of abiotic part of biosphere and anthropogenous changes in ecosystems due to the effect of pollution, agricultural land use, urbanization, etc. This type of monitoring is complex; it is connected to the systematic approach and used as the main in the planning of supervision in biospheric reserves.

It also can be subdivided into *bioecological*, *geosystemic and biospheric* depending on the ecosystem level (organism or population, geosystem, biosphere).

Besides it, there are *emergency kinds of monitoring* which are typical at the decision of essential world problems such as increase of carbonic gas concentration in atmosphere, ozone layer depletion, failure of oil tankers, etc.

Ecological monitoring generates the information required to assess and respond to ecosystem changes. Monitoring can assist with the identification of new environmental concerns, the prioritization of issues, and the evaluation of trends over time.

The social and hygienic monitoring is a system of collecting, analyzing and evaluating information about the state of life and health of the population depending on the quality of the environment. It is held in order to identify the level of risk for life and health and the development of

measures aimed at preventing, reducing and eliminating adverse effects of environmental factors on humans.

The social and hygienic monitoring includes environmental monitoring of air and water, monitoring of radioactive contamination of air, soil and water, monitoring of social and labor sphere, sanitary and epidemiological monitoring of food and water supply of the population, monitoring of morbidity, physical development, demographic indicators of the population.

Environmental pollution – is a risk factor for human health. It is indicated by the data from epidemiological studies (medical statistics showing trends in morbidity in the contaminated areas). This is confirmed by the data of special scientific studies aimed at quantifying the link between environmental pollution and its effect on the human body. A quantitative measure of the negative impact of adverse factors on the human body is the calculation of **risk** for disease appearance.

Methodology of estimation of risk of influence on health of the harmful factors – is a new, rapidly developing worldwide interdisciplinary research field. This is due to the fact that the problem of environmental pollution is a major health and environmental problem recently.

Long-term monitoring and analysis of environmental factors and human health within its unified information space, as it is done in the socio-hygienic monitoring, can provide the basis for the use of the results of this type of work and looking for the solution of the problems.

In modern conditions, medical professional must respond to complex questions that require further development of the concept of risk. Thus, the system of health risk assessment should naturally flow into the system of general management and decision making in administrative practice, the risk must be measured, to have a value, to be understood by the officials and the public, in order to allow comparisons and, therefore, the choice-making and regulation.

As the derivatives of risk the following kinds of risk are studied:

- absolute risk;
- relative risk;
- risk difference;
- etiologic risk;
- attributable risk.

Absolute risk – is a probability of occurrence of disease in humans for a predetermined period of time.

Relative risk - is a ratio of the values of absolute risk in the presence and absence of exposure to environmental factors. The relative risk determines the strength of the relationship between exposure and disease. The higher the value, the higher the risk of the disease in the group of exposed persons.

The difference in absolute risk indicates the value of the absolute increase of prevalence of the disease under the influence of risk factors, i.e., it points to the relevance of this issue for public health.

Etiological risk - is a percentage of all cases of the disease caused by this factor of risk.

Attributable risk - the indicator that assesses the proportion of morbidity associated with this risk factor. A special feature of this indicator in the risk assessment is that it essentially defines the main purpose of studying of the state of health or morbidity in populations who are in significantly different environments.

WHO Guidelines (1978) defines **risk** as "the expected frequency of undesirable effects resulting from exposure to the pollutant". The US Environmental Protection Agency (EPA US) describes **risk** as "the likelihood of damage, disease or death under certain circumstances".

Health and well-being are affected by many factors, and those that are associated with ill health, disability, disease or death are known as risk factors. Risk factors are presented here individually, however in practice they do not operate in isolation. They often coexist and interact with one another.

Behavioural risk factors. Risk factors that can be eliminated or reduced through lifestyle or behavioural changes include:

- tobacco smoking;
- excessive alcohol consumption;
- poor diet and nutrition;
- physical inactivity;
- excessive sun exposure;
- insufficient vaccination;
- unprotected sexual activity.

Biomedical risk factors. Biomedical risk factors may be influenced by a combination of genetic, lifestyle and other broad factors. Biomedical risk factors include:

- overweight and obesity;
- high blood pressure;

- high blood cholesterol;
- impaired glucose tolerance;

Environmental risk factors. Environmental determinants of health cover a wide array of topics, and can be split into two broad categories:

- social, economic, cultural and political;
- physical, chemical and biological.

Genetic risk factors. Some diseases, such as cystic fibrosis and muscular dystrophy, result entirely from an individual's genetic make-up whereas many others reflect the interaction between that make-up and environmental factors. There are three broad groups of genetic diseases / disorders:

- single gene (monogenic) disorders, for example haemophilia;
- chromosomal abnormalities, for example Down syndrome;
- multifactorial diseases, such as asthma.

Demographic risk factors. Demographic factors include age, sex, and population subgroups. Examples of risk associated with demographic factors include: stroke death rates increase dramatically with age, with 81% of all deaths from stroke occurring among those aged 75 and over; a woman's risk of developing breast cancer before age 75 is 1 in 11, whereas for men the chance is only 1 in 1.426; aboriginal and Torres Strait Islander people are far more likely to die from rheumatic fever and rheumatic heart disease than other Australians.

Environmental burden of disease all over the world is submitted on the picture 1.4.

Picture 1.4. Environmental burden of disease globally.

Methodology of estimation of risk of influence on health of the harmful factors includes some consecutive stages:

- hazard identification;
- exposure assessment;
- determination of dose dependence of the effect;
- calculation of specific risk.

1. Hazard identification. The action of xenobiotics is associated with adverse effects. It refers to any change on biochemical, physiological, anatomical, pathological and / or behavioral levels, which leads to the functional changes and are able to influence the activity of the whole organism, modify or distort its response.

Hazard identification involves the set of factors that may have adverse effects on human health. This stage includes the analysis of the environmental situation, accounting and registration of chemicals, used in industries and other purposes, the selective screening of the environment in order to identify those "dangers" that can occur and have not been previously considered.

The action of xenobiotics is divided into **system** and **contact**.

The **system action** is hepatotoxic, neurotoxic, fetotoxic effects, kidney damage, reproductive disorders, cancer; the **contact action** is action

through the skin.

The impacts are divided into ***acute*** (when one or more impacts are repeated in a few days), ***sub-chronic*** (is repeated within 14-90 days) and ***chronic*** (xenobiotics action is carried during the year or throughout life).

2. Exposure assessment. The accuracy of the calculations depends on two main aspects: the quality of the initial information and the accuracy of the selected model. At this stage the actual levels of exposure and absorption of toxic substances in the population of individuals are determined.

At assessment of the exposure it is necessary to determine:

- the concentration of the contaminants;
- time, frequency, duration and route of exposure;
- identification of the environment that carries pollutants and others.

Exposure – is a contact of an organism with a chemical, physical or biological agent. The exposure value is determined as the measured or calculated quantity of xenobiotic in the certain environment object being in contact with the border human organs (respiratory tract, digestive tract, skin, mucous membranes) for any established time.

Exposure can be expressed as **the amount of exposure** – is the mass of the substance, related to the unit of time (mg / day), or the absorbed dose as a number of xenobiotic per unit of body weight (mg / kg).

Absorbed dose (AD) is calculated as:

$$\mathbf{AD = XC \times A \times D \times F / M,}$$

where XC - concentration of the xenobiotic;

A - the amount of the incoming material;

D - duration of exposure;

F - frequency of exposure;

M - mass of the body.

In its simplest form, this index is calculated using the following formula:

$$\mathbf{AD = XC \times v\,(m, V) / M,}$$

where XC - concentration of the xenobiotic;

v, m, V- amount of the consumed water, foodstuff, inhaled air;

M - mass of the body.

In this case, it refers to the so-called **AADD - Average Adsorbed Daily Dose**.

Absorbed dose for children will be higher than for adults due to differences in body weight.

At *chronic exposure* uptake will be different at different stages of a person's life.

In this case it is necessary to allocate the specific time intervals, on which the whole life cycle is divided. Life expectancy is divided into five periods:

- infancy (1 year),
- children (1-6 years),
- children (7-12 years),
- adolescence (13-18 years)
- adults (19-70 years).

In this case, the **LADD - Lifetime Average Daily Dose** is calculated, which will be expressed by the following formula:

$$\mathbf{LADD = (1/70 \times AADD\ infancy) + (5/70\ AADD\ 1\text{-}6) + + (6/70 \times AADD\ 7\text{-}12) + (6/70 \times AADD\ 13\text{-}18) + (52/70 \times AADD\ 19\text{-}70)}$$

Often AADD for adults is used instead of LADD as maturity part age prevails throughout the lifespan.

Exposure route – is a way of the chemical substance from the source to the exposed organism. Evaluation of the impact of the route includes the characterization of pollution sources, emissions and discharges of chemicals, their location; probable fate of chemicals in the environment (distribution, transport, cross-media transitions); places of residence and activities of the exposed populations.

For each route of exposure *points of impact* (points of potential human contact to chemicals exposure) and *ways of exposure* (inhalation, peroral, percutaneous) are determined.

The assessment of exposure concentrations involves the determination of the concentration of chemical substances influencing human during the exposure period.

Concentration – is the content of the certain pollutant in the certain environment (for example, air) into the unit of its volume (for example, mg/m^3) in the certain period of time. All measurements of the concentrations are directly or indirectly related to the time interval.

Taking into account the given dose at the next stage of risk assessment dose-effect dependence is analyzed, which connects the dose of the toxic substance to probability of occurrence of adverse effects on human health.

3. Dose dependence.

Dose-dependent reaction of the body is determined experimentally at high exposure doses and evaluation of real level of contamination - by extrapolation. There are two models describing the dose - effect dependence:

- the threshold model for non-carcinogenic substances;
- the no-threshold model for carcinogenic substances.

The threshold model for non-carcinogenic substances presupposes the threshold below which the investigated factors do not practically affect.

The no-threshold model for carcinogenic substances evaluates cancergene effects on no-threshold principle. This means that any of even very small concentration can lead to malignant transformation of cells.

It is calculated under the formula:

$$\mathbf{CR = AADD \times PICR\ (PPCR) \times \alpha,}$$

where CR – is an additional carcinogenic risk, i.e. the risk of adverse effect occurrence, defined as the probability of occurrence of this effect under the specified conditions;

AADD - average adsorbed daily dose;

PICR (PPCR) – are values of potential inhalation or peroral carcinogenic risk, i.e. units of risks defined as the proportion factor of increase of the risk depending on the current concentration (dose) in $(mg / kg)^{-1}$ or $(g / m^3)^{-1}$, i.e. in the inverse units of exposure, respectively;

$\alpha = 1 = 70/70$ – is the value reflecting the number of years during which the individual is exposed to influence under the assumption that he has constantly lived on the studied site (70 years) divided by the total number of years of the expected average life span (70 years).

CR throughout life – is a function of three main factors:

- the average adsorbed daily dose, calculated from the concentration of xenobiotic in air, drinking water, foodstuffs;
- the probability that the certain chemical compound provokes the cancerous growth;
- duration of exposure.

4. Calculation of specific risk.

Data for risk estimation (standards) is submitted in the table 1.4.

Table 1.4. Data for risk estimation (standards).

Substance	Classification number CAS	Value of potential inhalation cancerogenic risk (PICR), $(mkg/m^3)^{-1}$	Value of potential peroral cancerogenic risk (PPCR), $(mg/kg)^{-1}$	Referent dose (RfD) of non-cancerogenic peroral risk, mg/kg	Value of potential cancerogenic risk at external irradiation, (risk/year) / (pCu/g)
Chrome	7440473	0.012		0.005	
Arsenic	7440382	0.0033	1.5	0.0003	
Chloroform	67663	0.019	0.031	0.01	
Chlorine	7782505	-		0.1	
Fluorine	7782414	-		0.06	
Copper	7440508	-		0.037	
Barium	7440393	-		0.07	
Aluminium	7429905	-		0.1	
Cadmium	7440439	0.0018		0.0005	
Strontium-90	10098972	0.0000000000594 risk/pCu	0.0000000000409 risk/pCu		
Cesium-137	10045973	0.0000000000191 risk/pCu	0.0000000000316 risk/pCu		0.00000209
Aldrin	309002	0.0049	17	0.00003	
Polichlorine Biphenile	1336363	0.00057	5	0.00002	
Thiourea	62566	0.000021	0.072		
Nickel	7440020	0.00026		0.02	
Hydrazine	302012	0.0049	3		
Formaldehyde	50000	0.000006		0.2	
Dichloro diphenyl trichloro-ethane	50293	0.000097	0.34	0.0005	
Benzene	71432	0.000029	0.1		
Alachlorine	15972608	0.000016016	0.056	0.01	
Lead	7439921	0.000012	0.0085	0.0000785	

The final stage – is a generalization of the results of the previous stages. It includes in addition to quantity risk the values of the analysis of uncertainties associated with the evaluation and the synthesis of all the information on risk assessment.

There are four main uncertainties:

- statistical sampling;
- the dose-effect model;
- initial sample free of databases;
- incomplete of the used models.

Risk assessment is one of the bases for decisions on prevention of adverse effects of environmental factors on the health of the population, but not by the decision.

Comparison of medical and environmental, social, technical and economic factors provides a basis for answering the question about the acceptability of risk and the necessity for making regulatory decisions, which restricts or prohibits the use of a technical solution, functional zoning of settlements at the development of its general plan, etc .

Chronic (non-carcinogenic) risk is expressed in the likelihood of occurrence of chronic intoxication symptoms for some period of time that is quantitatively connected to increase in general morbidity without the appearance of any specific forms of diseases. Its reasonable value is in the range of acceptable statistical error, which usually is 0.02 (or 20 additional cases per million of the population).

Carcinogenic risk shows the probability of additional cancer cases and its acceptable value is usually within 0.000001 – 0.00001 (or from 1 to 10 additional cases per 1 million of the population).

From the reverse value it is possible to calculate the amount of AADD for the xenobiotic possessing the carcinogenic activity. For this purpose, the amount of acceptable risk, for example, one case of cancer per million, is divided by the value of PPCR or PICR (table 4.1):

$$\mathbf{AADD = 1 / 10^6 \times PICR\ (PPCR)}$$

Calculation of individual risk is a special form of medical and environmental expertise, the purpose of which - is a diagnosing of cases of environmentally-related diseases. Identifying of the signs of the disease is carried out in the period of recourse of the population for health care and medical examinations. The following stages of diagnosis are distinguished:

- determination of the internal dose;
- assessment of adverse effects (diagnosis).

Determination of the internal dose of the chemical substance dependent on the specific characteristics of human contact with the environment is an important thing to assess the individual risk. The most accurate

method for calculating of the internal dose – is its *bioindication*, i.e. laboratory quantification of environmental pollutants or their metabolites in tissues and body organs. For the majority of the most common chemical contaminants bioindication is difficult.

Therefore, another method of determining the internal dose – is *calculation* way.

One of the variants of this calculation is the use of information on concentrations of chemicals in various areas of human habitation and the average residence time in these areas. For example, at questionnaire design the average time a man stays inside the house, in residential, suburban, working area and transport can be determined. Knowing the concentration of the substances, the volume of inhaled air, the spent time in different zones, the expert can calculate the resulting internal dose for the year, which is in this case called **aerogenic load**. Summing up the airborne load of the certain substances the total individual airborne load can be counted. Different substances have non-identical toxicity, in connection with that to assess the risk it is advisable to use not only airborne load in milligrams of substance but also value of potential risk.

Poor environmental quality has its greatest impact on people whose health status is already at risk. Therefore, environmental health must address the societal and environmental factors that increase the likelihood of exposure and disease.

Legal environmental protection – is a set of common legal rules which define the common requirements of environmental activities, as well as the special provisions for protection of land, water, forests, minerals and other natural resources for environmental safety.

These rules are contained in the Constitution of the Republic of Belarus, in the environmental, natural resource and economic legislation and other regulations.

The fundamental regulatory act in the sphere of nature protection is the Law of the Republic of Belarus **"About Environmental Protection"**. This Law fixed the objectives, the principles and the legal basis for environment-protection activities, the range of natural resources, facilities and complexes to be protected, the rights and duties of citizens and public associations on environmental protection, the system of ecological information and education, the state regulation and management in this sphere, the economic mechanism for protection of the environment, the state system of observation over its condition and cadaster account of natural re-

sources. It defines issues of regulatory and technical as well as scientific support of environmental protection measures.

All these provisions are fixed in ***The Concept of State Policy of the Republic of Belarus in the Sphere of Environment Protection*** of 1995.

In conformity with the principles and recommendations of the *UN Conference on Environment and Development* (Rio de Janeiro, 1992) shared and fixed by the Republic of Belarus in ***The National Strategy of Sustainable Development*** (1997), it is projected to base the environment-protection activities on the conceptual prerequisite that protection of environment and rational use of natural resources potential should be considered not as a goal in itself isolated from production but rather as an inalienable part of the process of general social and economic development and that the use of nature must be effected by such methods and on such a scale that would assure equal opportunities for conservation of a favorable environment and for using natural wealth for future generations as well.

The leading role in the system of state environment-protection regulators is played by **environmental standards**. This is first of all the permissible levels of content of harmful substances in natural environments that are reflected by maximum permissible concentrations for air and water environments and are regulated through release (discharge) limits. Quality of atmospheric air is constantly regulated for 543 pollutants, quality of water sources for 1,373 pollutants.

There are numbers of **regulations on the nature protection** in cities and other settlements, industry, energy, agriculture, and other fields of human activity in general and environmental safety.

Great attention is put to international cooperation in the sphere of environmental protection in Belarus. The Republic maintains permanent contacts with intergovernmental organizations: the UNEP (United Nations Environment Program), the World Health Organization, the UN Economic Commission for Europe on Environment and Water Resources, Executive bodies of the Convention on the Long-range Transboundary Air Pollution, the International Network for Environmental Information (INFOTERRA), etc.

The harm caused to natural resources and objects or environment, can be economic and ecological.

Economic harm is expressed in deterioration of useful properties, loss of stocks of natural resources or objects and negatively reflected in economic interests of proprietors, owners and users of natural resources or objects.

Ecological harm, in turn, consists of deterioration of natural resources

and objects or environment. It is connected with an encroachment on interests of the person in pure natural resources, objects and products, in a surrounding environment favorable for its ability to live.

Responsibility for violation of the rules of nature and environmental protection requirements, which generally can be called **environmental violations**, is possible if it is based on legal norms. It is provided by the ***administrative and criminal law***.

Environmental offense is an illegal, punishable guilt act (action or inaction) of the legal or physical person that is contrary to the requirements of natural resource or environmental law and infringes on the established order of nature and environment management.

Depending on the degree of social danger and the kind of sanctions for environmental offenses they are classified as:

- criminal offenses,
- administrative and disciplinary offenses,
- civil offenses.

There are *criminal, administrative, civil, legal, disciplinary and special responsibility* for environmental offenses.

The criminal liability is provided by **the Criminal Code of the Republic of Belarus** for especially dangerous ecological offences recognized as *crimes*. The punishments for environmental crimes: *imprisonment, correctional labor, deprivation of the right to occupy certain positions or engage in certain activities, fines, dismissal. Confiscation of the property* of the guilty person will be available as an additional punishment.

The Code of Administrative Offences of the Republic of Belarus contains the chapter 7 "Administrative offenses in the field of environmental protection, historical and cultural monuments," the articles of which provide for administrative liability for environmental offenses recognized as administrative offenses by virtue of less danger than environmental crimes. Types of **administrative penalties** for environmental offenses may include: warning, fines, compensated seizure of the object as a weapon of offense, confiscation of such object, deprivation of special rights (hunting, fishing, etc.), correctional labor, and administrative arrest.

Civil liability for environmental offenses may be *contractual*, arising from agreements and *non-contractual* related to facts of such offenses. This type of liability is applied in accordance with the provisions of **the Civil Code of the Republic of Belarus** to compensate for the economic and environmental damage to natural resources and facilities or the environment.

The disciplinary responsibility is provided by **the Labour Code of the**

Republic of Belarus, statutes of some transport kinds, other special acts can be used for environmental disciplinary offenses committed by employees of enterprises, organizations and other legal entities in the implementation of these workers of their duties related to the organization and implementation of natural resources or the environment. As disciplinary responsibility measures, *remark, reprimand, dismissal* are provided.

Question for self-control

1. An organism and environment, their interrelations.
2. Ecosystem, biogeocenosis, biosphere concept.
3. Environmental factors, the laws of their influence on an organism.
4. Environmental medicine as a science, its differentiation, purpose, tasks, methods, studying subject, connection with other sciences.
5. The brief outline of history of environmental medicine development.
6. The characteristic of environmental diseases.

Chapter 2.

MEDICAL VALUE OF HUMAN ENVIRONMENT

The Earth, its structure

The Earth consists of three main layers:

- ***the core***, or the inner layer, which is divided into the ***outer core, and inner core***;
- ***the mantle***, in the middle, which is divided into the ***upper mantle, lower mantle***;
- ***the crust***, which includes the continents and ocean floor.

The geologic component layers of Earth are at the following depths below the surface (table 2.1).

Table 2.1. The basic natural and man-caused environmental pathology.

Depth		**Layer**
Kilometres	Miles	
0–60	0–37	Lithosphere (locally varies between 5 and 200 km)
0–35	0–22	Crust (locally varies between 5 and 70 km)
35–60	22–37	Uppermost part of mantle
35–2.890	22–1.790	Mantle
210-270	130-168	Upper mesosphere (upper mantle)
660–2.890	410–1.790	Lower mesosphere (lower mantle)
2.890–5.150	1.790–3.160	Outer core
5.150–6.360	3.160–3.954	Inner core

The **biosphere** is the global sum of all ecosystems. It can also be called the zone of life on Earth, a closed (apart from solar and cosmic radiation and heat from the interior of the Earth), and self-regulating system.

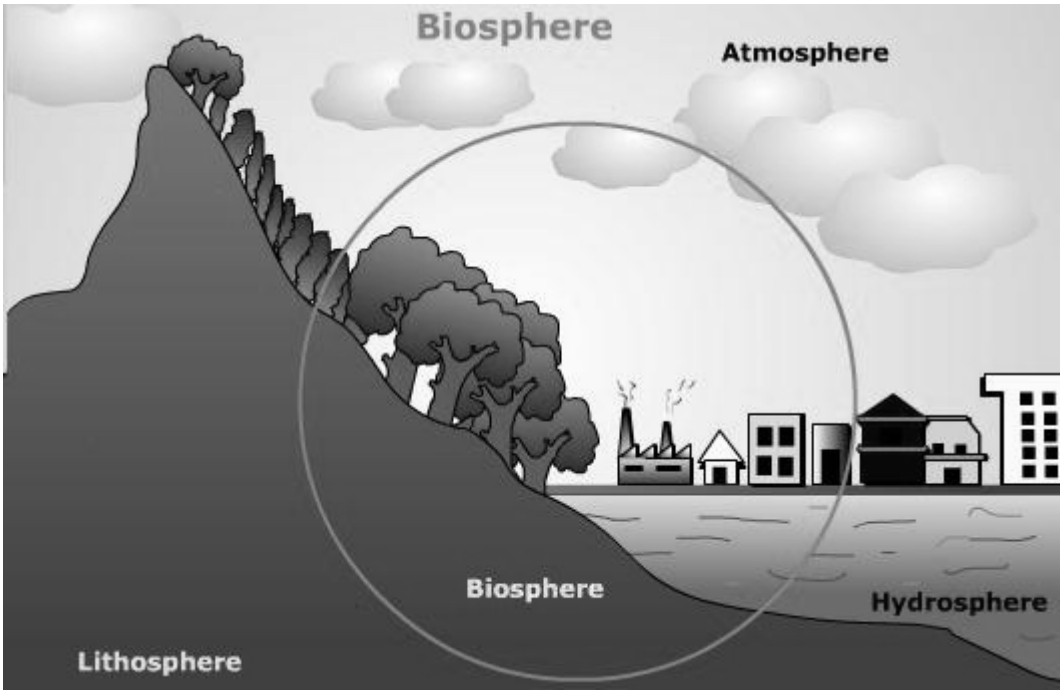
From the broadest biophysiological point of view, the biosphere is the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere, hydrosphere, and atmosphere.

The term "biosphere" was coined by geologist Eduard Suess in 1875, which he defined as: "The place on Earth's surface where life dwells."

Some life scientists and Earth scientists use biosphere in a more limited sense. For example, geochemists define the biosphere as being the total sum of living organisms (the "biomass" or "biota" as referred to by biologists and ecologists). In this sense, the biosphere is but one of four separate components of the geochemical model, the other three being lithosphere, hydrosphere, and atmosphere. The narrow meaning used by geochemists is one of the consequences of specialization in modern science. Some might prefer the word ecosphere, coined in the 1960s, as all encompassing of both biological and physical components of the planet.

Biosphere is the part of the Earth’s covering where life is possible. It extends from the floor of the oceans to the summit of the highest mountains

Earth is the only planet on which life exists. It consists of three components Lithosphere (Land), Hydrosphere (Water) and Atmosphere (Air) (picture 2.1). Life originated and evolved because of this unique combination of the three components and was ideal and favourable for life. The life supporting zone of the earth where atmosphere, hydrosphere and lithosphere meet, interact and make life possible, is known as biosphere.



Picture 2.1. Biosphere Structure**.**

The lithosphere, hydrosphere and atmosphere are non-living components of the environment and are known as abiotic. The biotic or living components include plants, animals and microbes living on the earth. A constant interaction between the abiotic and biotic components of the biosphere results in the transfer of food and energy, which makes it a dynamic but stable system. The biosphere is the biggest biological system. It consists of smaller functional units known as ecosystems or ecological systems.

Biosphere boundary in lithosphere is up to 5 km, in hydrosphere - up to 11 km, in atmosphere - up to 20-40 km. The greatest life concentration is marked in a top part of hydrosphere and in border of lithosphere surface layer with ground layer of atmosphere.

An **atmosphere** ([atmos] "vapor" and "sphere") is a layer of gases surrounding a material body of sufficient mass that is held in place by the gravity of the body. An atmosphere is more likely to be retained if the gravity is high and the atmosphere's temperature is low.

Earth's atmosphere, which contains oxygen used by most organisms for respiration and carbon dioxide used by plants, algae and cyanobacteria for photosynthesis, also protects living organisms from genetic damage by solar ultraviolet radiation. Its current composition is the product of billions of years of biochemical modification of the paleoatmosphere by living organisms.

The Earth's atmosphere consists, from the ground up, of the:

- troposphere 8-18 km (which includes the planetary boundary layer or peplosphere as lowest layer);

- stratosphere 20-55 km, at height of 20-55 km there is *ozone screen* (which includes the ozone layer);

- mesosphere 55-80 km;

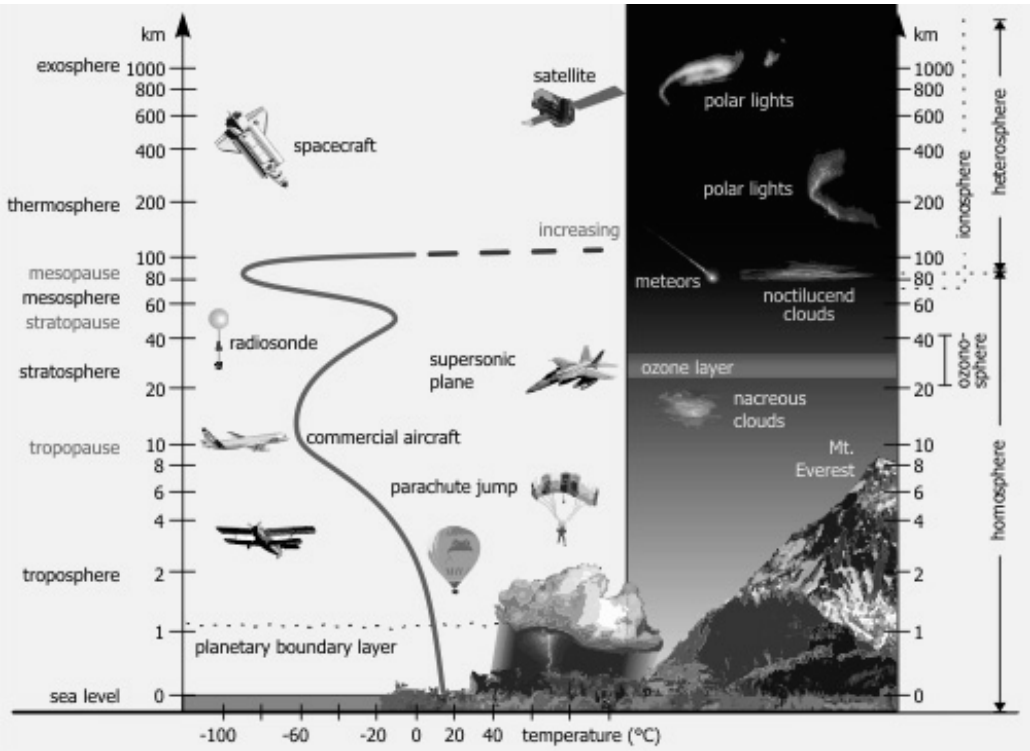
- thermosphere 80-1000 km, from 600 km there is the *helium crown* (which contains the ionosphere);

- exosphere 1000-2000 km, at height of 1000-2000 km there is the *hydrogen crown*;

- magnetosphere (picture 2.2).

Each of the layers has a different lapse rate, defining the rate of change in temperature with height.

Most of the atmosphere is held close to the earth by the pull of gravity, so the atmosphere gets thinner with increasing distance from the earth.



Picture 2.2. Earth's Atmosphere Structure**.**

Even though gravity keeps the air near the earth, the air is not static. As it absorbs heat from the earth, it expands and rises. When its heat content is radiated into space, the air cools, becomes denser, and flows toward the earth. As the air circulates due to heating and cooling, it also moves horizontally over the surface of the earth because the earth rotates on its axis. The combination of all air movements creates the specific wind patterns characteristic of different regions of the world. Wind is the movement of air caused by temperature differences and the rotation of the earth. Both of these contribute to the patterns of world air movement. In Belarus, most of the winds are westerlies (from the west to the east).

Three quarters of the atmospheric mass resides within the troposphere, and the depth of this layer varies between 17 km at the equator and 7 km at the poles. The ozone layer, which absorbs ultraviolet energy from the Sun, is located primarily in the stratosphere, at altitudes of 15 to 35 km.

The conditional border of atmosphere reaches height of 2000 km.

The mixture of gases, consisting of nitrogen, oxygen, carbon dioxide, helium, methane, hydrogen, ozone, ammonia and some other gases, filling the atmosphere, is called as **atmospheric air**. Atmospheric air is commonly called as **tropospheric air**, which is directly in contact with a person.

Hydrosphere (ὕδωρ - hudōr, "water" and σφαῖρα - sphaira, "sphere") in physical geography describes the combined mass of water found on, under, and over the surface of a planet.

The hydrosphere is a combination of all kinds of free water on the Earth - free in the sense that it is not chemically and/or physically confined with minerals, i.e. this water can move under the influence of the gravity forces and heat (energy). Water motion also means a transition of water from a certain aggregate phase to another. The hydrosphere forms an interrupted watery envelope of the Earth, because it involves not only the World Ocean, but discrete water bodies (rivers, lakes, swamps, etc.). The hydrosphere occupies the major portion of the Earth's surface, more than 380 mln sq.km or more than 75% of the total area of the planet. If the water of the hydrosphere was evenly distributed all over the Earth's surface, it would cover the planet with a water layer of 3000 m deep. Oceans and seas are the prevailing components of the hydrosphere on the Earth; their total area is 361 mln sq.km. Glaciers occupy about 16 mln sq.km (almost 11% of the land area). Much smaller land areas are occupied by lakes, reservoirs and rivers (about 2.3 mln sq.km) and by swamps and wetlands (about 3 mln sq.km). Water storage in different components of the hydrosphere is summarized in table 2.2.

Table 2.2. Volume of water in the components of the hydrosphere.

Components of the hydrosphere	**Water volume, 10^3 km^3**	**% of the volume**
world ocean	1.370.000	93.7
subsurface water (1)	60.000	4.10
zone of intensive water exchange (included in 1)	4.000	0.27
snow and ice storage	30.000	2.05
minor components:		
lakes	280	0.02
soil moisture	85	0.006
swamps	11	0.001
atmospheric moisture	14	0.001
rivers	2	0.0001
total	1.460.392	100

The **lithosphere** is the solid, outer part of the Earth.

There are two types of lithosphere:

- oceanic lithosphere, which is associated with oceanic crust and exists in the ocean basins (with mean density of about 2,9 grams per cubic centimeter);
- continental lithosphere, which is associated with continental crust (mean density of about 2.7 grams per cubic centimeter).

Continental Earth's crust has three layers: sedimentary, granite and basalt covering about 80 km thick. In the oceanic Earth's crust granite layer is absent, its thickness is 5 - 10 km.

The lithosphere is always moving, but very slowly. It is broken into huge sections called tectonic plates. The extreme heat from the mantle part of the lithosphere makes it easier for the plates to move; this is similar to how iron is bendable once it's heated. The movement of the lithosphere, called plate tectonics, is the reason behind a lot of Earth most dramatic geologic events. When one plate moves beneath another, or when two plates rub against each other, they can create earthquakes and volcanoes.

Soil and land are often thought of as being the same. However, **land** is the part of the world not covered by the oceans, while **soil** is an organized mixture of minerals, organic materials, living organisms, air, and water that together support the growth of plant life. Soil is a thin covering over the land.

Soil is a natural body consisting of layers (soil horizons) that are primarily composed of minerals, mixed with at least some organic matter, which differ from their parent materials in their texture, structure, consistency, color, chemical, biological and other characteristics. It is the loose covering of fine rock particles which cover the surface of the earth.

Soil is composed of particles of broken rocks (parent materials) which have been altered by *physical, chemical and biological* processes that include weathering with associated erosion. Soil is created from the alteration of parent material by the interactions between the lithosphere, hydrosphere, atmosphere, and biosphere.

Soil forms a structure filled with pore spaces and can be thought of as a mixture of solids (mineral and organic), water, and gases. Accordingly, soil is often treated as a three-state system (solid, liquid, gaseous). Most soils have a density between 1 and 2 g/cm^3.

Soil **structure** often give clue to its texture, organic matter content, biological activity, past soil evolution, human use, and the chemical and mineralogical conditions under which the soil is formed. While texture is defined by the mineral component of a soil and is an innate property of the

soil that does not change with agricultural activities, soil structure can be improved or destroyed by the choice and timing of farming practices.

The horizontal layer of the soil, whose physical features, composition and age are distinct from those above and beneath, is referred to as the **soil horizon**. The naming of a horizon is based on the type of material of which it is composed.

The exposure of parent material to favorable conditions produces mineral soils that are marginally suitable for plant growth. That growth often results in the accumulation of organic residues. The accumulated organic layer called the O horizon produces a more active soil due to the effect of the organisms that live within it. Organisms colonize and break down organic materials, making available nutrients upon which other plants and animals can live. After sufficient time, humus moves downward and is deposited in a distinctive organic surface layer called the A horizon.

Soil generally consists of visually and texturally distinct **layers**, which can be summarized as follows from top to bottom.

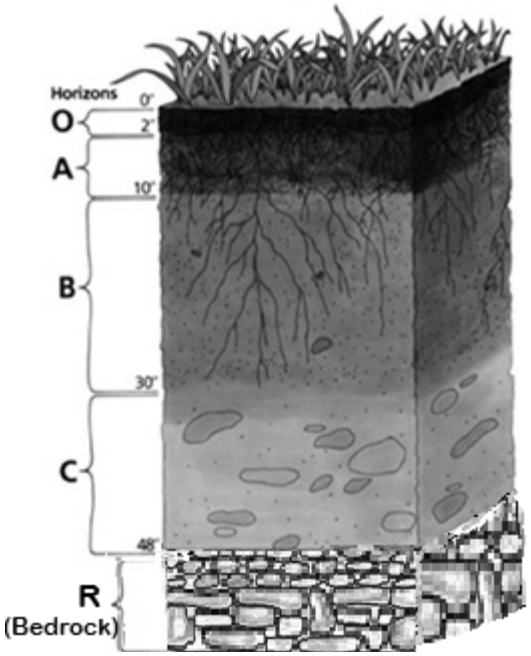
O) Organic matter: Litter layer of plant residues in relatively undecomposed form.

A) Surface soil: Layer of mineral soil with most organic matter accumulation and soil life. This layer eluviates (is depleted of) iron, clay, aluminum, organic compounds, and other soluble constituents. When eluviation is pronounced, a lighter colored "E" subsurface soil horizon is apparent at the base of the "A" horizon. A-horizons may also be the result of the combination of soil bioturbation and surface processes that winnow fine particles from biologically mounded topsoil. In this case, the A-horizon is regarded as a "biomantle".

B) Subsoil: This layer accumulates iron, clay, aluminum and organic compounds, a process referred to as illuviation.

C) Parent rock: Layer of large unbroken rocks. This layer may accumulate the more soluble compounds .

R) bedrock: R horizons denote the layer of partially weathered bedrock at the base of the soil profile. Unlike the above layers, R horizons largely comprise of continuous masses (as opposed to boulders) of hard rock that cannot be excavated by hand. Soils formed on place will exhibit strong similarities to this bedrock layer (picture 2.3).



Picture 2.3. Soil Horizon.

A small part of the organic matter is made up of the living cells such as bacteria, moulds, and actinomycetes that work to break down the organic matter. Without the action of these micro-organisms, the entire carbon dioxide part of the atmosphere would be sequestered as organic matter in the soil.

Humus refers to organic matter that has been decomposed by soil flora and fauna to the point where it is resistant to further breakdown. Humus usually constitutes only five percent of the soil or less by volume, but it is an essential source of nutrients and adds important textural qualities crucial to soil health and plant growth. Humus also holds particles of undecomposed organic matter which arthropods and worms feed on and further improve the soil. The end product, humus, is soluble in water and forms a weak acid that can attack silicate minerals. Humus has a high cation exchange capacity that on a dry weight basis is many times greater than that of clay colloids. It also acts as a buffer, like clay, against changes in pH and soil moisture.

Soil resources are the set of soil used by humans for their own purposes. The entire land area is 14.800 million hectares, 28 % of area is forests, 17% - meadows and pastures, 11% - cultivated land (arable land) and 45 % - the territory without soil or soil out of use. The treated soil is 0.5 hectares per 1 person in the world. During human existence, mankind has lost half of all the lands suitable for agriculture. Every year in the world

due to soil degradation and alienation for non-agricultural needs about 7 million hectares of arable soil is lost, that is an area that could feed 21 million people.

Land resources of the world are agricultural lands and other lands (or otherwise plots of land), which are or may be used in this level of development of the productive forces of society in many fields of human activity (agriculture, forestry , water management , building of settlements , roads, and etc.).

Soil formation, or pedogenesis, is the combined effect of physical, chemical, biological and anthropogenic processes on soil parent material. Soil is said to be formed when organic matter has accumulated and colloids are washed downward, leaving deposits of clay, humus, iron oxide, carbonate, and gypsum. These constituents are moved from one level to another by water and animal activity. As a result, layers (horizons) form in the soil profile. The alteration and movement of materials within the soil causes the formation of distinctive soil horizons.

Soil formation factors are: **parent material, climate, topography (relief), organisms, and time**. An example of the development of a soil would begin with the weathering of lava flow bedrock, which would produce the purely mineral-based parent material from which the soil texture forms. Soil development would proceed rapidly from bare rock of recent flows in a warm climate, under heavy and frequent rainfall. Under such conditions, plants become established very quickly on basaltic lava, even though there is very little organic material. The plants are supported by the porous rock as it is filled with nutrient-bearing water that carries dissolved minerals from the rocks and guano. Crevasses and pockets, local topography of the rocks, would hold fine materials and harbour plant roots. The developing plant roots are associated with mycorrhizal fungi that assist in breaking up the porous lava, and by these means organic matter and finer mineral soil accumulate with time.

The mineral material from which a soil forms is called **parent material**. Rock, whether its origin is igneous, sedimentary, or metamorphic, is the source of all soil mineral materials and the origin of all plant nutrients with the exceptions of nitrogen, hydrogen and carbon. As the parent material is chemically and physically weathered, transported, deposited and precipitated, it is transformed into soil.

Climate is the dominant factor in soil formation, and soils show the distinctive characteristics of the climate zones in which they form. Mineral

precipitation and temperature are the primary climatic influences on soil formation.

The direct influences of climate include:

- a shallow accumulation of lime in low rainfall areas as caliche;
- formation of acid soils in humid areas;
- erosion of soils on steep hillsides;
- deposition of eroded materials downstream;
- very intense chemical weathering, leaching, and erosion in warm and humid regions where soil does not freeze.

Climate *directly* affects the rate of weathering and leaching. Soil is said to be formed when detectable layers of clays, organic colloids, carbonates, or soluble salts have been moved downward. Wind moves sand and smaller particles, especially in arid regions where there is little plant cover. The type and amount of precipitation influence soil formation by affecting the movement of ions and particles through the soil, and aid in the development of different soil profiles. Soil profiles are more distinct in wet and cool climates, where organic materials may accumulate, than in wet and warm climates, where organic materials are rapidly consumed. The effectiveness of water in weathering parent rock material depends on seasonal and daily temperature fluctuations. Cycles of freezing and thawing constitute an effective mechanism which breaks up rocks and other consolidated materials.

Climate also *indirectly* influences soil formation through the effects of vegetation cover and biological activity, which modify the rates of chemical reactions in the soil.

The **topography**, or relief, characterized by the inclination of the surface, determines the rate of precipitation runoff and rate of formation or erosion of the surface soil profiles. Steep slopes allow rapid runoff and erosion of the top soil profiles and little mineral deposition in lower profiles. Depressions allow the accumulation of water, minerals and organic matter and in the extreme, the resulting soils will be saline marshes or peat bogs. Intermediate topography affords the best conditions for the formation of an agriculturally productive soil.

Soil is the most abundant ecosystem on Earth, but the vast majority of **organisms** in soil are microbes, a great number of which have not been described. There may be a population limit of around one billion cells per gram of soil, but estimates of the number of species vary widely. One estimate put the number at over a million species per gram of soil, although a later study suggests a maximum of just over 50.000 species per gram of

soil. The total number of organisms and species can vary widely according to soil type, location, and depth.

Plants, animals, fungi, bacteria and humans affect soil formation. Animals, soil mesofauna and micro-organisms mix soils as they form burrows and pores, allowing moisture and gases to move about. In the same way, plant roots open channels in soils. Plants with deep taproots can penetrate many meters through the different soil layers to bring up nutrients from deep part in the profile. Plants with fibrous roots that spread out near the soil surface have roots that are easily decomposed, adding organic matter. Micro-organisms, including fungi and bacteria, affect chemical exchanges between roots and soil and act as a reserve of nutrients. Humans impact soil formation by removing vegetation cover with erosion as the result. Their tillage also mixes the different soil layers, restarting the soil formation process as less weathered material is mixed with the more developed upper layers.

Vegetation impacts soils in numerous ways. It can prevent erosion caused by excessive rain that results in surface runoff. Plants shade soils, keeping them cooler and slowing evaporation of soil moisture, or conversely, by way of transpiration, plants can cause soils to lose moisture. Plants can form new chemicals that can break down minerals and improve soil structure. The type and amount of vegetation depends on climate, topography, soil characteristics, and biological factors. Soil factors such as density, depth, chemistry, pH, temperature and moisture greatly affect the type of plants that can grow in a given location. Dead plants and fallen leaves and stems begin their decomposition on the surface. There, organisms feed on them and mix the organic material with the upper soil layers; these added organic compounds become part of the soil formation process.

Time is a factor in the interactions of all the above. Over time, soils evolve features that are dependent on the interplay of other soil forming factors. Soil is always changing. It takes about 800 to 1000 years for a 2.5 cm (1 inch) thick layer of fertile soil to be formed in nature. For example, recently deposited material from a flood exhibits no soil development because there has not been enough time for the material to form a structure that further defines soil. The original soil surface is buried, and the formation process must begin anew for this deposit. Over a period of between hundreds and thousands of years, the soil will develop a profile that depends on the intensities of biota and climate. While soil can achieve relative stability of its properties for extended periods, the soil life cycle ultimately ends in soil conditions that leave it vulnerable to erosion. Despite

the inevitability of soil retrogression and degradation, most soil cycles are long.

Soil-forming factors continue to affect soils during their existence, even on “stable” landscapes that are long-enduring, some for millions of years. Materials are deposited on top or are blown or washed from the surface. With additions, removals and alterations, soils are always subject to new conditions. Whether these are slow or rapid changes depend on climate, topography and biological activity.

Under ideal climatic conditions, soft parent material may develop into a centimeter of soil within fifteen years. Under poor climatic conditions, a hard parent material may require hundreds of years to develop into an equivalent amount of soil. In any case, soil formation is a slow process.

The value of air, water and soil in nature and human life

Tropospheric air plays an important role in nature and human life.

The meaning of atmospheric or tropospheric air**:**

- environment-formational (inhabitation of birds, insects, bacteria, elementary, mushrooms);
- protective (from space, solar beams, meteorites);
- climate- and weather- formational;
- participation in the circulation of substances;
- sound passing;
- participation in geological, power processes of the Earth;
- a source of oxygen for organisms;
- removal of exchange products;
- maintenance of heat exchange;
- source of raw material;
- tank of pollution;
- source of pollution of water and ground,
- transport way;
- air environment of residential and industrial premises.

Atmospheric air is involved in the heat exchange process, removing the products of dissimilation. It can be used as a means of tempering. Many components of the air are used to treat variety of diseases. In particular, infrared and ultraviolet rays are used to treat inflammation, low temperatures - in surgery, hyperbaric oxygen therapy - in the treatment of

internal and nervous diseases, air ion therapy - in the treatment of hypertension, asthma, anemia.

Sudden changes in the properties and composition of the air beyond the adaptive capacities of man are ***risk factors*** and adversely affect the essential functions of the body, leading to various diseases.

Physical, chemical and biological factors of air, both in together or individually, possess physiological and pathological effects on the human body. Individual factors have isolated action on the human. *Joint influence* of environmental factors (constellation) has combined, complex or conjoined impact.

Combined influence is simultaneous or sequential effect on the body of several factors of one nature at the same route of exposure.

Complex influence is simultaneous or sequential effect of exposure of the body of the same factor in different ways.

Conjoined influence is simultaneous or sequential impact on the human of factors of various nature.

Abiotic components (also called abiotic factors) are non-living chemical and physical factors in the environment, which affect ecosystems. Abiotic phenomena underlie all of biology.

Abiotic factors can include solar radiation, light, radiation, temperature, humidity, air movement, atmospheric pressure, electric field, geomagnetic field (**physical** factors), atmospheric gases (**chemical** factors). All of these factors affect different organisms to different extents.

Biotic components (**biological** factors) are the living things that shape an ecosystem. A biotic factor is any living component that affects another organism, including animals that consume the organism in question, and the living food that the organism consumes. Each biotic factor needs energy to do work and food for proper growth. Biotic factors include human influence.

Water is a basic necessity of life. Unlike mineral resources, water is a renewable natural resource. Being in a natural cycle, the water falls to earth as rain, solid precipitation, with river flows back into the sea, then from the surface of smooth sea surface evaporates into the atmosphere and re-transformed into the clouds, only to again fall to the ground of life-giving moisture.

Water ensures the existence of living organisms on Earth, and the course of their life processes. It is part of the cells and tissues of any animal and plant. On average, water is about 90% of the mass of all plants and 75% of the mass of animals. Climate and weather on Earth is largely de-

pendent on and determined by the presence of water space and water vapor content in the atmosphere.

In human water is widely used. Water is used in industry, serves as coolants used in the construction and. Agricultural activities associated with the consumption of vast quantity of water. Rivers, canals, lakes - important means of communication.

The daily balance of water in a human organism is 2.5 dm^3. The quantity of consumed water is subjected to considerable fluctuations depending on climatic conditions, microclimate and intensity of performed work. Loss of water in number of 10 % from weight of a body leads to metabolism infringement, 15 - 20 % is deadly at air temperature 30°C, and 25 % is absolutely deadly.

However, water can have ***negative value***, being by transfer of activators of infectious diseases, a risk factor at insufficient or superfluous salt structure, the reason of occurrence of some diseases of not infectious origin because of possible presence of pollutants. Contact of the person to hydrospheric components occurs by three ways.

1. Through the top respiratory ways. Toxic components of air influence through soaking surface of alveolus of lungs and through the big circle of blood circulation get to the internal environment of an organism, passing the liver.

2. Through a gastrointestinal tract. The considerable part of water is soaked up in duodenum, small intestine and stomach. At an adverse condition of sources of water supply there is defeat of gastrointestinal tract, development of gastroenteritis.

3. Through a skin. At bathing it is possible contact to the elementary, bacteria, helminthes and the subsequent human infection.

Natural waters as a result of physical, chemical and biological processes possess the high **self-cleaning ability**. Self-cleaning of natural waters is carried out as a result of the circulation of substances including processes of formation of organic substances, their transformation and destruction.

From ***chemical factors*** of self-cleaning it is necessary to note oxidation of organic and inorganic substances. Self-cleaning of the polluted water is accompanied by improvement of organoleptic properties and clearing of pathogenic microorganisms.

Speed of self-cleaning depends on degree of pollution of water, a season of year. At small pollution water basically self-cleans for 3 - 4 days. Pollution by chemical substances (nitrogen, phosphorus), aromatic hydro-

carbons and mineral oil renders negative influence on self-cleaning process. Self-cleaning of water from oil is stretched for a long time (months, and on the rivers with a small current even for years).

Water is characterized by abiotic and biotic factors.

Abiotic factors of water sphere are:

- **high density** and **viscosity** (pressure grows on 1 atm by everyone 10 m);
- horizontal and vertical **mobility**;
- stable **temperature mode** (the lowest temperature is $+2^0$ C, the highest one is $+36^0$ C);
- **transparency** and **light mode** dependent from depth, season, quantities of the weighed particles;
- **salt mode** (in fresh reservoirs up to 0,5 g/dm^3 - hypotonic environment, in sea - up to 35 g/dm^3 - izo and hypertonic medium);
- **oxygen mode** (in the sated with oxygen water there is less oxygen than in atmospheric air in 21 times);
- **carbon dioxide mode** (in water there is more CO_2 than in an atmosphere in 7000 times);
- **pH of water** (fresh waters with pH 3.7 - 4.7 are acid, 6.95-7.8 - neutral, pH › 7.8 - alkaline);
- **chemical compound of water**.

Biotic factors of water sphere are:

- living organisms.

For needs humans uses basically only fresh pure water from **underground and superficial water sources**.

Land waters are ***continental waters***:

1. **underground**, being in the top part of earth crust (to depth 12 - 16 km);

2. **superficial** - waters of the rivers, lakes, swamps, glaciers.

Superficial waters are divided into 2 types: natural (rivers, lakes, swamps, glaciers) and artificial (ponds, canals).

The waters lying in thicknesses of rocks of earth crust are known ***as underground***. Possibility of finding of waters in earth crust is caused by porosity of rocks.

Coarse-grained or rock-face (pebble stone, gravel, sand) breeds are **water-permeable** (easily pass water). Fine-grained breeds pass it slowly or is not permeable and they are **waterproof** (clay, crystal breeds ((granites, basalts)) if they are not broken by cracks).

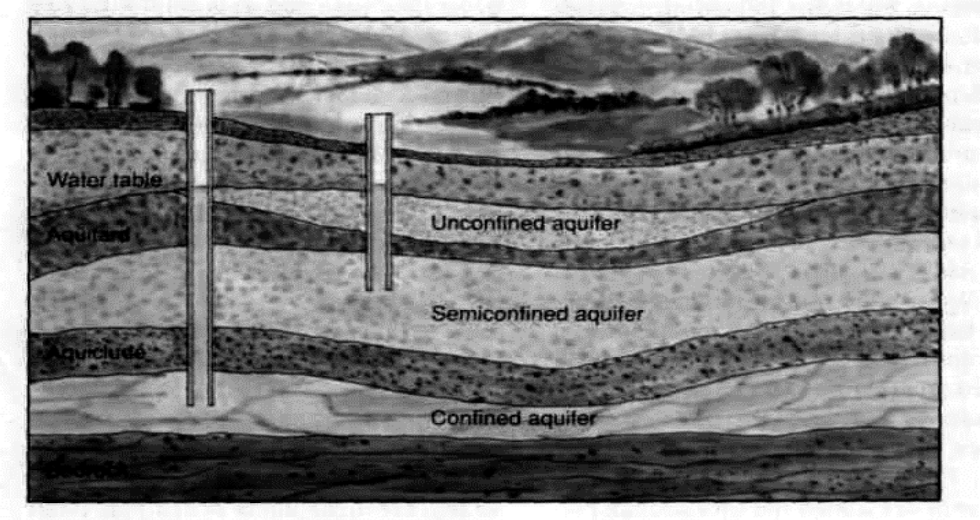
Underground waters are formed as a result of infiltration and a congestion of an atmospheric precipitation on different depth from a terrestrial surface. ***Soil waters*** are closest to soil surface, i.e. the waters taking part in formation of soils and used by roots of plants. More deeply over the first waterproof horizon the ***subsoil waters*** which do not have roofs from water-proof breeds lay (unconfined groundwater).

Below the first waterproof horizon, between water-proof layers, the waters named ***middle water*** lie down.

Water that enters the soil and is picked up by plant roots moves slowly downward until it reaches an impervious layer of rock. This water accumulates in porous strata called an **aquifer**. There are two basic kinds of aquifers: **unconfined and confined**. An unconfined aquifer usually occurs near the land surface and may be called a water-table aquifer because the upper surface of its water is the **water table**. The lower boundary is an impermeable layer of clay or rock. **Unconfined** aquifers are replenished (recharged) primarily by rain that falls on the ground directly above the aquifer and percolates down to the water table. The water in such aquifers is at atmospheric pressure and flows in the direction of the water table slope.

A **confined** aquifer, also known as an **artesian aquifer**, is bounded on the top and bottom by confining layers and is saturated with water under greater atmospheric pressure. The artesian aquifer is primarily replenished by rain and surface water from a recharge zone that may be many kilometers from where the aquifer is tapped for use. If water cannot pass through the confining layer (impermeable) of an artesian aquifer, the layer is called an **aquiclude**. If water can pass in and out of the confining layer (permeable), the layer is called an **aquitard**. The vadose zone (also known as the unsaturated zone or zone of aeration) is an unsaturated area below the ground surface (picture 2.4).

Aquifers are extremely important in supplying water for industrial, agricultural, and municipal uses. Most of the larger urban areas in the western part of the United States depend on underground water for their water supply. This groundwater supply exists as long as it is not used faster than it can be replaced. Determining how much water can be used and what the uses should be is often a problem.



Picture 2.4. Types of Aquifers.

Water supply system – is an infrastructure for the collection, transmission, treatment, storage, and distribution of water for homes, commercial establishments, industry, and irrigation, as well as for such public needs as firefighting and street flushing. Of all municipal services, provision of potable water is perhaps the most vital. People depend on water for drinking, cooking, washing, carrying away wastes, and other domestic needs. Water supply systems must also meet requirements for public, commercial, and industrial activities. In all cases, the water must fulfill both quality and quantity requirements.

There are two systems of water supply of the occupied places:

- centralized (water pipe);
- decentralized, or local.

At **centralized** system of water supply water delivery to the consumer occurs in pipes from underground and superficial water sources, at **local** by means of various containers such as buckets, tankers from wells, springs.

Advantages of the centralized water supply are conclusive, as this system allows by means of a number of constructions and a network of pipelines water from a waterworks to deliver direct to a consumption place. For the water pipe device use the rivers, and then water basins and lakes more often. The water pipe consists of head constructions (water intaking and treatment facilities, pump stations, the tank of pure water) and a water supply system.

Water pipe building begins with a choice of a place for a water fence. This place should provide enough of water irrespective of changes in a

mode of a reservoir and to be free from dangerous pollution in the sanitary relation. The place of a fence of water gets out above on a watercourse from the settlement which is in this case by a source of pollution of water. Thus arriving pollution from territory of settlement will be carried away by a watercourse downwards and will not get to water intaking constructions.

At the decentralized system of water supply reception of water and its transportation are fraught with danger of pollution.

Quality of *tap water* is estimated on microbiological and parasitological indicators, content of harmful chemical substances, organoleptic properties and radio-activity. Sanitary Ruls and Norms 10-124 RB 99 «Potable water. Hygienic requirements to quality of water of the centralized systems of drinking water supply. Quality assurance» (table 2.3).

Table 2.3. Parameters of quality of tap water.

Parameters	Value
dry rest	1000 mg/dm^3
chlorides	350 mg/dm^3
sulphates	500 mg/dm^3
the general rigidity	7 mg-ekv/dm^3
pH	6-9
iron	0.3 mg/dm^3
manganese	0.1 mg/dm^3
fluorine	1.5 mg/dm^3
permanganate oxidability	5 mg/dm^3
chromaticity	not more than 20^0
turbidity	not more than 1.5 mg/dm^3
smell	2 marks
general α-radio-activity	0.1 Bq/dm^3
general β-radio-activity	1 Bq/dm^3

Controllable parameters of water of underground water source are:

- organoleptic (smell, taste, turbidity, chromaticity, temperature);
- chemical (pH, weighed substances, chlorides, sulphates, iron, fluorine, etc.);
- biological (microbial count, coli-index).

Controllable parameters of water of superficial water source are:

- organoleptic (smell, taste, turbidity, chromaticity, temperature);
- chemical (pH, weighed substances, chlorides, sulphates, iron, fluorine, etc.);
- sanitary (BCO, CCO, ammonia, nitrates, nitrites);

- biological (microbial count, coli-index).

The water of used water sources should meet the requirements of state standard 2671-84 "Sources of the centralized economy-drinking water supply. The hygienic, technical requirements and rules of a choice" (table 2.4).

Table 2.4. Parameters of quality of water sources of centralized economic–drinking water supply.

Parameters	**1 class**	**2 class**	**3 class**
Underground water sources			
chromaticity	20º	20º	50º
turbidity	1.5 mg/dm^3	1.5 mg/dm^3	10 mg/dm^3
coli-index	3	3	3
iron	0.3 mg/dm^3	10 mg/dm^3	20 mg/dm^3
manganese	0.1 mg/dm^3	1 mg/dm^3	2 mg/dm^3
fluorine	1.5 mg/dm^3	1.2 mg/dm^3	5 mg/dm^3
oxidability	2 mg/dm^3	5 mg/dm^3	15 mg/dm^3
number of lactose positive intestinal sticks	3 in 1 dm^3	100 in 1 dm^3	1000 in 1 dm^3
Superficial water sources			
chromaticity	35º	120º	200º
turbidity	20 mg/dm^3	1500 mg/dm^3	10000 mg/dm^3
coli-index	3	3	3
iron	1 mg/dm^3	3 mg/dm^3	5 mg/dm^3
manganese	0.1 mg/dm^3	1 mg/dm^3	2 mg/dm^3
fluorine	1.5 mg/dm^3	1.2 mg/dm^3	5 mg/dm^3
oxidability	7 mg/dm^3	15 mg/dm^3	20 mg/dm^3
number of lactose positive intestinal sticks	1000 in 1 dm^3	10000 in 1 dm^3	50000 in 1 dm^3

Water of sources of all three classes should not contain causative agents of the intestinal infections, and toxic chemical substances and radionuclides in concentration exceeding the special standards.

Soil is an environmental factor which the person is directly connected during all life. Man constantly is exposed to the influence the factors connected with soil, consequently influencing their health and life conditions.

Soil structure defines district vegetation, a chemical compound of foodstuff. Quantitative fluctuations of those or other chemical elements in soil lead to a lack or surplus of foodstuff, water that influences population health. So, for example, it is known, that lack of iodine in the soil in some

districts causes its low maintenance in plants and underground waters and in a population diet that promotes occurrence of endemic goiter.

Heating of the soil by the sun influences thermal properties of ground layer of atmosphere. Physical and chemical properties of soil define depth of arrangement and structure of underground waters. High standing of subsoil waters influences humidity of air and microclimate, as it promotes bogging, makes climate unhealthy, crude. It, in turn, causes dampness of buildings. Therefore the relief of soil and level of standing of subsoil waters consider at a choice of the ground areas for building.

Today ***geomedicine*** is intensively developed, the branch of medicine that studies the spread of diseases, especially their origin, clinical course and outcome in a variety of geographical conditions.

Soil is characterized by abiotic and biotic factors. The physical and chemical properties are abiotic, and biological - biotic factors.

The physical properties of soils are texture, porosity, air permeability, absorption capacity, moisture content, heat capacity, water permeability.

The chemical properties of soil are content of chemical elements, organic and inorganic compounds.

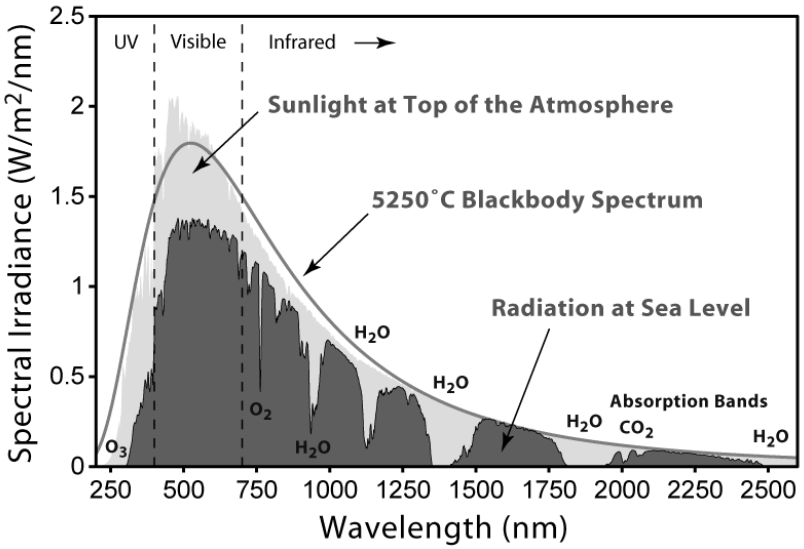
The biological properties of soil are living organisms (edafobionts).

Medical value of physical factors of atmospheric air, water and soil

Solar radiation is an integrated stream of electromagnetic fluctuations of various wave length. The spectrum of the Sun's solar radiation is close to that of a black body with a temperature of about 5,800 K. The Sun emits electromagnetic radiation across most of the electromagnetic spectrum. Although the Sun produces gamma rays as a result of the nuclear fusion process, these super high energy photons are converted to lower energy photons before they reach the Sun's surface and are emitted out into space. As a result, the Sun does not emit gamma rays. The Sun does, however, emit X-rays, ultraviolet, visible light, infrared, and even radio waves (picture 2.5).

Although the solar corona is a source of extreme ultraviolet and X-ray radiation, these rays make up only a very small amount of the power output of the Sun (see spectrum at right). The spectrum of nearly all solar electromagnetic radiation striking the Earth's atmosphere spans a range of

100 nm to about 1 mm. This band of significant radiation power can be divided into five regions in increasing order of wavelengths.



Picture 2.5. Solar Irradiance Spectrum above atmosphere and at surface.

- **Ultraviolet C** or (UVC) range, which spans a range of 100 to 280 nm. The term ultraviolet refers to the fact that the radiation is at higher frequency than violet light (and, hence also invisible to the human eye). Owing to absorption by the atmosphere very little reaches the Earth's surface. This spectrum of radiation has germicidal properties, and is used in germicidal lamps.
- **Ultraviolet B** or (UVB) range spans 280 to 315 nm. It is also greatly absorbed by the atmosphere, and along with UVC is responsible for the photochemical reaction leading to the production of the ozone layer. It directly damages DNA and causes sunburn.
- **Ultraviolet A** or (UVA) spans 315 to 400 nm. This band was once held to be less damaging to DNA, and hence is used in cosmetic artificial sun tanning (tanning booths and tanning beds) and PUVA therapy for psoriasis. However, UV A is now known to cause significant damage to DNA via indirect routes (formation of free radicals and reactive oxygen species), and is able to cause cancer.
- **Visible range or light** spans 380 to 780 nm. As the name suggests, it is this range that is visible to the naked eye. It is also the strongest output range of the sun's total irradiance spectrum.
- **Infrared range** that spans 700 nm to 106 nm (1 mm). It is responsible for an important part of the electromagnetic radiation that reaches the Earth. It is also divided into three types on the basis of wavelength:

- infrared-A: 700 nm to 1.400 nm;
- infrared-B: 1.400 nm to 3.000 nm;
- infrared-C: 3.000 nm to 1 mm.

Sunbathing is a popular leisure activity in which a person sits or lies in direct sunshine. People often sunbathe in comfortable places where there is ample sunlight. Some common places for sunbathing include beaches, open air swimming pools, parks, gardens, and sidewalk cafes. Sunbathers typically wear limited amounts of clothing or some simply go nude.

For some, an alternative to sunbathing is the use of a sun bed that generates ultraviolet light and can be used indoors regardless of outdoor weather conditions and amount of sunlight.

For many people with pale or brownish skin, one purpose for sunbathing is to darken one's skin color (get a sun tan) as this is considered in some cultures to be beautiful, associated with outdoor activity, vacations/holidays, and health. Some people prefer naked sunbathing so that an "all-over" or "even" tan can be obtained, sometimes as part of a specific lifestyle.

For people suffering from psoriasis, sunbathing is an effective way of healing the symptoms.

Skin tanning is achieved by an increase in the dark pigment inside skin cells called melanocytes and it is actually an automatic response mechanism of the body to sufficient exposure to ultraviolet radiation from the sun or from artificial sunlamps. Thus, the tan gradually disappears with time, when one is no longer exposed to these sources.

The body produces **vitamin D** from sunlight (specifically from the UVB band of ultraviolet light), and excessive seclusion from the sun can lead to deficiency unless adequate amounts are obtained through diet.

Sunburn can have mild to severe inflammation effects on skin; this can be avoided by using a proper sunscreen cream or lotion or by gradually building up melanocytes with increasing exposure. Another detrimental effect of UV exposure is accelerated skin aging (also called skin photodamage), which produces a difficult to treat cosmetic effect. Some people are concerned that ozone depletion is increasing the incidence of such health hazards. A 10% decrease in ozone could cause a 25% increase in skin cancer.

A lack of visible light is considered one of the primary causes of seasonal affective disorder (SAD), a serious form of the "winter blues". SAD occurrence is more prevalent in locations further from the tropics, and most of the treatments (other than prescription drugs) involve light therapy, rep-

licating sunlight via lamps tuned to specific wavelengths of visible light, or full-spectrum bulbs.

A recent study indicates that more exposure to sunshine early in a person's life relates to less risk from multiple sclerosis (MS) later in life.

The visible part of solar spectrum exposed to a person by change of activity of *biological rhythms* (are temporary manifestation of rhythmic structure of the organism). **Chronomedicine** – is an area of medicine that uses the idea of biological rhythms, which are studied in the framework of chronobiology. So chronomedicine is not limited with our biological rhythms, and tries to consider all the "temporal structure of an organism" as a whole. The **tasks** are to apply chronobiological data to improve prevention, diagnosis, and to improve the effectiveness of treatment of people diseases.

Air electric condition includes ionization, electrical and magnetic fields.

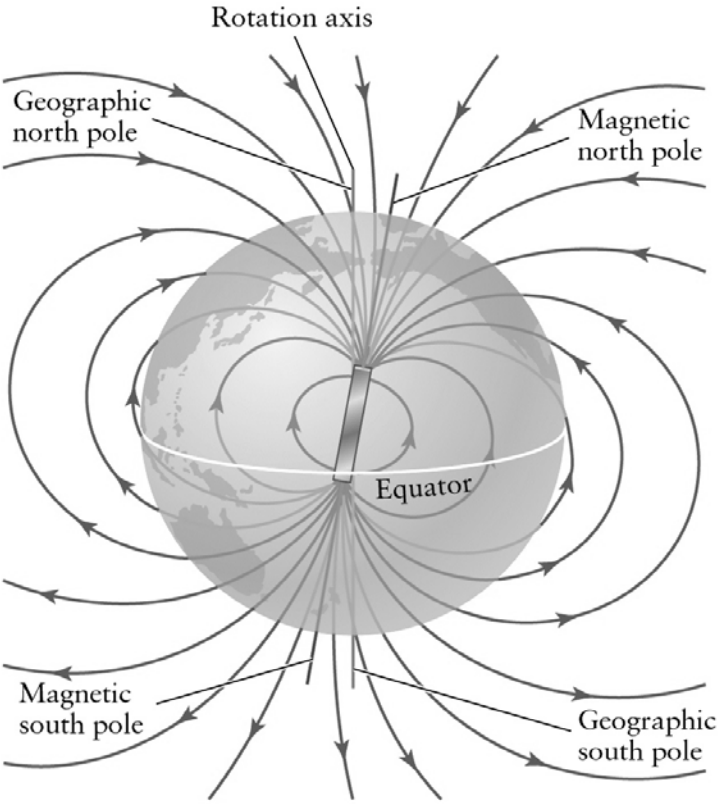
Air ionization is a process of formation of the electro charged particles of a various nature. It occurs under influence of radioactive substances, ultra-violet, x-ray and space beams. As a result easy (negative) and heavy (positive) ions are formed. For the characteristic of air ionization the **unipolarity factor** (relation of positive charges to negative) is applied. At a terrestrial surface it is equal 1.1-1.3. Countryside contains 4000 easy ions in 1 ml of air on the average, and industrial areas - 40-400 respectively.

Electrical field is formed as a result of interaction of negative charge of the Earth and positive charge of air. At a surface of the Earth the gradient of electrical potential makes 120 B/m^2. Especially strongly electrical field varies during a thunder-storm, when its intensity grows in hundred thousand time.

Magnetic field of the Earth is caused by that the Earth represents an original magnet, its power lines surround globe and forms around of it magnetosphere, which protects organisms from a solar wind.

Over the Earth's equator, the magnetic field lines become almost horizontal, then return to connect back again at high latitudes (picture 2.6). However, at high altitudes, the magnetic field is significantly distorted by the solar wind and its solar magnetic field. On the dayside of the Earth, the magnetic field is significantly compressed by the solar wind to a distance of approximately 65.000 kilometers (40.000 mi). The Earth's bow shock is about 17 kilometers (11 mi) thick and located about 90.000 kilometers (56.000 mi) from the Earth. The magnetopause exists at a distance of several hundred kilometers off the surface of the earth. The Earth's magneto-

pause has been compared to a sieve, as it allows particles from the solar wind to enter.



Picture 2.6. The Earth's magnetic field.

The magnetic field of our planet keeps electrons and nucleus of hydrogen, which form a radiating zone around of the Earth. If this zone would absent, for rather short term the space radiation would spread out on ions and electrons of atmosphere and consequently has destroyed life on the Earth. However some particles of solar plasma with high energy can penetrate through a radiating zone and even to reach biosphere. The flares on the sun cause more powerful corpuscular flows, which revolt a magnetic field of the Earth (magnetic storms). The influence of a geomagnetic field on organisms has rather difficult character, being shown on a cellular level and mentioning the genetic apparatus. During magnetic storms the state of health of the people is worsened, the quantity of heart attacks and others heart-vessels diseases grows.

Atmospheric **temperature** is a measure of temperature at different levels of the Earth's atmosphere. It is governed by many factors, including incoming solar radiation, humidity and altitude. The ecological meaning of heat is first of all influence of environment temperature on organism tem-

perature. It also renders influence on speed and character of all chemical reactions determining an exchange of substances. Optimum parameter of temperature for humans is 20^0C (15-25^0C).

Hyperthermia is elevated body temperature due to failed thermoregulation that occurs when a body produces or absorbs more heat than it dissipates. Extreme temperature elevation then becomes a medical emergency requiring immediate treatment to prevent disability or death.

The most common causes include heat stroke and adverse reactions to drugs. The former is an acute temperature elevation caused by exposure to excessive heat, or combination of heat and humidity, that overwhelms the heat-regulating mechanisms. The latter is a relatively rare side effect of many drugs, particularly those that affect the central nervous system. Malignant hyperthermia is a rare complication of some types of general anesthesia.

Hyperthermia can also be deliberately induced using drugs or medical devices and may be used in the treatment of some kinds of cancer and other conditions, most commonly in conjunction with radiotherapy.

Hyperthermia differs from fever in that the body's temperature set point remains unchanged.

The opposite is hypothermia. **Hypothermia** is a condition in which core temperature drops below the required temperature for normal metabolism and body functions which is defined as 35.0 °C (95.0 °F). Body temperature is usually maintained near a constant level of 36.5–37.5 °C (98–100 °F) through biologic homeostasis or thermoregulation. If exposed to cold and the internal mechanisms are unable to replenish the heat that is being lost, a drop in core temperature occurs. As body temperature decreases, characteristic symptoms occur such as shivering and mental confusion.

Humidity is the amount of water vapor in the air. Water vapor is the gas phase of water and is invisible. Humidity indicates the likelihood of precipitation, dew, or fog. Higher humidity reduces the effectiveness of sweating in cooling the body by reducing the rate of evaporation of moisture from the skin. This effect is calculated in a heat index table or humidex, used during summer weather.

There are three main measurements of humidity: absolute, relative and specific.

Absolute humidity is the water content of air.

Relative humidity, expressed as a percent, measures the current absolute humidity relative to the maximum for that temperature.

Specific humidity is a ratio of the water vapor content of the mixture to the total air content on a mass basis.

Humidity is one of the fundamental abiotic factors that defines any habitat, and is a determinant of which animals and plants can thrive in a given environment. The human body dissipates heat through perspiration and its evaporation. Heat convection to the surrounding air, and thermal radiation are the primary modes of heat transport from the body. Under conditions of high humidity, the rate of evaporation of sweat from the skin decreases. Also, if the atmosphere is as warm as or warmer than the skin during times of high humidity, blood brought to the body surface cannot dissipate heat by conduction to the air, and a condition called ***hyperpyrexia*** results. With so much blood going to the external surface of the body, relatively less goes to the active muscles, the brain, and other internal organs. Physical strength declines and fatigue occurs sooner than it would otherwise. Alertness and mental capacity also may be affected, resulting in ***heat stroke or hyperthermia***.

Humans are sensitive to humid air because the human body uses evaporative cooling as the primary mechanism to regulate temperature. Under humid conditions, the rate at which perspiration evaporates on the skin is lower than it would be under arid conditions. Because humans perceive the rate of heat transfer from the body rather than temperature itself, we feel warmer when the relative humidity is high than when it is low.

Some people experience difficulty breathing in high humidity environments. Some cases may possibly be related to respiratory conditions such as asthma, while others may be the product of anxiety. Sufferers will often hyperventilate in response, causing sensations of numbness, faintness, and loss of concentration, among others.

Air conditioning reduces discomfort in the summer not only by reducing temperature, but also by reducing humidity. In winter, heating cold outdoor air can decrease relative humidity levels indoor to below 30%, leading to discomfort such as dry skin and excessive thirst.

Optimum parameter of humidity for humans is 50 (40-60) %.

Air movement is characterized by direction and speed. It is caused by moving of air masses because of a difference of temperature and pressure.

The air movement influences on the processes of thermoregulation. Optimum parameter of air movement for humans is 2.5 (1-4) m/s.

Atmospheric pressure is the force per unit area exerted on a surface by the weight of air above that surface in the atmosphere of Earth (or that of another planet).

For years, the effect of barometric pressure on the body has been studied and disputed. There has always been anecdotal evidence suggesting the link between barometric pressure and aches and pains. Sufferers of arthritis and the elderly often suggest that they know when it is about to rain, as their joints begin to ache. In addition, many that suffer from migraines and headaches claim their condition worsens when barometric pressure falls. While there are studies that offer concrete evidence on the connection between barometric pressure and an increase in pain, many orthopedic doctors also believe that a connection exists.

Optimum parameter of atmospheric pressure for humans is 760 mm hg (740-780 mm of hg).

Low atmospheric pressure causes ***mountain [(high-)altitude] disease, or acute mountain sickness, or hypobaropathy***, high - ***caisson disease or aeroembolism, or decompression sickness***.

The available amount of oxygen to sustain mental and physical alertness decreases with altitude. Available oxygen drops as the air density itself, the number of molecules (of both oxygen and nitrogen) per given volume, drops as altitude increases.

Altitude sickness — is a pathological effect of high altitude on humans, caused by acute exposure to low partial pressure of oxygen at high altitude. It commonly occurs above 2.400 meters. It presents as a collection of nonspecific symptoms, acquired at high altitude or in low air pressure, resembling a case of "flu, carbon monoxide poisoning, or a hangover". It is hard to determine who will be affected by altitude sickness, as there are no specific factors that correlate with a susceptibility to altitude sickness. However, most people can ascend to 2.400 meters without difficulty.

Acute mountain sickness can progress to high altitude pulmonary edema (HAPE) or high altitude cerebral edema (HACE), which are potentially fatal. Chronic mountain sickness, also known as *Monge's disease*, is a different condition that only occurs after very prolonged exposure to high altitude.

Primary symptoms of altitude sickness are headaches, lack of appetite, nausea or vomiting, fatigue or weakness, dizziness or lightheadedness, insomnia, pins and needles, shortness of breath upon exertion, nosebleed, persistent rapid pulse, drowsiness, excessive flatulation, general malaise, peripheral edema (swelling of hands, feet, and face).

Severe symptoms that may indicate life-threatening altitude sickness include:

- pulmonary edema (fluid in the lungs) symptoms similar to bronchitis, persistent dry cough, fever, shortness of breath even when resting;

- cerebral edema (swelling of the brain) headache that does not respond to analgesics, unsteady gait, gradual loss of consciousness, increased nausea, retinal hemorrhage.

Decompression sickness is connected to gas embolism. An **air embolism**, or more generally **gas embolism**, is a pathological condition caused by a gas bubble, or bubbles, in a vascular system. For venous air embolisms, death may occur if a large bubble of gas becomes lodged in the heart, stopping blood from flowing from the right ventricle to the lungs. Gas embolism into an artery, termed *arterial gas embolism*, is a more serious matter than in a vein, because a gas bubble in an artery may directly stop blood flow to an area fed by the artery.

As a general rule, any diver who has breathed gas under pressure at any depth who surfaces unconscious loses consciousness soon after surfacing, or displays neurological symptoms within about 10 minutes of surfacing should be assumed to be suffering from arterial gas embolism.

Symptoms of arterial gas embolism may be present but masked by environmental effects such as hypothermia, or pain from other obvious causes. ***Symptoms of decompression sickness*** include loss of consciousness, cessation of breathing, vertigo, convulsions, tremors, loss of coordination, loss of control of bodily functions, numbness, paralysis, extreme fatigue, weakness in the extremities, areas of abnormal sensation, visual abnormalities, hearing abnormalities, personality changes, cognitive impairment, nausea or vomiting, bloody sputum, symptoms of other consequences of lung overexpansion such as pneumothorax, subcutaneous or mediastinal emphysema may also be present.

Discrimination between gas embolism and decompression sickness may be difficult for injured divers, and both may occur simultaneously. Dive history may eliminate decompression sickness in many cases, and the presence of symptoms of other lung overexpansion injury would raise the probability of gas embolism.

Climate is also abiotic factor affecting human health.

Climate is the long-term pattern of weather in a particular area. It is measured by assessing the patterns of variation in temperature, humidity,

atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time.

Climate is different from **weather**, in that weather only describes the short-term conditions of these variables in a given region.

Weather conditions are divided into *optimum, irritant and acute*. Under the influence of climatic factors there is stimulation of all kinds of metabolism, raising a total and immunobiological resistance of the organism, which contributes to the improvement of health, the prevention of exacerbations of chronic diseases. Climatic factors have a significant impact on the periodical physiological reactions of the organism, its biological rhythms.

Changes associated with the impact of climatic factors lead to the development of seasonal diseases or seasonal exacerbation of chronic diseases. Seasonal diseases are recorded in the transitional seasons (spring and autumn) when weather conditions are unstable and prone to sharp fluctuations. These are colds, cardiovascular and gastrointestinal diseases.

Meteotropic reactions occur in people under the influence of sudden weather changes or electromagnetic characteristics of the atmosphere. The reaction of the organism to the effects of weather factors or increased sensitivity to fluctuations in the weather due to the weakening of mechanisms of adaptation, immunity or chronic disease is called **meteosensitivity or meteolability**.

There are *three degrees of meteosensitivity*.

Mild degree is manifested by the subjective health complaints.

The changes in blood pressure and electrocardiogram are marked when meteosensitivity is of *moderate degree*.

In *severe degree* of meteosensitivity the pronounced violations are observed, it manifests by five types of meteopatic reactions.

At the ***heart type*** of meteosensitivity heart pains and shortness of breath arise.

Brain type of meteosensitivity is characterized by headaches, dizziness and noise in the head.

Mixed type of meteosensitivity is a combination of cardiac and nervous disorders.

Asthenoneurotic type of meteosensitivity is characterized by anxiety, irritability, insomnia, blood pressure changes.

In healthy people with well-functioning mechanisms of adaptation a sharp change in the weather is reflected mainly in the state of psycho-

emotional sphere, there may be headache, slowing of the body's response to various external stimuli.

The process of adaptation of biological objects in new climatic conditions is called **acclimatization**. From a physiological point of view acclimatization is a long-term adaptation to the new climate and geographical conditions associated with the formation of a new dynamic stereotype that arises through the establishment of temporary and permanent reflex connections with the environment.

The meteosensitivity can be as individual pathology, and companion of chronic disease. Most often, the unpleasant symptoms of meteosensitivity are associated with pathology of the vascular system. In those cases, when the reaction of organism to changing weather conditions is not associated with the disease, then the best way to go through this trouble will be a normalization of sleep and rest, giving up bad habits, proper nutrition, conditioning, hardening and moderate exercise.

Physical factors of water are:

- smell;
- taste;
- chromaticity;
- transparency;
- turbidity;
- temperature.

Smell, taste, chromaticity, transparency and turbidity are defined through the sense organs and named ***organoleptic properties***, which depend from a number of the reasons. The growth of water vegetation in dead-water results in occurrence of chromaticity and smell.

Odor in drinking water signifies the presence of different kinds of impurities in water. The impurities present in drinking water can be of different types, creating different kinds of odors and Tastes in drinking water.

Understanding the various kinds of drinking water odor is essential to determine the ability to drink of the water sample that is available. There can be multiple reasons why drinking water is odorous, and understanding these various reasons is in the interest of the person who is going to use the water. The nature of impurities dissolved in drinking water is important to understand both for the general public as well as for water technicians who operate machines that purify water from the supply to make it suitable for drinking.

Common drinking water odor includes a strong chlorinated smell or taste, a rotten egg smell, musty smells and a metallic taste and smell. All

these different types of odors in drinking water make it unsafe for drinking by anyone and proper water treatment steps should thereby be taken to remove the odor from the water. Drinking water odor like chlorine smell is caused by high extent of dissolved chlorine in water. Chlorine is usually added in the disinfection of plants to kill harmful bacteria from the water but the water acquires a chlorine smell as a byproduct. The rotten egg smell from the water again is acquired by water passing through decaying underground organic deposits. As the groundwater passes through these regions it picks up the hydrogen sulfide gas released from the decaying organic matter and acquires the unpleasant rotten egg smell. Actinomycetes give to water the specific smell of crude ground, sulphates, sulfur iron and hydrogen sulfide - smell of rotten eggs. The health effects of excess sulphates in water can cause dehydration and diarrhea. The presence of particles of sand and clay in water increases water turbidity. In the hot days temperature of water can raise under the influence of solar radiation. In areas with strong mineralizational ground water has salty or bitter - salty taste.

Pure water is colorless, odorless and tasteless. However, the water that we drink has some taste in it. Different types of tastes in drinking water are a result of the cations, anions and other minerals present in drinking water. Water has a capability that it can dissolve any minerals, salts, acids, sugar and alkali in it readily. Many gases such as carbon monoxide, ammonia and methane are also dissolved in water. Thus, water is called a universal solvent. The presence of different types of minerals imparts specific tastes in drinking water. Some of the major types of tastes are:

Strong Chlorinous smell: Chlorine is generally added to treat water and make them free from bacteria and other harmful microbes. This chlorine that is added in the water treatment procedures imparts a strong smell of chlorine to the water.

Metallic taste: Due to the high concentration of minerals in drinking water, water gets a salty or soda type taste. If manganese or iron is present the strong taste of metals can be easily detected.

Sulfurous or decayed taste: The presence of excess amount of bacteria can impart sulfurous tastes in drinking water.

Turpentine taste: The turpentine taste can be a result of methyl tertiary butyl ether contamination in drinking water.

Turbidity in open water may be caused by growth of phytoplankton. Human activities that disturb land, such as construction, can lead to high sediment levels entering water bodies during rain storms due to stream wa-

ter runoff. Areas prone to high bank erosion rates as well as urbanized areas also contribute large amounts of turbidity to nearby waters, through stream water pollution from paved surfaces such as roads, bridges and parking lots. Certain industries such as quarrying, mining and coal recovery can generate very high levels of turbidity from colloidal rock particles.

In drinking water, the higher the turbidity level, the higher the risk that people may develop gastrointestinal diseases. This is especially problematic for immunocompromised people, because contaminants like viruses or bacteria can become attached to the suspended solid. The suspended solids interfere with water disinfection with chlorine because the particles act as shields for the virus and bacteria. Similarly, suspended solids can protect bacteria from ultraviolet (UV) sterilization of water.

Organoleptic properties concern to the rather important hygienic parameters of quality of drinking water, so they not only cause appearance of water, but also can specify on its pollution. Besides, muddy, opaque, painted in any colour, warm, with unpleasant smell and taste water causes feeling of repugnance, has negative effect on water-salt exchange, results in refusal from water supply.

The physical properties of soils are texture, porosity, air permeability, heat capacity, absorption capacity, moisture content.

Texture. The mineral components of soil, sand, silt and clay, determine a soil's texture. While even pure sand, silt or clay may be considered a soil, from the perspective of food production a loam soil with a small amount of organic material is considered ideal. The mineral constituents of a loam soil might be 40% sand, 40% silt and the balance 20% clay by weight. Soil texture affects soil behavior, in particular its retention capacity for nutrients and water.

Sand and silt are the products of physical and chemical weathering; clay, on the other hand, is a product of chemical weathering but often forms as a secondary mineral precipitated from dissolved minerals. It is the specific surface area of soil particles and the unbalanced ionic charges within them that determine their role in the cation exchange capacity of soil, and hence its fertility. Sand is least active, followed by silt; clay is the most active. Sand's greatest benefit to soil is that it resists compaction and increases porosity. Silt is mineralogically like sand but with its higher specific surface area it is more chemically active than sand. But it is the clay content, with its very high specific surface area and generally large number of negative charges that gives a soil its high retention capacity for water

and nutrients. Clay soils also resist wind and water erosion better than salty and sandy soils, as the particles are bonded to each other.

Porosity. Pore space is that part of the bulk volume that is not occupied by either mineral or organic matter but is open space occupied by either gases or water. Ideally, the total pore space should be 50% of the soil volume. The gas space is needed to supply oxygen to organisms decomposing organic matter, humus, and plant roots. Pore space also allows the movement and storage of water and dissolved nutrients. Because soil pore space is tortuous or highly curved and twisted, the slow diffusion of solutes and gases through soil pores can limit the bioavailability of substrates to microorganisms.

Air permeability. The atmosphere of soil is radically different from the atmosphere above. The consumption of oxygen, by microbes and plant roots and their release of carbon dioxide, decrease oxygen and increase carbon dioxide concentration. Atmospheric CO_2 concentration is 0.03%, but in the soil pore space it may range from 10 to 100 times that level. At extreme levels CO_2 is toxic. In addition, the soil voids are saturated with water vapour. Adequate porosity is necessary not just to allow the penetration of water but also to allow gases to diffuse in and out. Movement of gases is by diffusion from high concentrations to lower. Oxygen diffuses in and is consumed and excess levels of carbon dioxide diffuse out with other gases as well as water. Soil texture and structure strongly affect soil porosity and gas diffusion. Platy and compacted soils impede gas flow, and a deficiency of oxygen may encourage anaerobic bacteria to reduce nitrate to the gases N_2, N_2O, and NO, which are then lost to the atmosphere. Aerated soil is also a net sink of methane CH_4 but a net producer of greenhouse gases when soils are depleted of oxygen and subject to elevated temperatures.

With increase of depth down to 5 - 6 meters the amount of oxygen is reduced to 14% and the carbon dioxide content is increased to 8%.

Heat capacity is a set of heat exchange processes in the system ground layer of air - the soil - soil-forming rock. It determines the processes of transfer and accumulation of heat in the soil. The temperature of the surface layer of the atmosphere, the vital activity of soil organisms and processes of self-purification of soil largely depend on heat capacity.

Absorption capacity is a soil property to detain, absorb solids, liquids and gases. It is associated with the mineral composition of the rocks and depends on the fineness of the soil.

Water permeability is an ability of soil to pass the water.

Moisture content. The amount of water remaining in a soil drained to field capacity and the amount that is available are functions of the soil type. Sandy soil will retain very little water, while clay will hold the maximum amount.

The fine-grained, with a low content of pores, low air permeability and high moisture capacity, badly warmed soils have the medical significance, reducing the thermal regime of the premises of the first floor, causing dampness of basements and first floors, involving in the pathogenesis of ***"disease associated with the building" and "sick building syndrome"*** .

Medical value of chemical factors of atmospheric air, water and soil

The **atmospheric air** represents a mixture of gases filling the atmosphere. The major component of air is nitrogen gas followed by oxygen. The first two gases nitrogen and oxygen make up 99.0% of the atmosphere by volume. Nitrogen is fairly inert because of its strong triple bond holding the atoms together in the molecule. Oxygen gas is produced by photosynthesis and removed by combustion and respiration (table 2.5).

Air chemical compound are divided into the follow ingredients:

- constants (nitrogen, oxygen, inert gases);
- variables (carbonic gas, water steams);
- casual (ammonia, hydrogen sulphide, methane, sulphurus gas, dust, smoke, microorganisms).

Table 2.5. Atmospheric Air Composition.

Name	Chemical formula	Percentage composition by volume, %
nitrogen	N_2	78.1
oxygen	O_2	20.9
argon	Ar	0.9
carbon dioxide	CO_2	0.03
neon	Ne	0.002
helium	He	0.0005
methane	CH_4	0.0002

krypton	Kr	0.0001
hydrogen	H_2	0.00005
xenon	Xe	0.000009 %

Nitrogen is one of the primary nutrients critical for the survival of all living organisms. Although nitrogen is very abundant in the atmosphere, it is largely inaccessible in this form to most organisms.

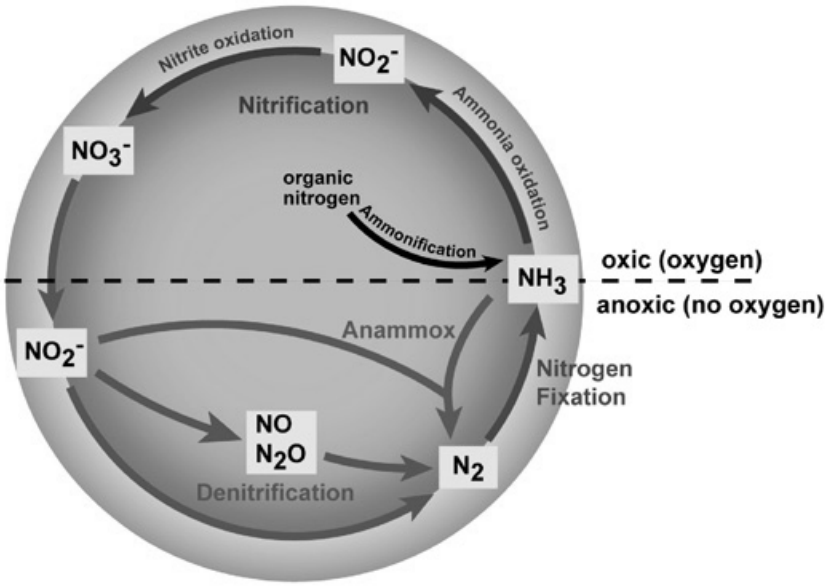
Nitrogen is one of the primary nutrients critical for the survival of all living organisms. It is a necessary component of many biomolecules, including proteins, DNA, and chlorophyll. Although nitrogen is very abundant in the atmosphere as dinitrogen gas (N_2), it is largely inaccessible in this form to most organisms, making nitrogen a scarce resource and often limiting primary productivity in many ecosystems. Only when nitrogen is converted from dinitrogen gas into ammonia (NH_3) does it become available to primary producers, such as plants.

In addition to N_2 and NH_3, nitrogen exists in many different forms, including both inorganic (e.g., ammonia, nitrate) and organic (e.g., amino and nucleic acids) forms. Thus, nitrogen undergoes many different transformations in the ecosystem, changing from one form to another as organisms use it for growth and, in some cases, energy. The major transformations of nitrogen are nitrogen fixation, nitrification, denitrification, anammox, and ammonification (picture 2.7). The transformation of nitrogen into its many oxidation states is key to productivity in the biosphere and is highly dependent on the activities of a diverse assemblage of microorganisms, such as bacteria, archaea, and fungi.

Humans have changed natural nitrate and nitrite proportions radically, mainly due to the application of nitrate-containing manures. Nitrogen is emitted extensively by industrial companies, increasing the nitrate and nitrite supplies in soil and water as a consequence of reactions that take place in the nitrogen cycle. Nitrate concentrations in drinking water will greatly increase due to this.

Health effects of nitrogen. Nitrates and nitrites are known to cause several *health effects*. These are the most common effects:

- reactions with haemoglobin in blood, causing the oxygen carrying capacity of the blood to decrease (nitrite);
- decreased functioning of the thyroid gland (nitrate);
- vitamin A shortages (nitrate);
- fashioning of nitro amines, which are known as one of the most common causes of cancer (nitrates and nitrites).



Picture 2.7. Major Transformations in the Nitrogen Cycle.

Environmental effects of nitrogen. Humans have radically changed natural supplies of nitrates and nitrites. The main cause of the addition of nitrates and nitrites is the extensive use of fertilizers. Combustion processes can also enhance the nitrate and nitrite supplies, due to the emission of nitrogen oxides that can be converted to nitrates and nitrites in the environment.

Nitrates and nitrites also form during chemical production and they are used as food conservers. This causes groundwater and surface water nitrogen concentration, and nitrogen in food to increase greatly.

The addition of nitrogen bonds in the environment has various effects. Firstly, it can change the composition of species due to susceptibility of certain organisms to the consequences of nitrogen compounds. Secondly, mainly nitrite may cause various health effects in humans and animals. Food that is rich in nitrogen compounds can cause the oxygen transport of the blood to decrease, which can have serious consequences for cattle.

High nitrogen uptake can cause problems in the thyroid gland and it can lead to vitamin A shortages. In the animal stomach and intestines nitrates can form nitroamines, dangerously carcinogenic compounds.

At standard temperature and pressure, **oxygen** is a colorless, odorless gas with the molecular formula O_2, in which the two oxygen atoms are chemically bonded to each other with a spin triplet electron configuration.

Singlet oxygen is a name given to several higher-energy species of molecular O_2 in which all the electron spins are paired. It is much more re-

active towards common organic molecules than is molecular oxygen per se. In nature, singlet oxygen is commonly formed from water during photosynthesis, using the energy of sunlight. It is also produced in the troposphere by the photolysis of ozone by light of short wavelength, and by the immune system as a source of active oxygen.

Oxygen plays a vital role in the breathing processes and in the metabolism of the living organisms.

In the human body, the oxygen is absorbed by the blood stream in the lungs, being then transported to the cells where an elaborated change process takes place.

Apart from the daily usage of oxygen, for many people oxygen therapy is a must:

- people who have problems with the respiratory system such as bronchitis and bronchial asthma; long time smokers and, in general, all those who are not able to digest that tiny portion of oxygen from the environment;
- people suffering from stenocardia and those who had heart attacks;
- people who suffer from stress and overfatigue on the daily basis and especially those who are engaged in intense intellectual work as well as sportsmen who have exhausting training sessions;
- oxygen therapy helps expectant mothers to avoid fetal hypoxia;
- children especially those who suffer from long-term diseases.

Ozone, or trioxygen, is a triatomic molecule, consisting of three oxygen atoms. It is an allotrope of oxygen that is much less stable than the diatomic allotrope (O_2), breaking down in the lower atmosphere to normal dioxygen. Ozone is formed from dioxygen by the action of ultraviolet light and also atmospheric electrical discharges, and is present in low concentrations throughout the Earth's atmosphere. In total, ozone makes up only 0.6 ppm of the atmosphere.

Ozone is a powerful oxidant (far more so than dioxygen) and has many industrial and consumer applications related to oxidation. This same high oxidizing potential, however, causes ozone to damage mucus and respiratory tissues in animals, and also tissues in plants, above concentrations of about 100 ppb. This makes ozone a potent respiratory hazard and pollutant near ground level. However, the so-called ozone layer (a portion of the stratosphere with a higher concentration of ozone, from two to eight ppm) is beneficial, preventing damaging ultraviolet light from reaching the Earth's surface, to the benefit of both plants and animals.

When ozone breaks down to dioxygen it gives rise to oxygen free radicals, which are highly reactive and capable of damaging many organic molecules.

Carbon dioxide is the waste product of the respiratory system, and of several other chemical reactions in the body, such as the creation of ATP. Pure carbon cannot be transported in the body, so CO_2 is one form it takes that is water soluble. Levels of CO_2 also tell the body when it needs more oxygen. Carbon dioxide has three very important functions.

1. It is a dilator of smooth muscle. Smooth muscle surrounds any hollow space in the body, i.e. bronchial airways, bladder, bowel, arteries etc. If your alveolar CO_2 level is low the smooth muscle around these hollow spaces will spasm and constrict.

2. Transport of oxygen to the tissues. Oxygen is transported to the tissues through the bloodstream with the haemoglobin molecule, each haemoglobin molecule carries 4 oxygen molecules bound to it, the Bohr effect proves that if the alveolar CO_2 levels are low that the oxygen molecules will not dissociate from the haemoglobin molecules to the optimal level.

3. It is the regulator of pH levels of the blood.

Burning of carbon-based fuels since the industrial revolution has rapidly increased concentrations of atmospheric carbon dioxide, increasing the rate of global warming and causing anthropogenic climate change. It is also a major source of ocean acidification since it dissolves in water to form carbonic acid, which is a weak acid as its ionization in water is incomplete.

$$CO_2 + H_2O \leftrightarrow H_2CO_3$$

Argon, neon, helium are inert gases.

The most important **chemical components** of water are chlorides, sulphates and sulphites, phosphates, carbonates and hydrocarbonates, iodine, iron, zinc, molibden, manganese, cobalt, fluorine, sodium, potassium, calcium, magnesium, hydrogen, oxygen etc. Except for them, organic substances of a soil origin and inorganic impurity can be in water.

Depending on quantity of mineral salts there are **fresh** (up to 1 g/dm^3), **salinity** (1-2.5 g/dm^3) and **salty** (more than 2.5 g/dm^3 of mineral substances).

High general mineralization of drinking water at the constant use results in frustration of digestion, decrease of appetite, occurrence of weakness, loss of work capacity, aggravation of chronic diseases of gastric-intestinal tract.

Strongly mineralization water causes the less of water in the organism, breaks the acid-base balance, results to the weakness of activity of heart.

Influence of general water mineralization on organism depends also on those included in it compounds. The superfluous intake with drinking water of *chlorides* in organism causes the oppression of gastric secretion, reduction of diuresis, the increase of arterial pressure, *sulphates* - causes infringement of water-salt exchange and dyspepsia. The salts of *calcium and magnesium*, causing natural rigidity, are rendered the essential influence on organism. In rigid water vegetables and meat are badly boiled, tea is badly insisted, soap is badly washed. At the regular use of *water with high rigidity* ***urolithiasis*** arises more often.

The constant use of water with a high content of *sodium salts* (sea or mineral) can lead to ***hypernatremia***. Excessive sodium intake of water causes the movement of water from the intracellular space, resulting in increased intracellular osmotic activity and cell dehydration. The water comes out from the cells and their volume decreases. Reducing of the volume of brain cells leads to disruption of consciousness, weakness, increasing the risk of subarachnoid and intracerebral hemorrhage.

Areas, where there is excess or deficiency of the microelements in water, ground, plants are called **biogeochemical provinces**, and diseases, connected with them, - **biogeochemical endemias** or endemic disease.

Endemic disease is a disease constantly found in the certain location or among the certain population groups.

Fluorine participates in development of skeleton, teeth, blood creation and immunity stimulation.

The fluoride ion is readily absorbed by the stomach and intestines. Ingested fluoride forms hydrofluoric acid in the stomach. In this form, fluoride crosses cell membranes and then binds with calcium and interferes with various enzymes. Fluoride is excreted through urine. Fluoride exposure limits are based on urine testing, which has determined the human body's capacity for ridding itself of fluoride. Chronic excess fluoride consumption can lead to *skeletal fluorosis*, a disease of the bones.

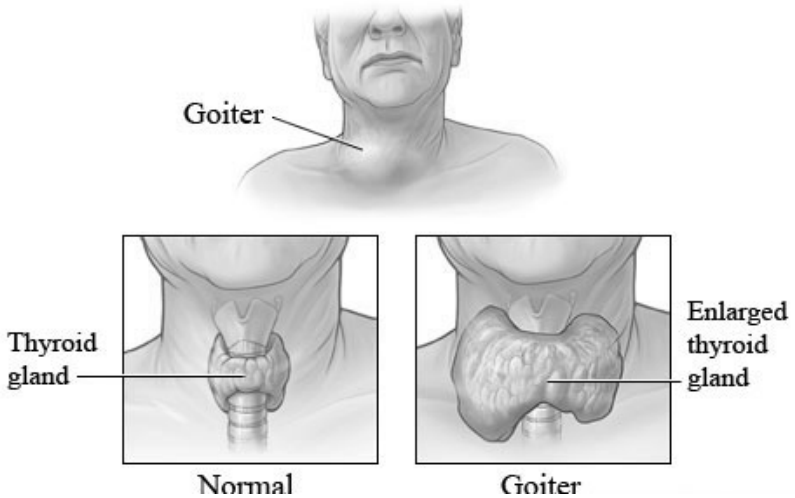
Dental fluorosis, also called mottling of tooth enamel, is a developmental disturbance of dental enamel caused by excessive exposure to high concentrations of fluoride during tooth development. The risk of fluoride overexposure occurs at any age but it is higher at younger ages.

At fluorine deficiency *caries* develops. Caries is a progressive destruction of any kind of bone structure, including the skull, ribs and other bones, or the teeth.

Iodine is necessary for function of thyroid gland.

Iodine deficiency promotes the development of *endemic goiter*. A goitre or goiter (Latin gutteria, struma), is a swelling of the neck or larynx resulting from enlargement of the thyroid gland (thyromegaly), associated with a thyroid gland that is functioning properly or not. Worldwide, the most common cause for goitre is iodine deficiency, usually seen in countries that do not use iodized salt. In the most severe form of iodine deficiency *cretinism* develops, with severe dementia, growth retardation, a disproportion of physical development.

Selenium deficiency is also considered a contributing factor. In countries that use iodized salt, Hashimoto's thyroiditis is the most common cause (picture 2.8).



Picture 2.8. Endemic Goiter.

Excess **strontium** intake causes changes in bone mineral metabolism, leading to the development of *strontium rickets*. The displacement of calcium ions by strontium ions from bone and the accumulation of strontium ions leads to osteopenia processes. There is a total delay of growth and deformity of joints with limited mobility, degenerative and reparative, necrobiotic processes in cartilages.

Cobalt stimulates blood creation, participates in synthesis of proteins, in regulation of carbo-hydrate exchange. It is a key constituent of cobalamin, also known as vitamin B_{12}, which is the primary biological reser-

voir of cobalt as an "ultratrace" element. At its deficiency B_{12} *hypovitaminosis* and *anemia* develop.

Iron participates in blood creation, breath, immunobiological and oxidize-restored reactions. At iron deficiency iron - deficient anemia arises, at excess - hemochromatosis.

Iron-deficiency anemia (or iron-deficiency anemia) is a common anemia (low red blood cell or hemoglobin levels) caused by insufficient dietary intake and absorption of iron, and/or iron loss from bleeding which can originate from a range of sources such as the intestinal, uterine or urinary tract.

Iron deficiency causes approximately half of all anemia cases worldwide, and affects women more often than men. World estimates of iron deficiency occurrence are somewhat vague, but the true number probably exceeds one billion people. This can result if:

- the body does not make enough red blood cells;
- bleeding causes loss of red blood cells more quickly than they can be replaced.

Hemochromatosis, the most common form of iron overload disease, is an inherited disorder that causes the body to absorb and store too much iron. The extra iron builds up in organs and damages them. Without treatment, the disease can cause these organs to fail.

Excess iron due to water consumption is substantially deposited in reticuloendothelial or parenchymal cells of certain tissues as hemosiderin. Excessive intake of soluble salts of II valent iron in conjunction with increase of its absorption in the intestine can lead to *hemosiderosis*, characterized by excessive accumulation of hemosiderin in the tissues of the body. Hemosiderin accumulation in the liver and spleen leads to their fibrosis, in the myocardium - to cardiomyopathy.

Skin hemosiderosis is characterized by pigment spots from yellow to dark brown color, telangiectasia, punctate hemorrhages, areas of atrophy. The clinical manifestations of common forms of the disease are weakness, fatigue, dry skin, hair loss, diarrhea.

Manganese influences development of skeleton, participates in reactions of immunity, blood creation and tissue breath. Manganese is an essential trace nutrient in all known forms of life. The classes of enzymes that have manganese cofactors are very broad, and include oxidoreductases, transferases, hydrolases, lyases, isomerases, ligases, lecitins, and integrins.

Waterborne manganese has a greater bioavailability than dietary manganese. Higher levels of exposure to manganese in drinking water are associated with increased *intellectual impairment and reduced intelligence quotients* in school-age children. At manganese deficiency *exhaustion*, *delay of growth and development of skeleton* are marked. Excessive intake of manganese in the body leads to formation of rachitis changes in bones (*manganese rickets*), impedes the absorption of iron and copper in the gastrointestinal tract, causing *anemia*.

With a lack of manganese the synthesis of glycosaminoglycans in the bones and calcium and phosphorus metabolism are disturbed, ossification is slowed down. The geochemical provinces with low manganese content lead to development of *hypomanganosis*, which is characterized by growth retardation and impaired formation of the skeleton (thickening and shortening of the bones of the lower limbs, joint deformation). Hypomanganosis may be accompanied by anemia caused by a violation of the synthesis of hemoglobin.

Molybdenum enters into the structure of ferments, influences growth. Chronic influence of molybdenum can cause diarrhea, growth retardation, infertility, low birth weight and gout. It can also affect the lungs, kidneys and liver. In humans, four enzymes depend on molybdenum: sulfite oxidase, xanthine oxidoreductase, aldehyde oxidase, and mitochondrial amidoxime reductase. People severely deficient in molybdenum have poorly functioning sulfite oxidase and are prone to toxic reactions to sulfites in foods.

Molybdenum in excess causes *molybdenosis* disease.

Zinc participates in processes of blood creation, activity of internal secretion glands. Symptoms of mild zinc deficiency are diverse. Clinical outcomes include depressed growth, diarrhea, impotence and delayed sexual maturation, alopecia, eye and skin lesions, impaired appetite, altered cognition, impaired host defense properties, defects in carbohydrate utilization, and reproductive teratogenesis. Mild zinc deficiency depresses immunity, although excessive zinc does also.

The chemical properties of soil are content of chemical elements, organic and inorganic compounds.

Sixteen nutrients are essential for plant growth and reproduction. They are **carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, iron, boron, manganese, copper, zinc, molybdenum, and chlorine**. Nutrients required for plants to complete their life cycle are considered essential nutrients. With the exception of carbon,

hydrogen and oxygen, which are supplied by carbon dioxide and water, the nutrients derive originally from the mineral component of the soil. Although minerals are the origin of those nutrients, the organic component is the reservoir of the majority of readily available plant nutrients. The application of finely ground minerals, feldspar and apatite, to soil does not provide the necessary amounts of potassium and phosphorus for good plant growth.

Due to the nature of geological and soil formation factors there are deficiency or excess content in the soil of certain chemical elements (iodine, cobalt, fluorine, molybdenum, manganese, zinc, boron, strontium, selenium, etc.) in biogeochemical provinces. Deficiency or excess of mineral substances directly affects the chemical composition of the water and the plant and may lead to biogeochemical endemies at humans. They are most often characterized by metabolic disturbances.

Areas, where there is excess or deficiency of the microelements in water, ground, plants are called **biogeochemical provinces**, or areas, and diseases, connected with them, - **biogeochemical endemias** or endemic disease. Endemic disease is a disease constantly found in the certain location or among the certain population groups.

The concentration of elements in living matter is directly proportional to their content in the environment, taking into account the solubility of their compounds. The most important for the human organism are essential ones (vital) elements: Ca, P, K, Cl, Na, Zn, Mn, Mo, J, Se, S, Mg, Fe, Cu, Co.

Now *endemic goiter* due to insufficient intake of **iodine** into the human body is well studied.

Insufficient **selenium** in the soil, water, food leads to the development of *Keshan disease (endemic cardiomyopathy).* The pathogenesis of the disease is associated with decreased activity of selenium-containing enzyme - glutathione peroxidases, which in turn leads to disruption of lipid peroxides recovery to less toxic hydroxy acid and hydrogen peroxide to water. As a result, content of free radicals increases in plasma and tissues, which leads to disruption of the cell integrity of cardiomyocytes.

Keshan disease is manifested in an increase of sizes of heart, the development of focal myocardial necrosis, arrhythmia, followed by the occurrence of cardiac insufficiency. Sometimes there is thromboembolism of vessels. In adult patients except heart muscle damage liver injury (50% of the focal biliary cirrhosis, and 5% - heavy lobar cirrhosis), and skeletal muscle damage are often developed.

The high content of **selenium** causes a violation of the gastrointestinal tract and liver. Selenium excess entering the body can manifest itself as pro-oxidants. In large doses, selenium compounds, especially inorganic, inhibit redox enzymes, possesses immunotoxic, embryotoxic effects, inhibit the mitotic activity and reproductive function. Selenium excess causes *hyperselenosis,* exhibiting as an increased desquamation of the skin, brittle and hair loss, flaking and brittle nails, extension of the skin capillaries. Violation of the gastrointestinal tract accompanied by a decrease in appetite, constant nausea, spontaneous diarrhea.

With deficiency of **molybdenum** in the body the ability of oxidation of xanthine to uric acid is broken, the catabolism of methionine is inhibited, excretion of uric acid and inorganic sulfate is reduced, and the growth rate is decreases. The xanthine stones are formed in kidneys, leading to *urolithiasises*. Molybdenum deficiency can result in decreased cleavage of cellulose and excessive accumulation of copper in the body, up to copper toxicity.

The high content of **molybdenum** in the soil causes *molybdenum gout*. Molybdenum, being a part of the enzyme xanthine oxidase of erythrocytes, stimulates the oxidation of hypoxanthine and xanthine to uric acid, causing hyperuricemia. The gout clinic is firstly signs of joint damage (there are tophi - gouty nodules) due to deposits on the synovial membrane of uric acid crystals. The skin in the joint swells, becomes hyperemic. Later arthritis with gouty nodules develops**.**

Cobalt excess causes *cobalt cardiomyopathy*. Cobalt replaces calcium in the heart muscle, thereby reducing its contractile capacity, increasing cardiac volume and cardiac failure. In the acute stage of the disease the presence of hydropic and fat dystrophy, destruction of intracellular organelles, focal necrosis of cardiomyocytes are marked. Soon diffuse or small focal interstitial fibrosis develops, ultimately causing the formation of large scars.

Urovskaya disease or Kashin-Beck disease (KBD) (endemic osteopathy) is one of the most famous endemias arising due to excess of **strontium** or **barium** on the background of **calcium deficiency**. It is characterized by the development of deforming osteoarthrosis with symmetrical deformation and restriction of joint mobility, muscle atrophy, changes in gait.

KBD is a chronic, endemic osteochondropathy (disease of the bone). The symptoms of KBD include joint pain, morning stiffness in the joints, disturbances of flexion and extension in the elbows, enlarged inter-

phalangeal joints and limited motion in many joints of the body. Death of cartilage cells in the growth plate and articular surface is the basic pathologic feature. This can result in growth retardation and secondary osteoarthrosis. Histological diagnosis of KBD is particularly difficult, clinical and radiological examinations have proved to be the best means for identifying KBD. Little is known about the early stages of KBD before the visible appearance of the disease becomes evident in the destruction of the joints (picture 2.9).

Picture 2.9. Patient diagnosed with Kashin–Beck Disease.

Medical value of biological factors of atmospheric air, water and soil

There are two main sources of microorganisms in air. These are *saprophytic soil organisms* raised as dust and organisms for body tissues introduced into the air through coughing, sneezing etc consists of saliva and *mucus*, and each of them may contain thousands of microorganisms. Most droplets are large (i.e. 100mm) and like dust, tend to settle rapidly. Some droplets are of such size that complete evaporation occurs in warm, dry climate, and before they reach the floor quickly become droplets nuclei. These are small and light, may float about for a relatively long period.

Pollen of wind-pollinated plants can lead to the development of ***pollinosis***.

The set of microorganisms is called as **aeroplankton**. Most often it is adsorbed on the surface of dust particles, which are carried by currents of air. The main source of the appearance of microorganisms in air is the soil, of pollen and spores are plants and fungi. The content of microorganisms in atmosphere is subjected to considerable fluctuations, depending on the time of day, season, weather, altitude.

Many factors of air are fatal for microorganisms. Atmospheric air contains mainly saprophytic flora, the number of which decreases with altitude due to the bactericidal action of the UV radiation from the sun. Saprophytes, spores, pollen when ingested can cause allergic reactions.

Number of bacteria in summer is 750, in winter – 150 of bacteria/m^3.

Water contains a considerable quantity of **microorganisms**, such as autotrophic and heterotrophic bacteria. Except microorganisms, seaweed, mushrooms, the elementary, multicellular organisms, worms, mollusks, arthropods, fishes, plants live in water. Autotrophic organisms absorb carbonic gas and enrich water with oxygen, heterotrophic organisms participate in self-cleaning processes.

Microorganisms of water, entering the human gastrointestinal tract together with drinking water or flowering water as a result of the reproduction of cassock, lead to the development of ***dyspepsia*** and ***irritable bowel syndrome***.

Hydrobionts and their individual representatives, in particular, blue-green algae, are sanitary and indication organisms and their ability to survive and develop which is called as *saprobity*, is widely used to judge the degree of pollution of the reservoir.

An European system of classifying organisms according to their response to organic pollution in slow-moving streams is listed below.

(1) **Alpha-Mesaprobic Zone**: Area of active decomposition, partly Aerobic, partly Anaerobic, in a stream heavily polluted with organic wastes;

(2) **Beta-Mesaprobic Zone**: The stream that is moderately polluted with organic waste;

(3) **Oligosaprobic Zone**: The stream that is slightly polluted with organic wastes and contains the mineralized products of self-purification from organic pollution, but with none of the organic pollution remaining;

(4) **Polysaprobic Zone**: The area of a grossly polluted stream that contains the complex organic wastes that are decomposing primarily by anaerobic processes.

The interactions between soil organisms are referred as biotic factors. Soil organisms (edafobionts) are divided into **constant** (geobionts), **temporary** (geophiles) and **facultative** (geoxens). These are nitrogen-fixing bacteria, cellulose bacteria , sulfur bacteria, iron bacteria, pigmented bacteria, pathogenic bacteria, bacterial spores, viruses (poliomyelitis, ECHO, bacteriophages), algae (blue- green), protozoa (amebas) , infusorians, fungi (actinomycetes).

From vegetation algae, roots, bulbs, tubers are found in the soil.

Besides free-living nematodes, helminthes eggs, pathogens exist in the soil.

From mammal rodents, moles, gophers live in the soil.

Organisms have adapted to life in the soil environment and live in sand, clay, salt, acid, alkali, peat and other soils. The inhabitants of soil loosen the soil as a result of their life activity, contribute to its aeration, mix its various layers together, transfer the organic matter to a soil depth, decompose and mineralize the foliage, dead organisms, fertilize it with their own secretions. The number of living organisms in the soil depends on the mechanical structure, chemical properties, soil temperature and water regimes, sunlight and air.

The **fertility** of the soil is the most important feature, it is the ability to ensure the plants have water, nutrients and air in the period of their life activity. Fertile soil layer formed over thousands of years as a result of the interaction of water, air, heat, plant and animal organisms (especially microorganisms) with soil- rock and ensured by the formation of humus - the result of biochemical enzymatic processes that are carried out by soil organisms.

In lands used for agriculture and other human activities, fertile soil typically arises from the use of soil conservation practices, basically the ability of a soil to supply plant nutrients.

Protozoa, nematodes, earthworms, insects, bacteria, and fungi are typical inhabitants of soil. All of these organisms occupy the soil and contribute to it by rearranging soil particles, participating in chemical transformation, and recycling dead organic matter.

The role of *protozoa* in the soil is not firmly established, but they seem to act as parasites on other forms of soil organisms and, therefore, help to regulate the population size of other soil organisms.

Nematodes, which are often called wireworms or roundworms, may aid in the recycling of dead organic matter. Some nematodes are parasitic on the roots of plants. Even though *insects* contribute to the soil by forming burrows and recycling organic material, they are also major crop pests that feed on plant roots.

Bacteria and fungi are particularly important in the decay and recycling of materials. Their chemical activities change complex organic materials into nutrients that can be used by plants. For example, these microorganisms can convert the nitrogen contained in the protein component of organic matter into ammonia or nitrate, nitrogen compounds that can be utilized by plants. The amount of nitrogen produced will vary with the type of organic matter, type of microorganisms, drainage, and temperature.

Burrowing animals, soil bacteria, fungi, and the roots of plants are also part of the biological process of soil formation. One of the most important burrowing animals is the earthworm. One hectare of soil may support a population of five hundred thousand earthworms that can process as much as 9 metric tons of soil a year. These animals literally eat their way through the soil, resulting in further mixing of organic and inorganic material, which increases the amount of nutrients available for plant use. They often bring nutrients from the deeper layers of the soil up into the area where plant roots are more concentrated, thus improving the soil's fertility. Soil aeration and drainage are also improved by the burrowing of earthworms and other small soil animals. They also help to incorporate organic matter into the soil by collecting dead organic material from the surface and transporting it into burrows and tunnels.

Fungi and bacteria are important decomposers and serve as important links in many mineral cycles. They, along with animals, reduce organic material to smaller particles and, therefore, improve the quality of the soil.

In a process called **mineralization**, microbes feed on organic matter, releasing ammonia (NH_3) (which may be reduced to ammonium NH^{4+}) and other nutrients. In nitrogen fixation, *Rhizobium bacteria* convert N_2 to nitrate by the way of nitrogen fixation.

The *mineralization* of organic substances can occur in *aerobic* (at oxygen access) and *anaerobic* conditions (at absence or insufficient quantity of oxygen). In anaerobic conditions there is rotting and fermentation of organic substances and allocation of fetid gases (ammonia, hydrogen sulphide, methane).

The anaerobic bacteria have medical significance. They decompose organic substances with the release of odorous and harmful substances -

ammonia, hydrogen sulfide, methane, indole, skatole, causing the ***"disease associated with the building," "sick building syndrome"***.

Diagnostic, treatment and prevention of environmental pathology, caused by pessimal factors of human environment

To **diagnose** the environmental pathology caused by the pessimal factors of human environment a detailed anamnesis is collected by the interview method to reveal the hereditary changes which have been appeared under the influence of stressful, biological, chemical and physical factors of the environment, triggers of the environmental pathology, as well as the time of residence in the region, phenomena of elimination and re-exposure.

The patient is examined, the status of nutrition is clarified, specific and non-specific signs associated with the area of residence are established in the clinical picture, biochemical, physiological, immunological, bacteriological, genetic, parasitological laboratory tests are appointed to determine the level of hormones, free radicals, mediators, deficiency and surplus of essential factors, metabolic disorders, and parasites.

The group character of the disease is found out, the correlation factor of the number of cases of the disease with the level of the factor is calculated, the strength and force of the correlation is determined.

Treatment of the environmental disease includes the restoration of broken nutritional status, specific desensitization, immunocorrection, appointment of antioxidants, elimination of organ and system dysfunctions, increase in the resistance of the organism, symptomatic therapy.

Treatment is carried out, first of all, with the help of nutrition and phytopreparations.

When treating the endemic diseases caused by a lack of essential factors, it is recommended the reception of the elements into food which are in deficiency, intake of vitamin and mineral complexes.

When treating the endemic diseases caused excess of mineral elements, it is recommended the appointment of the means which are binding, accelerating excretion and detoxifying the surplus elements ones.

Treatment of seasonal affective disorder is carried out by visible light in the morning hours with an intensity of 10.000 lux for 15 minutes by the special light sources. In addition to light therapy, the above mentioned treatment is performed.

When treating the desynchrosis, a positive effect is observed when a person stays in sunlight for 2 days for 3 hours.

Treatment of allergic diseases includes desensitization, immunocorrection, correction of nutritional status, symptomatic therapy.

For individual **prevention** of environmental pathology, a person who is exposed to pessimal environmental factors should consume high-quality bottled water and food stuffs grown on clean soils, breathe the air full-fledged with oxygen, nitrogen and carbon dioxide, lead a healthy lifestyle with an emphasis on rational nutrition and drinking mode, reduce the time of contact with pessimal factors, consume less defective food stuffs and water, use the personal protective means, intake adaptogens and phytopreparations.

To prevent diseases of ultraviolet insufficiency, daily exposure to sunlight for 15 minutes is recommended, which causes the synthesis of the necessary 400 IE of vitamin D_3, excess - the reduction or elimination of ultraviolet irradiation. In the period of a magnetic storm, you need to reduce physical and mental stress, as well as caloric intake, it is recommended to take antioxidants and symptomatic drugs, biologically active additives.

The prevention of biogeochemical endemias includes the addition of necessary chemical elements in water, food, creating of special vitamin and mineral preparations (iodizing of the cooking salt, fluorination of water, application of tooth pastes with fluorine), processing of water with the purpose of removing of microelements excess,.

To improve water quality the ***methods on optimization of water quality*** are widely used**.** For improvement of water quality **general** (**clearing, disinfecting)** and **special methods** are used.

Water **clearing** is carried out by *mechanical* (upholding), *physical* (filtering) and *chemical* (coagulation) methods.

Water **disinfecting** (destruction of pathogens) is carried out by *chemical* (chlorination by means of gaseous chlorine, chlorine dioxide, ozone, iodine, silver) and *physical* (boiling, ultra-violet irradiation, electric pulse, ultrasound, ionizing radiation) methods.

The **special methods** of water treatment include:

- **Deodorization** - the process of odor and taste removing. It is performed by ozonation, chlorination, aeration, treatment with potassium permanganate, hydrogen peroxide.

- **Decontamination** (aeration) - removal of carbon dioxide, chlorine, oxygen, hydrogen sulfide and other gases from the water. It is performed by physical, chemical, physical and chemical methods.

- **Softening** - removal of calcium and magnesium cations in order to reduce the total hardness of water. It is performed by ion exchange and thermal methods.

- **Desalination** - the process of reducing of salt amount in sea waters to a level at which the water becomes suitable for use. It is performed by means of distillation, freezing, electro dialysis and reverse osmosis method.

- **Deironing** - the process of reducing the amount of water-soluble salts of iron. It is performed by aeration followed by upholding, coagulation, liming, cation exchange, and filtration.

- **Defluorination** - removal of fluoride anions. It is performed by precipitation.

- **Deactivation** - removal of radioactive substances. It is performed by sedimentation, coagulation, chemical methods.

Doctors conduct medical survey and prophylactic medical examinations, supervision of the population in out-patient - policlinic establishments. They also send the individuals of the risk group for rehabilitation to sanatorium treatment, conduct environmental education and training, participate in supervision of the morbidity, physical development, and demographic indicators according to the program of social and hygienic monitoring. The maximum permissible concentrations and levels of pessimal environmental factors are developed.

Question for self-control

1. The Earth, its structure.
2. The value of air, water and soil in nature and human life.
3. Medical value of physical factors of atmospheric air, water and soil.
4. Medical value of chemical factors of atmospheric air, water and soil.
5. Medical value of biologial factors of atmospheric air, water and soil.
6. Diagnostic, treatment and prevention of environmental pathology, caused by pessimal factors of human environment.

Chapter 3.

MEDICAL VALUE OF POLLUTION OF HUMAN ENVIRONMENT

Pollution of environment

Pollution of human environment is the introduction of new, non characteristic components (physical, biological, chemical agents or energy kinds) into the environment or excess of their natural level in the quantities having a negative influence on human, animals or plants as direct and indirect ways.

The pollution on spatial location is subdivided into:

- **local** – cities, large industrial enterprises, areas of production of minerals;
- **regional** - significant territories and water areas which are subjected to influence of large industrial areas;
- **global** - is caused by atmospheric emissions extending on the large distances from a place of the occurrence and rendering adverse influence on large regions.

Kinds of man intervention in natural processes in biosphere:

- **ingredient** (mineral and organic), or entering of chemical materials which are quantitatively or qualitatively alien to natural biogeocenoses;
- **parametrical**, connected with qualitative environment parameters (thermal, noise, radiating, electromagnetic);
- **biocenotic** which consists in influence on compound and structure of living organisms of populations, populating a biogeocenose;
- **statial-destructive**, as change of visual environments and ecological systems in the course of natural management.

By the force and nature of the impact on environment pollution can be background, impact (salvo), constant, creeping and catastrophic. According to the sources of the pollutant pollution is divided into industrial, vehicles, agricultural and municipal.

A pollutant is a non characteristic component for environment or its increased natural level having a negative influence on human as direct and indirect way. A pollutant may cause long- or short-term damage by changing the growth rate of plant or animal species, or by interfering with

human amenities, comfort, health, or property values. It is a substance that causes a nonobservance of air, water or soil quality standards.

The pollutants are subdivided on nature into three kinds: ***chemical, physical***, ***biological***.

The pollutants of **physical nature** are represented by energy, radiations, fields.

Chemical substances and other pollutants of **chemical nature** are commonly found in the environment in the form of aerosols or solutions, evenly distributed in the environment and characterized by an average concentration. They are capable of transforming a habitat and accumulation in the body.

The pollutants of **biological nature** are discrete organisms, often going into conglomerates or adsorbing on suspended particulate matter. They form various infecting dose, have a certain invasiveness and virulence, multiply in the host organism or water, foods, and are not cumulated.

The pollutants of chemical and biological nature are ***xenobiotics***, which refers to any compounds foreign to the organism that can cause certain changes in it, including disease and death.

The object, releasing pollutant, is **a source of pollution**.

There are ***natural and anthropogenic sources of pollution***. The most significant of these are anthropogenic sources such as industrial, transport, agricultural and municipal.

The environment has a tremendous ability to accept and disperse pollutants. Human environment as a result of the physical, chemical and biological processes occurring in it has a great ability to clean itself. **Self-cleaning** of air, water and soil is effected by rotation of substances, including the formation of organic substances and their transformation and destruction. The self-cleaning system is characterized by interacting of physical, chemical and biological processes among themselves.

Thus, the settling of mineral particles – is a purely physical process, the formation of insoluble compounds, matter oxidation - chemical process. The biological and biochemical processes of self-cleaning are provided by the activities of plants, animals and bacteria. Self-cleaning of the polluted environment is accompanied by improvement of its quality. The rate of self-cleaning depends on the degree of contamination, the season of the year. Self-cleaning stops with the growth of the intensity of pollution.

Self-cleaning of water is the natural process that allows to clean the surface stream water. There are 2 types of self-cleaning: surface self-cleaning and percolating water self-cleaning:

- surface self-cleaning: microorganisms will degrade into minerals when then consume dioxygen;
- percolating water self-cleaning: when water penetrates different layers of soil (sand, rocks), its polluting charge is decreased.

The ground has the ability to clearing itself from pollutants by self-cleaning, however at strong pollution this processes is slowed down. Content of soil air determines ability of the soil undergo through self-cleaning, humification (instead of rotting) of organic substances. The soil self-cleaning takes much time due to biological decomposition processes. Soil can be self-cleaned from the numbers of pollutants such as invasive eggs of ascarides, radionuclides, etc.

Garbage, arriving in soil, is neutralized thanks to ability of soil to self-cleaning. Soil self-cleaning is the difficult process depending on physical properties of soil, its structure and chemical compound. But the leading role in this process belongs to microorganisms. Pollution (organic character), gets to the soil, under the influence of microorganisms decays and turns to water, carbonic gas, mineral salts and humus.

The mineralization of organic substances can occur in *aerobic* (at oxygen access) and *anaerobic* conditions (in the absence or insufficient quantity of oxygen). Thus organic substances decay the enzymes allocated with microorganisms and mushrooms. In anaerobic conditions there is a rotting and fermentation of organic substances with allocation of fetid gases (ammonia, hydrogen sulphide, methane). Plowing or soil digging promotes aeration and accelerates it’s self-cleaning.

Consequences of atmosphere pollution can be both environmental and medical ones.

Air pollution is a significant risk factor for multiple health conditions including *respiratory infections, heart diseases, and lung cancer*, according to the World Health Organization (WHO). The health effects caused by air pollution may include difficulty in breathing, wheezing, coughing, asthma and aggravation of existing respiratory and cardiac conditions. These effects can result in increased medication use, increased doctor or emergency room visits, more hospital admissions and premature death. The human health effects of poor air quality are far reaching, but principally affect the body's respiratory system and the cardiovascular

system. Individual reactions to air pollutants depend on the type of pollutant, a person is exposed to, the degree of exposure, the individual's health status and genetics. Children aged less than five years who live in developing countries are the most vulnerable population in terms of total deaths attributable to indoor and outdoor air pollution.

The WHO states that 2.4 million people die each year from causes directly attributable to air pollution, with 1.5 million of these deaths attributable to indoor air pollution.

The worst short term civilian pollution crisis in India was the 1984 Bhopal Disaster. Leaked industrial vapors from the Union Carbide factory, belonging to Union Carbide, Inc., U.S.A., killed more than 25.000 people outright and injured anywhere from 150.000 to 600.000. The United Kingdom suffered its worst air pollution event when the December 4 Great Smog of 1952 formed over London. In six days more than 4.000 died, and 8.000 more died within the following months. An accidental leak of anthrax spores from a biological warfare laboratory in the former USSR in 1979 near Sverdlovsk is believed to have been the cause of hundreds of civilian deaths. The worst single incident of air pollution to occur in the US occurred in Donora, Pennsylvania in late October, 1948, when 20 people died and over 7,000 were injured.

Diesel exhaust (DE) is a major contributor to combustion derived particulate matter air pollution. In several human experimental studies, using a well validated exposure chamber setup, DE has been linked to acute vascular dysfunction and increased thrombus formation. This serves as a plausible mechanistic link between the previously described association between particulates air pollution and increased cardiovascular morbidity and mortality.

Effects on cardiovascular health. Air pollution exposure is a risk factor correlating with increased total mortality from cardiovascular events. Air pollution is also emerging as a risk factor for stroke, particularly in developing countries where pollutant levels are highest. In women air pollution is associated not with hemorrhagic but with ischemic stroke. Air pollution was also found to be associated with increased incidence and mortality from coronary stroke. Associations are believed to be causal and effects may be mediated by vasoconstriction, low-grade inflammation or autonomic nervous system imbalance or other mechanisms.

Effects on cystic fibrosis. A study showed that patients near and around particulates air pollution had an increased risk of pulmonary exacerbations and decrease in lung function. Patients were examined before the study for amounts of specific pollutants like *Pseudomonas aeruginosa* or *Burkholderia cenocepacia* as well as their socioeconomic standing. As cystic fibrosis patients already suffer from decreased lung function, everyday pollutants such as smoke, emissions from automobiles, tobacco smoke and improper use of indoor heating devices could further compromise lung function.

Effects on COPD and asthma. Chronic obstructive pulmonary disease (COPD) includes diseases such as chronic bronchitis and emphysema. Researches have demonstrated increased risk of developing asthma and COPD from increased exposure to traffic-related air pollution. Additionally, air pollution has been associated with increased hospitalizations and mortality from asthma and COPD.

It is believed that much like cystic fibrosis, by living in a more urban environment serious health hazards become more apparent. Studies have shown that in urban areas patients suffer mucus hyper secretion, lower levels of lung function, and more self diagnosis of chronic bronchitis and emphysema.

Links to cancer. There is increased risk of lung cancer for patients who lived in areas with high nitrogen oxide concentrations, associations between air pollution and other forms of cancer, including cervical cancer and brain cancer.

Carbon monoxide, hydrocarbons, particulates, sulfur monoxide, and nitrogen compounds are the **primary air pollutants**. They can cause a variety of health problems. Photochemical smog is a **secondary pollutant** formed when hydrocarbons and oxides of nitrogen are trapped by thermal inversions and react with each other in the presence of sunlight to form peroxyacetylnitrates and ozone. Elimination of **photochemical smog** requires changes in technology, such as scrubbers, precipitators, and filter removal of sulfur from fuels. This kind of smog is caused by the burning of large amounts of coal within a city; this smog contains soot particulates from smoke, sulfur dioxide and other components. Modern smog is a type of air pollution derived from vehicular emission from internal combustion engines and industrial fumes that react in the atmosphere with sunlight to form secondary pollutants that also combine with the primary emissions to form photochemical smog.

Smog is a serious problem in many cities and continues to harm human health. Ground-level ozone, sulfur dioxide, nitrogen dioxide and carbon monoxide are especially harmful for senior citizens, children, and people with heart and lung conditions such as emphysema, bronchitis, and asthma. It can inflame breathing passages, decrease the lungs' working capacity, and cause shortness of breath, pain when inhaling deeply, wheezing, and coughing. It can cause eye and nose irritation and it dries out the protective membranes of the nose and throat and interferes with the body's ability to fight infection, increasing susceptibility to illness. Hospital admissions and respiratory deaths often increase during periods when ozone levels are high.

Acid rain is caused by emissions of sulfur dioxide and oxides of nitrogen in the upper atmosphere, which form acids that are washed from the air when it rains or snows. Direct effects of acid rain on terrestrial ecosystems are difficult to prove, but changes in many forested areas are suspected of being partly the result of additional stresses caused by acid rain. The effect of acid rain on aquatic ecosystems is easy to quantify. As waters become more acidic, the complexity of the ecosystem decreases, and many species fail to reproduce.

Currently, many are concerned about the damaging effects of greenhouse gases: carbon dioxide, methane, and chlorofluorocarbons. Chlorofluorocarbons are also thought to lead to the destruction of ozone in the upper atmosphere. Many commonly used materials release gases into closed spaces where they cause potential health risks.

An appreciation of the problem requires careful examination of several facts. Several gases in the atmosphere are transparent to light but absorb infrared radiation. These allow sunlight to penetrate the atmosphere and be absorbed by the earth's surface. This energy is reradiated as infrared radiation (heat), which is absorbed by the gases. Because the effect is similar to what happens in a greenhouse (the glass allows light to enter but retards the loss of heat), these gases are called greenhouse gases and the warming thought to occur from their increase is called **the greenhouse effect**. The most important greenhouse gases are carbon dioxide (CO_2), chlorofluorocarbons (primarily $CC1_3F$ and $CC1_2F_2$), methane (CH_4), and nitrous oxide (N_20). Each of these gases is currently increasing in amount as a result of human activity.

Ozone Depletion. The use of chlorofluorocarbons in air conditioners, refrigerators, and as propellants has resulted in the release of large amounts

into the atmosphere. Because chlorofluorocarbons are implicated in both global warming and ozone depletion, considerable international attention is focused on controlling their manufacture and release.

Increase of World Ocean level owing to global rise of temperature. Rise of temperature of climate will be accompanied by increase of a degree of instability of weather, growth of number of storm and hurricanes.

The occurrence of **extreme climatic conditions** is quite probable: droughts, hurricanes. Amplification annual fluctuations of air temperature with the establishment of lower temperatures per winter months are possible.

The change of climate can render the negative influence on human health owing to amplification of thermal stress in southern areas and distribution of many kinds of diseases. The direct effects of action of the changed climatic factors at increase of temperature can result in increase of blood volume, increase of activity of narrow system of blood, increase of blood pressure. The increase of number of allergic diseases is predicted. The global increase of temperature will result in destruction of woods that they cannot quickly adapt to varied conditions. The perishing woods will release plenty of carbon dioxide. Last, in turn, will speed up global rise of temperature and destruction of woods. The increase of global temperature will be connected to droughts, reduction of stocks of drinking water and serious changes of agriculture.

Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds.

Water pollution affects plants and organisms living in these bodies of water, and, in almost all cases the effect is damaging not only to individual species and population, but also to the natural biological communities.

The term *hydrospheric pollution* refers not only to water quality but also to biodiversity and habitats. Pollution can be classified as either ***reversible or irreversible***, based on duration. Reversible pollution lasts for less than one hundred years. Examples include the acidification of lakes and rivers, the introduction of heated cooling water from power plants, harmful algal blooms, oil pollution, the introduction of metals, and excessive aquaculture. These forms of pollution cause damage to ecosystems, but the systems generally recover within one hundred years of eliminating the pollutants. Examples of irreversible pollution include the presence of environmental endocrine disrupters and radioactive pollution,

the introduction of non-indigenous species, the destruction of habitats through construction and reclamation, and global warming. Irreversible pollution must be avoided at all costs.

Classifying pollution is helpful for understanding its degree of impact. It is recommended (by Meinesz) four categories, based on the duration of impact:

- **short-term pollution** disappears within about ten years after the cause of the pollution has been eliminated;
- **middle-term pollution** is caused, in the main, by non-biodegradable chemicals, that are active on fauna and flora. This type of pollution generally has duration of several decades. Here, non-biodegradable chemicals are classified as those causing irreversible pollution due to their persistence in the hydrosphere;
- **long-term pollution** causes ecosystem destruction and usually requires reconstruction that takes at least one hundred years;
- **"point-of-no-return"** pollution is irreversible and results in the definitive destruction of a specie or ecosystem. Any associated reconstruction period is longer than several centuries.

If the cause of the pollution is not eliminated, short-term pollution can become middle term. The time period used in the above definition is based on the period once contamination ends. Short, medium and long-term pollution are all reversible (non- conservative), while point-of-no-return pollution is irreversible (conservative). Irreversible pollution occurs when pollutants that do not decompose for at least several hundred years accumulate. Meinesz has claimed that reclamation is actually an irreversible pollution because of the impossibility of reinstating reclaimed coast to its original condition, and the fact that the reclaimed area exists quasi-perpetually. Irreversible pollution is incompatible with sustainable development.

Water pollution makes it unfit for drinking, bathing, water sports, technical needs and leads to poisoning, infectious diseases, remote carcinogenic and mutagenic effects.

Groundwater mining is a serious problem in some areas. These areas depend on irrigation for agriculture. The population of these areas has also increased dramatically over the last years. The ever-increasing demand for groundwater has led to its rapid depletion. Precipitous declines in agricultural production are forecast within the next years. As the groundwater is depleted, the land values will decline.

When saltwater intrudes on fresh groundwater, the groundwater becomes unusable for human consumption and for many industrial processes. Saltwater intrusion is a serious problem in heavily populated coastal areas throughout the world.

Salinization. Another water-use problem results from the salinity caused by increasing salt concentrations in soil. When plants extract the water they need, the salts present in all natural waters become concentrated. Irrigation of arid farmland makes this problem more acute because so much water is lost due to evaporation. Irrigation is most common in hot, dry areas, which normally have high rates of evaporation. This results in a concentration of salts in the soil and in the water that runs off the land. Even river increases in salinity as it flows to the ocean. The problem of salinity will continue to increase as irrigation increases.

Soil contamination results when hazardous substances are either spilled or buried directly in the soil or migrate to the soil from a spill that has occurred elsewhere. For example, soil can become contaminated when small particles containing hazardous substances are released from a smokestack and are deposited on the surrounding soil as they fall out of the air. Another source of soil contamination could be water that washes contamination from an area containing hazardous substances and deposits the contaminated substances in the soil as it flows over or through it.

The problem of lithosphere pollution is different from mechanisms of atmosphere and hydrosphere pollution:

- ground – is an inactive environment;
- processes of pollutants migration are slow;
- ground collects xenobiotic (human-made) chemicals in good way.

On **danger** ground is divided into: *safe, dangerous, extremely dangerous*.

On **impurity degree** ground is divided into: *pure, poorly polluted, polluted and strongly polluted.*

Pollution of ground is a risk factor of adverse health influences such as infringement of organs and systems functions, development of acute and chronic poisonings, development of the long-term effects, physical retardation, deterioration of demographic parameters.

People living near polluted land have high incidences of migraines, nausea, fatigue, and miscarriage and skin disorders. Long-term effects of pollution include cancer, leukemia, reproductive disorders, kidney and

liver damage, as well as central nervous system failure. Children often suffer from developmental problems and weakened immune systems.

In addition to direct health effects, soil pollution also harms plants Americans feed on. Chemicals can sometimes be absorbed into food like lettuce and can be ingested. Other times, the pollutants simply kill the plants, this has created widespread crop destruction and famine in other parts of the world. The entire ecosystem changes when new materials are added to the soil, as microorganisms die off or move away from contaminants.

Health consequences from exposure to soil contamination vary greatly depending on pollutant type, pathway of attack and vulnerability of the exposed population. Chronic exposure to chromium, lead and other metals, petroleum, solvents, and many pesticide and herbicide formulations can be *carcinogenic*, and can cause congenital disorders, or can cause other chronic health conditions. Industrial or man-made concentrations of naturally occurring substances, such as nitrate and ammonia associated with livestock manure from agricultural operations, have also been identified as health hazards in soil and groundwater.

Chronic exposure to benzene at sufficient concentrations is known to be associated with higher incidence of leukemia. Mercury and cyclodienes are known to induce high incidences of kidney damage, some of which are irreversible. Polychlorinated biphenyls and cyclodienes are linked to liver toxicity. Organophosphates and carbonates can induce a chain of responses leading to neuromuscular blockage. Many chlorinated solvents induce liver changes, kidney changes and depression of the central nervous system. There is an entire spectrum of further health effects such as headache, nausea, fatigue, eye irritation and skin rash for the above cited and other chemicals. At sufficient dosages a large number of soil contaminants can cause death by exposure via *direct contact, inhalation or ingestion* of contaminants in groundwater contaminated through soil.

Collecting in soil pollutants can be passed on food chains to the human.

Modern soil problems are:

- loss of grounds (owing to erosion, direct destruction, cutting down of woods);
- decrease in fertility (owing to salinization and waterlogging);
- pollution of grounds (consequences are braking of soil formation process, decrease in productivity, decrease in consumer qualities

of agricultural production, braking of ground auto purification processes, formation of artificial biogeochemical provinces, accumulation of xenobiotics and their further migration on food chain).

The basic sources of pollution and pollutants of air, water and soil

Air pollutants are subdivided on nature into three kinds:

- **chemical** (carbon, nitrogen, sulfur oxides, ammonia, hydrogen sulfide, dioxins);
- **physical** (electromagnetic radiation, noise, infrasound);
- **biological** (pathogenic microorganisms - viruses, bacteria, fungi).

Pollutants can be classified as ***primary or secondary***.

Usually, **primary** pollutants are directly produced from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulfur dioxide released from factories.

Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. Secondary air pollutants are compounds that result from the interaction of various primary air pollutants with one another. An important example of a secondary pollutant is ground level ozone - one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary: that is, they are both emitted directly and formed from other primary pollutants.

Major **primary pollutants** produced by human activity include the following ones.

Sulfur oxides (SO_x) - especially sulfur dioxide, is produced by volcanoes and in various industrial processes. Since coal and petroleum often contain sulfur compounds, their combustion generates sulfur dioxide.

Nitrogen oxides (NO_x) - especially nitrogen dioxide are expelled from high temperature combustion, and are also produced naturally during thunderstorms by electric discharge. Can be seen as the brown haze dome above or plume downwind of cities. NO_2 is one of the most prominent air pollutants.

- **Carbon monoxide** (CO) - is a colourless, odourless, non-irritating but very poisonous gas. It is a product by incomplete combustion

of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.

Ammonia (NH_3) - emitted from agricultural processes.

Secondary pollutants include the following ones.

- Particulates created from gaseous primary pollutants and compounds in **photochemical smog**. Photochemical smog is a mixture of pollutants resulting from the interaction of nitrogen oxide and nitrogen dioxide with ultraviolet light. The two most destructive kinds of materials formed are **ozone (0_3)** and peroxyacetylnitrates.

Sources of air pollution refer to the various locations, activities or factors which are responsible for the releasing of pollutants into the atmosphere. These sources can be classified into two major categories such as **anthropogenic (man-made)** and **natural sources**.

Anthropogenic sources mostly related to burning different kinds of fuel.

- "**Stationary Sources**" include smoke stacks of power plants, manufacturing facilities (factories) and waste incinerators, as well as furnaces and other types of fuel-burning heating devices. In developing and poor countries, traditional biomass burning is the major source of air pollutants; traditional biomass includes wood, crop waste and dung.
- **"Mobile Sources"** include **motor vehicles**, marine vessels, aircraft and the effect of sound etc.
- **Chemicals**, dust and **controlled burn** practices in agriculture and forestry management. Controlled or prescribed burning is a technique sometimes used in forest management, farming, prairie restoration or greenhouse gas abatement. Fire is a natural part of both forest and grassland ecology and controlled fire can be a tool for foresters. Controlled burning stimulates the germination of some desirable forest trees, thus renewing the forest.
- Fumes from **paint, hair spray, varnish, aerosol sprays** and other solvents.
- Waste deposition in **landfills**, which generate **methane**. Methane is highly flammable and may form explosive mixtures with air. Methane is also an asphyxiant and may displace oxygen in an enclosed space. Asphyxia or suffocation may result if the oxygen concentration is reduced to below 19.5% by displacement.
- Military, such as **nuclear weapons, toxic gases, germ warfare** and **rocketry.**

Natural sources are listed below.

- **Dust** from natural sources, usually large areas of land with few or no vegetation.
- **Methane**, emitted by the **digestion** of food by animals, for example cattle.
- Radon gas from **radioactive decay** within the Earth's crust. Radon is a colorless, odorless, naturally occurring, radioactive noble gas that is formed from the decay of radium. It is considered to be a health hazard. Radon gas from natural sources can accumulate in buildings, especially in confined areas such as the basement and it is the second most frequent cause of lung cancer, after cigarette smoking.
- Smoke and carbon monoxide from **wildfires.**
- **Vegetation**, in some regions, emits environmentally significant amounts of VOCs on warmer days. These VOCs react with primary anthropogenic pollutants - specifically, NO_x, SO_2, and anthropogenic organic carbon compounds - to produce a seasonal haze of secondary pollutants.
- **Volcanic activity**, which produce sulfur, chlorine, and ash particulates.

The main sources of pollution of surface water are: discharges into watercourses untreated ***sewage***. Much of the river «absorb» waste, becoming similar to the lifeless waste ditch, which flows no longer water, but the «chemical cocktail».

Urban waste water includes mainly municipal wastewater.

Among the *industrial waste water* and the most intensive sectors of the economy energy, ferrous and nonferrous metallurgy, machine building, chemical, petrochemical, wood-chemical, petrochemical industry, as well as housing and agriculture are large consumers of water. These drainage pipes are often very difficult to detect because they are immersed in water and are usually outside the Pale of settlement. Industrial waste water depending on the specific industries includes petroleum products, synthetic surface active substances (surfactants), phenols, fluorides, heavy metals and so on.

Gas and smoke releases fall into water from precipitation and in the process of mechanical settling. They contain both coarse contaminants, which include ash, soot, dust and gases, primarily sulfur dioxide and nitrous oxide, which, which combining with water form sulfuric and nitric acid.

Agriculture waste water contains a large number of biogenous elements, leading to the mass reproduction of phytoplankton, especially blue-green and brown algae.

Atmospheric waters contain washed out from the air pollutants of industrial origin.

The nonliving organic matter in sewage presents a different kind of pollution problem because it decays in the water. Microorganisms use oxygen dissolved in the water when they degrade the organic material. Oxygen depletion can result in fish death and changes in the normal algae community, which lead to visual and odor problems. Nutrients, such as nitrates and phosphates from detergents and agricultural runoff, enrich water and stimulate algae and aquatic plant growth. If too much organic matter is added to the water, all of the available oxygen will be used up. Then anaerobic (not requiring oxygen) bacteria begin to break down wastes. Anaerobic respiration produces chemicals that have a foul odor and an unpleasant taste and that generally interfere with the well-being of humans.

Sometimes pollution that enters the environment in one place has an effect hundreds or even thousands of miles away. This is known as **transboundary pollution**. One example is the way radioactive waste travels through oceans from nuclear reprocessing plants in England and France to nearby countries such as Ireland and Norway.

Pollution of *surface water, groundwater, and oceans* is of major concern today.

Surface Water Pollution. All sorts of pollutants from various sources enter surface waters.

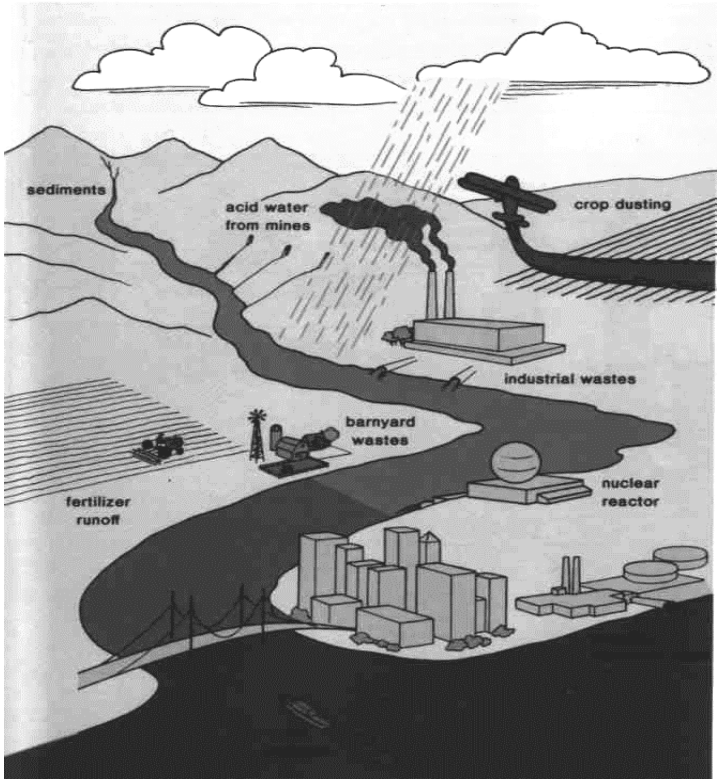
Sewage treatment plants can help degrade organic waste, which otherwise can cause oxygen depletion in lakes and rivers. As the oxygen level decreases, the diversity of life is greatly reduced. Also, human faeces can contain pathogenic microorganisms that cause cholera, typhoid fever, and dysentery. In less developed countries, where the population is growing and where waste treatment is practically nonexistent, many children die each year from these diseases.

Typically, sewage treatment plants use bacteria to break down organic matter to inorganic nutrients, like nitrates and phosphates, which then enter surface water. These types of nutrients, which also can enter waters by fertilizer runoff and soil erosion, lead to *cultural eutrophication,* an acceleration of the natural process by which bodies of water fill in and

disappear. First, the nutrients cause overgrowth of algae. Then, when the algae die, oxygen is used up by the decomposers, and the water's capacity to support life is reduced. Massive fish death is sometimes the result of cultural eutrophication.

Industrial wastes can include heavy metals and organochlorides, such as pesticides. These materials are not degraded readily under natural conditions or in conventional sewage treatment plants. Sometimes, they accumulate at the bottom mud of deltas and estuaries of highly polluted rivers and cause environmental problems if they are disturbed.

Some pollutants enter bodies of water from the atmosphere. Acid deposition has caused many lakes to become sterile in industrialized world, because acid leaches aluminum and iron out of the soil. A high concentration of these ions kills fishes and other forms of aquatic life. Lime is sometimes helpful against acidification of a lake (picture 3.1, table 3.1).

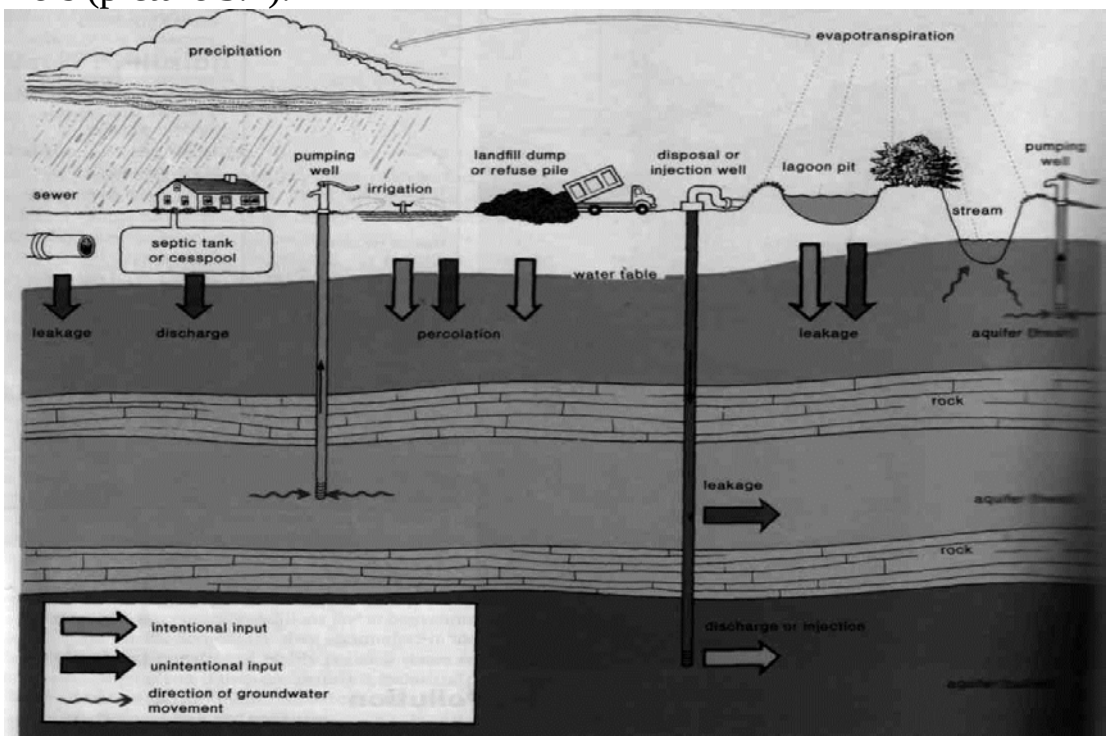


Picture 3.1. Surface Water Pollution.

Table 3.1. Sources of Water Pollution.

Leading to Cultural Eutrophication	
Oxygen-demanding wastes	biodegradable organic compounds (e.g., sewage, wastes from food processing, plants, paper mills, and tanneries)
Plant nutrients	nitrates and phosphates from detergents, fertilizers, and sewage treatment plants
Sediments	enriched soil in water due to soil erosion
Thermal discharges	heated water from power plants
Health Hazards	
Disease-causing agents	bacteria and viruses from sewage (e.g., food poisoning and hepatitis)
Synthetic organic compounds	pesticides, industrial chemicals (e.g., PCBs)
Inorganic chemicals and minerals	acids from mines and air pollution; dissolved salts; heavy metals (e.g., mercury) from industry
Radioactive substances	from nuclear power plants, medical and research facilities, and nuclear weapon testing

Groundwater Pollution. These are the ways - both intentionally and unintentionally - these pollutants can reach underground rivers called aquifers (picture 3.2).



Picture 3.2. Sources of Groundwater Pollution.

In areas of intensive animal farming or where there are many septic tanks, ammonium (NH_4^+) released from animal and human waste is converted by soil bacteria to soluble nitrate, which moves down through the soil (percolates) into underground water supplies.

Ocean Water Pollution. Coastal regions are not only the immediate receptors for local pollutants, they are also the final receptors for pollutants carried by rivers that empty at a coast. Waste dumping also occurs at sea, and ocean currents sometimes transport both trash and pollutants back to shore. Examples are the no biodegradable plastic bottles, pellets, and containers that now commonly litter beaches and the oceans' surfaces.

Offshore mining and shipping add pollutants to the oceans. Some 5 million metric tons of oil a year, or more than one gram per 100 square meters of the oceans' surfaces, end up in the oceans. Large oil spills kill plankton, fish larvae, and shellfishes, as well as birds and marine mammals.

The water pollutants are divided into:

- chemical (organic and inorganic substances);

- physical (thermal pollution, sand, clay, macroscopic impurities);

- biological (pathogenic bacteria, viruses, cysts of protozoa, fungi and helminthes eggs).

Chemical water contaminants may include ***organic and inorganic substances***.

Organic water pollutants include:

- *detergents*;
- *disinfection by-products* found in chemically disinfected drinking water, such as chloroform;
- *food processing waste*, which can include oxygen-demanding substances, fats and grease;
- *insecticides and herbicides*, a huge range of chemical compounds;
- *petroleum hydrocarbons*, including fuels (gasoline, diesel fuel, jet fuels, and fuel oil) and lubricants (motor oil), and fuel combustion byproducts, from storm water runoff;
- tree and bush debris from logging operations;
- *volatile organic compounds* (VOCs), such as industrial solvents, from improper storage;
- *chlorinated solvents*, which are dense non-aqueous phase liquids (DNAPLs), may fall to the bottom of reservoirs, since they don't mix well with water and are denser.

- *polychlorinated biphenyls* (PCBs);
- *trichloroethylene*;
- *perchlorate;*
- various chemical compounds found in personal *hygiene* and *cosmetic* products.

Inorganic water pollutants include:

– *acidity* caused by industrial discharges (especially sulfur dioxide from power plants);

– *ammonia* from food processing waste;

– *chemical waste* as industrial by-products;

– *fertilizers* containing nutrients--nitrates and phosphates—which are found in storm water runoff from agriculture, as well as commercial and residential use;

– *heavy metals* from motor vehicles (via urban storm water runoff) and acid mine drainage;

– *silt* (sediment) in runoff from construction sites, logging, slash and burn practices or land clearing sites.

Macroscopic pollution - large visible items polluting the water - may be termed "***floatables***" in an urban storm water context, or marine debris.

The sources of **soil pollution** are typically caused by industrial activity, agricultural chemicals, or improper disposal of waste.

The most common *anthropogenous* sources of lithosphere pollution are agriculture, industrial enterprises, transport and household objects (sewage, firm household waste). Contamination is correlated with the degree of industrialization and intensity of chemical usage.

Soil pollution can be caused by:

- application of pesticides and fertilizers;
- mining;
- oil and fuel dumping;
- disposal of coal ash;
- leaching from landfills;
- drainage of contaminated surface water into the soil;
- discharge of urine and faeces in the open.

The soil pollutants of **physical** nature are dust, radionuclides.

The soil pollutants of **chemical** nature are petroleum hydrocarbons, polynuclear aromatic hydrocarbons (such as naphthalene and

benzo(a)pyrene), solvents, pesticides, fertilizers, acids, alkaline, lead, and other heavy metals.

The soil pollutants of **biological** nature are pathogenic bacteria, viruses, protozoan cysts and helminthes eggs, fungi.

Medical value of physical pollutants of air, water and soil

Noise is referred to as unwanted sound. However, noise can be more than just unpleasant sound. Research has shown that exposure to noise can cause physical, as well as mental, harm to the body. The loudness of the noise is measured by decibels (db). Decibel scales are logarithmic, rather than linear. Thus, the change from 40 db (a library) to 80 db (a dishwasher or garbage disposal) represents a ten-thousand fold increase in sound loudness (table 3.2).

Table 3.2. Noise intensity.

Intensity Of Noise	
Source of sound	**Intensity, decibels**
jet aircraft at takeoff	145
pain occurs	140
hydraulic press	130
jet airplane (160 meters overhead)	120
unmuffled motorcycle	110
subway train	100
farm tractor	98
gasoline lawn mower	96
food blender	93
heavy truck (15 meters away)	90
heavy city traffic	90
vacuum cleaner	85
hearing loss after long exposure	85
garbage disposal unit	80
dishwasher	65
window air conditioner	60
normal speech	60

In addition to *hearing loss*, noise pollution is linked to a variety of other ailments, ranging from *nervous tension headaches to neuroses*.

Vegetative asthenic syndrome with symptoms of vascular hypertension develops. Chronic exposure to noise may cause *noise-induced hearing loss*.

The maximum permissible noise level in residential area should be not more than 55 dBA during the day (from 7 a.m. to 11 p.m.), not more than 45 dBA during the night (from 11 p.m. to 7 a.m.) (table 3.3).

Infrasound waves cause changes in the nervous, cardiovascular, respiratory, endocrine and other systems, as well as violation of cochleovestibular analyzer. Infrasound at sound pressure levels above 120 dB causes the irritating of the psycho-emotional sphere, causes the feeling of vibration of thoracic and abdominal walls, dysrhythmia of breathing, pain in the ears, dizziness, nausea, difficulty in swallowing, modulation of voice, hand tremors, chills, feeling of inexplicable fear and anxiety alternating with a feeling of exhaustion, fatigue, weakness and absent-mindedness.

Table 3.3. Maximum permissible noise levels in areas of the different economic purposes.

Name of territory	Equivalent noise level, dBA	
	day (7-23)	night (23-7)
residential area of settlements	55	45
redeveloped residential area	60	50
residential area near airports and airfields	65	55
public recreation area	50	30-35
sanitary and resort area	40-45	30-35
area of nature reserves and sanctuaries	to 25	to 20

Prolonged exposure to infrasound leads to the development of v*egetative asthenic syndrome* (weakness, fatigue, irritability, reduced working capacity).

The main symptoms of **electromagnetic fields** exposure on health are fatigue, irritability, sleep, memory and attention disturbances. The action of the electromagnetic field causes a change in the structure of cell membranes, DNA, disruption of the flow of ionic metabolic reactions. It causes functional abnormalities of the nervous, cardiovascular and endocrine systems. Prolonged stay of human in the electromagnetic field can develop diseases of the cardiovascular and nervous systems.

Neurasthenia with memory loss, decreased mental performance, constant headaches, sleep disorders, pain in the heart, hypotension, bradycardia develops.

The development of *cancer* is among of the long-term effects of electromagnetic fields.

Wide spread occurrence of electromagnetic radiation and their rush penetration in all spheres of human activity led to the appearance of a comparatively new set of pollutants, named "electromagnetic smog", which means a totality of electromagnetic fields and various radiations, emerging in the course of operation of complex electromagnetic equipment (table 3.4).

Table 3.4. Maximum permissible levels of exposure to electromagnetic fields of industrial frequency on the population of transmission line.

MPL, κV/m^2	**Irradiation conditions**
0.5	in residential buildings
1.0	in residential area
5.0	in populated areas outside the residential area, as well as in gardens and orchards
10.0	in the areas of overhead power lines and automobile roads of i-iv categories
15.0	in unpopulated area
20.0	in difficult terrain and in areas of enclosed specifically to exclude public access

With regard to the cardiovascular system hypertensive neurocirculatory dystonia, myocardiodsystrophy accompanied by rapidly progressing coronary insufficiency have been observed. Leucopenia and thrombocytopenia have been typical of peripheral blood.

Biological studies have proved that it is the central nervous system, eyes and gonads that are the most sensitive to electromagnetic radiation exposure. At this, disorders in cardiovascular, neuroendocrine, hemopoietic and immune system's activity and in metabolic processes may occur. Studies have shown that human reproductive system is very sensitive to electromagnetic radiation exposure. At this, among men rather high percentage of impotency and blood testosterone value reduction have

been detected. Disorders in women's genital function (toxicosis of pregnancy, spontaneous abortion, and partus pathology) may be observed.

Heating is the main biological effect of the electromagnetic fields of radiofrequency fields.

Particles. Airborne particles are sometimes referred to as 'particulate matter' or 'PM'. They include **dust, dirt, soot, smoke, and liquid droplets**.

Some particles are emitted directly into the air from a variety of sources that are either natural or related to human activity. Natural sources include bushfires, dust storms, pollens and sea spray. Those related to human activity include motor vehicle emissions, industrial processes (electricity generation, incinerators and stone crushing), unpaved roads and wood heaters.

Particle pollution is the major cause of reduced visibility. This can be a serious safety issue on roads and in traffic tunnels and can also affect our enjoyment of the natural landscape.

Particulates, small pieces of solid materials dispersed into the atmosphere, constitute the third largest category of air pollutants. Smoke particles from fires, bits of asbestos from brake linings and insulation, dust particles, and ash from industrial plants contribute to the particulate load. Particulates cause problems ranging from the annoyance of soot settling on a backyard picnic table to the *carcinogenic* (cancer-causing) effects of asbestos.

Particulates cause most of their health effects by acting as centers for the deposition of moisture and gases from the atmosphere. As we breathe air containing particulates, we come in contact with concentrations of other potentially more harmful materials that have accumulated on the particulates. Sulfuric, nitric, and carbonic acids, which irritate the lining of our respiratory system, frequently form on particulates.

Thermal pollution of water is the rise or fall in the temperature of a natural body of water caused by human influence. Thermal pollution, unlike chemical pollution, results in the change in the physical properties of water. A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. Elevated water temperature decreases oxygen levels, which can kill fish, and can alter food chain composition, reduce species biodiversity, and foster invasion by new thermophilic species. Urban runoff may also elevate temperature on the surface of water. Thermal pollution can also be caused by the release of very cold water from the base of reservoirs into warmer rivers.

The medical value of physical pollutants is the development of *dyspepsia*, *irritable bowel syndrome*. The pathogenesis of ***dyspepsia*** is that physical pollutants cause mechanical irritation of the nerve endings of the intestinal mucosa, increasing its motility.

Irritable Bowel Syndrome, or IBS, is called as a functional disorder of the activities of small intestine and (or) of the colon, which is clinically manifested by pain and discomfort in the abdomen, disturbance of the transport function of the intestine, a change in the number and form of stool. Mechanical stimuli cause physical trauma of the intestinal mucosa, increase the sensitivity of the intestinal wall receptors, which play an important role in the formation of peristaltic movements and the perception of pain.

The content of artificial **radionuclides** in soil depends on the number of nuclear weapons tests and on the quality of work at atomic industries. Radionuclides cause ***deterministic*** effects (radiation sickness, local radiation injuries) and ***stochastic*** effects (cancer, mutations).

Medical value of chemical pollutants of air, water and soil

Air pollution has significant medical value, as it is the cause of 50% of all environment-related diseases. The reason is that the alveolar lung tissue has a great absorbing ability and pollutants can easily penetrate into the internal environment of the body. The pollutants received by inhalation way are released into the systemic circulation passing a liver. To prevent inhalation of xenobiotics in the respiratory tract there is practically no personal protection means.

Mode of action of air chemical pollutants on humans at the time of exposure and the manifestation of the effect can be represented as follows (picture 3.3).

Sharp action of air pollutions is provoked by:

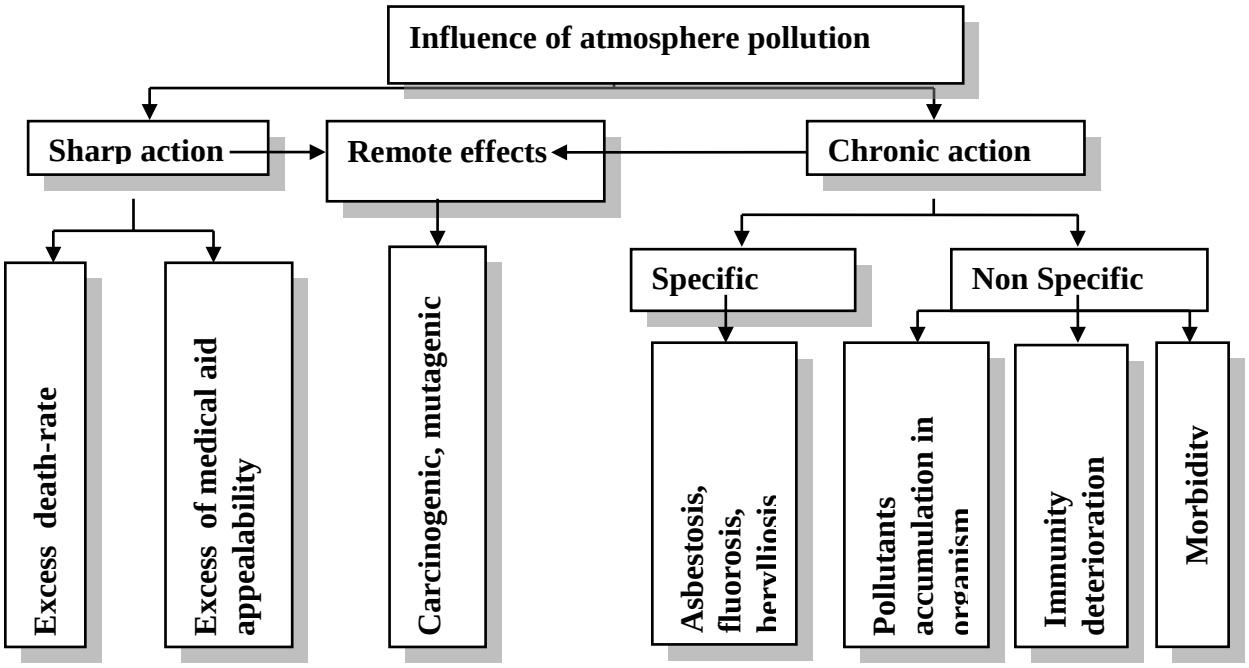
1. sharp change of weather in the given territory (temperature inversion, calm, fog, strong stable wind from the side of industrial enterprise);

2. failures at the industrial enterprises or treatment facilities, as a result air pollution of residential areas considerably increases, exceeding maximum permissible levels often in ten times.

Chronic action of air pollutions are:

1. ***chronic specific action*** is shown at the population which have not been bound to professional work, but living in regions in which there is this or that industrial enterprise or effecting;

2. ***chronic nonspecific action*** is the most typical manifestation of long influence of factors of small intensity on the population of cities and is characterized by a wide spectrum of biological answers.



Picture 3.3. Influence of atmosphere pollution.

In the main mass of population in terms of air pollution, premorbid condition with minor biochemical, physiological and other changes or accumulation in organs and tissues of certain pollutants without visible signs of health disorders are formed. In addition, a reduction of immune resistance and sensibilization to chemicals, forming the susceptibility to the development of *acute respiratory diseases, bronchial asthma, asthmatic bronchitis, allergic diseases*.

Chemical air pollutants possess ***pulmonary toxicity***, i.e. ability to cause structural and functional disorders of the respiratory system.

Acute poisoning is accompanied by *acute laryngitis, acute tracheobronchitis, pulmonary edema, acute interstitial pneumonia, acute respiratory failure*.

Chronic exposure to chemical pollutants leads to *long-term current rhinitis, sinusitis, bronchiectasis, emphysema, asthma, interstitial fibrosis* and other diseases.

Reception of chemical xenobiotics into the respiratory system causes immediate protective response in the form of cough, increased mucus secretion, bronchospasm, moderate edema. *Syndrome of reactive dysfunction of respiratory tract* may develop.

Direct contact of lung tissue with blood leads to *hematotoxicity* of pollutant. **Hematotoxicity** – is a property of the chemical substances which selectively disrupts the function of blood cells or cellular structure. It can be manifested by violations of the properties of hemoglobin in the form of *methemoglobinemia, carb- and carboxyhemoglobinemia, so as anemia, thrombocytopenia, leukopenia, leukemia*.

Carbon Monoxide (CO) affects healthy and unhealthy people. Increased levels of carbon monoxide reduce the amount of oxygen carried by haemoglobin around the body in red blood cells due to formation of carboxyhemoglobin. The result is that vital organs, such as the brain, nervous tissues and the heart, do not receive enough oxygen to work properly. No more than 2.5% of haemoglobin can be bound to carbon monoxide before some health effects become noticeable. At very high concentrations of carbon monoxide, up to 40% of the haemoglobin can be bound to carbon monoxide in this way. This level will almost certainly kill humans.

At 20% saturation of hemoglobin with carbon monoxide headache, emotional instability, decreased serviceability, deteriorated memory appear, at 20 - 50% - a severe headache, dizziness, nausea, weakness, mental disorders, at more than 50% - an arrhythmia, hypotension, loss of consciousness with oppression of the respiratory and cardiac center and death may occur.

Increased content of **carbon oxide (IV)** in the inhaled air to 3% leads to headache, shortness of breath, reduced working capacity, up to 4 - 5% - redness of the face, strong headaches, tinnitus, high blood pressure, tachycardia, excitation, up to 8 - 10% - a rapid loss of consciousness and death due to formation of carbhemoglobin in the blood.

Oxides of nitrogen (NO and $N0_2$) are also major primary air pollutants. A variety of different compounds contain nitrogen and oxygen; however, nitrogen oxide (NO) and nitrogen dioxide ($N0_2$) are the most

common. The nitrogen dioxide in the mixture reacts with other compounds to produce photochemical smog.

The main effect of breathing in raised levels of nitrogen dioxide is the increased likelihood of respiratory problems. Nitrogen dioxide inflames the lining of the lungs, and it can reduce immunity to lung infections. This can cause problems such as wheezing, coughing, colds, flu and bronchitis.

Nitrogen oxides in contact with a wet tissue of respiratory tract form nitrous and nitric acid, tracheobronchitis and in a consequence toxic pneumonia are developed.

Increased levels of nitrogen dioxide can have significant impacts on people with asthma because it can cause more frequent and more intense attacks. Children with asthma and older people with heart disease are most at risk.

Sulfur dioxide (SO_2). Sulfur dioxide is a gas. It is invisible and has a nasty, sharp smell. It reacts easily with other substances to form harmful compounds, such as sulfuric acid, sulfurous acid and sulfate particles.

Sulfur dioxide affects human health when it is breathed in. It irritates the nose, throat, and airways to cause coughing, wheezing, shortness of breath, or a tight feeling around the chest. The effects of sulfur dioxide are felt very quickly and most people would feel the worst symptoms in 10 or 15 minutes after breathing it in.

Those most at risk of developing problems if they are exposed to sulfur dioxide are people with asthma or similar conditions.

During a dense fog, the air over the city failed to mix with the layers of air in the upper atmosphere due to the temperature conditions. The factories continued to release smoke and dust into this stagnant layer of air, and the air became so full of the fog, smoke, and dust that people got lost in familiar surroundings. This combination of smoke and fog has become known as smog. Many individuals who lived in London, for example, developed such symptoms as respiratory discomfort, headache, and nausea. Four thousand people died in the next few weeks. Their deaths have been associated with the high levels of sulfur compounds in the smog. Thousands of others suffered from severe bronchial irritation, sore throats, and chest pains. Such incident already mentioned also involved symptoms related to the particles and sulfur dioxide in the air.

The **ammonia** content in the air in amount of 0.1 mg/dm^3 reflexively irritates the upper respiratory tract and eyes, leading to the development of

rhinitis, laryngitis, tracheobronchitis, 0.49 mg/dm^3 - causes coughing, 1.2 mg/dm^3 - loss of sense of smell.

Hydrogen sulfide has a strong irritant action, causing burning pain in the eyes, tearing, blepharospasm, conjunctival hyperemia, cough, bronchospasm. Prolonged impact causes *conjunctivitis, keratitis, laryngitis, bronchitis*. Hydrogen sulfide reacts with the iron of cytochrome A, B, C, inhibits cytochrome oxidase, resulting in tissue hypoxia. *Vegetative asthenic syndrome* is developed, which accompanied by headache, dizziness, weakness, sleep disorders.

Dioxins are the most toxic from the synthesized by man substances. Under the influence of even low doses, dioxin possesses by mutagenic, carcinogenic, embryotoxic action. They damage the individual links of cellular and humoral immunity. As a result, immunosuppressive condition called as *"dioxin AIDS"* is developed.

Dioxins disrupt metabolism, leading to the development of *skin porphyria* - pigmentation, emergence of bubbles, hypertrichosis, hyperkeratosis. Hepatomegaly with *impaired hepatic function* and its structure up to necrosis occurs.

Large doses of dioxins are responsible for *"exhaustion syndrome"* with the gradual depletion of the body, and subsequent death without explicit pathological symptoms.

Chemical water pollutants may cause harmful effect on human when entering by *inhalation, peroral and percutaneous* routes. Ingested with drinking water xenobiotics possesses neuro- and nephrotoxicity.

Neurotoxicity – is a property of chemical pollutants cause distortion of the structure and function of the nervous system, thus pollutants, coming through blood-brain barrier, have a direct effect on the central nervous system, and do not penetrate through the barrier – on the synapses and peripheral ganglia.

Neurotoxicity can manifest itself in the form of a violation of motor and sensory functions, emotional status, memory and learning. Vision, sound, tactile and pain sensitivity are frequently violated.

Nephrotoxicity – is a property of chemical substances to cause changes in the structure and functions of the kidneys. Nephrotoxic action begins with the accumulation of xenobiotic passing through the glomerular filtration barrier in tubular epithelial cells. Subsequently, the cells are destroyed, and their decay products stoppered the lumen of the tubules. When kidneys are damaged syndrome of acute renal failure, chronic renal

insufficiency, nephrotic syndrome, rapidly progressive glomerulonephritis syndrome, tubulointerstitial nephritis syndrome are marked.

In medical usage, *heavy metals* are loosely defined and include all toxic metals irrespective of their atomic weight: "heavy metal poisoning" can possibly include excessive amounts of iron, manganese, aluminium, mercury, cadmium, beryllium or such a semimetal as arsenic. This definition excludes bismuth, the heaviest of approximately stable elements, because of its low toxicity.

Lead enters into drinking water from pipes, solder, the water distribution system fixtures, especially in large quantities from a tap in the morning without draining. Getting through the digestive tract into the blood it binds to hemoglobin and distributes throughout the body. Prolonged exposure leads to muscle weakness and **hypochromic anemia**.

Lead forms hardly soluble lead phosphate in the bones and teeth. When a small doses with food and water, chronic intoxication develops slowly. In the early stages there is a decrease in adaptive abilities of the organism. General weakness, headache, dizziness, unpleasant taste in the mouth, tremor of limbs, loss of appetite, weight loss, constipation, epigastric pain are later joined. Diffuse myocardial degeneration, mental disorders, chronic nephropathy can be detected.

Elemental and methylmercury are toxic to the central and peripheral nervous systems. Neurological and behavioral disorders may be observed after exposure of different mercury compounds. Symptoms include tremors, insomnia, memory loss, neuromuscular effects, headaches and cognitive and motor dysfunction. High exposures to *inorganic mercury* may result in damage to the gastrointestinal tract, the nervous system, and the kidneys. Symptoms of high exposures to inorganic mercury include: skin rashes and dermatitis; mood swings; memory loss; mental disturbances; and muscle weakness.

Minamata disease results from *mercury* poisoning, and itai-itai disease from *cadmium* poisoning.

Minamata disease is a neurological syndrome caused by severe mercury poisoning. Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision, and damage to hearing and speech. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms. A congenital form of the disease can also affect fetuses in the womb.

Acute intoxication with cadmium is manifested by nausea, vomiting, abdominal cramps, in severe cases - *diarrhea and shock*. Cadmium accumulation causes degenerative changes in the nasal mucosa of the pharynx, the destruction of the olfactory epithelium, resulting in *cadmium rhinitis, obstructive diseases of the upper respiratory tract*.

In chronic poisoning *cadmium nephropathy, renal hypertension, cadmium osteomalacias (***Itai-Itai Disease***), iron deficiency, neurotoxic syndrome* occur.

Pesticides may cause acute and delayed health effects in humans who are exposed to it. Pesticide exposure can cause a variety of adverse health effects, ranging from simple irritation of the skin and eyes to more severe effects such as affecting the nervous system, mimicking hormones causing reproductive problems, also causing cancer and poisoning. Strong evidence also exists for other negative outcomes from pesticide exposure including birth defects, fetal death, neurological and neurodevelopmental disorders.

VOCs – benzol, carbon tetrachloride, toluene, vinyl chloride, dichloroethane and under prolonged exposure can damage the *kidneys, liver and* possess *carcinogenic effect*.

Saturated and unsaturated *hydrocarbons*, which are included into the mineral oil, possess a narcotic effect, cause changes in the cardiovascular and central nervous system. In conditions of acute exposure aromatic hydrocarbons affect primarily the central nervous system, causing a narcotic effect, accompanied by drowsiness, lethargy, tremors, and also have an impact on blood-forming organs and vascular systems of some bodies.

Nitrates form when microorganisms break down fertilizers, decaying plants, manures or other organic residues. Usually plants take up these nitrates, but sometimes rain or irrigation water can leach them into groundwater. Although nitrate occurs naturally in some groundwater, in most cases higher levels are thought to result from human activities. Common sources of nitrate include:

- fertilizers and manure;
- animal feedlots;
- municipal wastewater and sludge;
- septic systems;
- N-fixation from atmosphere by legumes, bacteria and lightning.

There is 2% of methemoglobin in the average in the red blood cells in humans. At the increasing in its content up to 10% there is an asymptomatic cyanosis, up to 20 - 50% - symptoms of hypoxia: expressed cyanosis, headache, weakness, shortness of breath, tachycardia, loss of consciousness. The content of methemoglobin in the blood of above 50% leads to death.

High nitrate levels in water can cause **methemoglobinemia or blue baby syndrome**, a condition found especially in infants less than six months. The gastric acid of an infant is not as strong as in older children and adults. This causes an increase in bacteria that can readily convert nitrate to nitrite (NO_2).

Nitrite is absorbed in the blood, and hemoglobin (the oxygen-carrying component of blood) is converted to methemoglobin. Methemoglobin does not carry oxygen efficiently. This results in a reduced oxygen supply to vital tissues such as the brain. Methemoglobin in infant blood cannot change back to hemoglobin, which normally occurs in adults. Severe methemoglobinemia can result in brain damage and death.

Pregnant women, adults with reduced stomach acidity, and people deficient in the enzyme that changes methemoglobin back to normal hemoglobin are all susceptible to nitrite-induced methemoglobinemia. The most obvious symptom of methemoglobinemia is a bluish color of the skin, particularly around the eyes and mouth. Other symptoms include headache, dizziness, weakness or difficulty in breathing.

Fluorine occurs naturally in the earth's crust where it can be found in rocks, coal and clay. Small amounts of fluorine are naturally present in water. As a result humans are exposed to fluorine through drinking water. If fluorine is absorbed too frequently, it can cause teeth decay, osteoporosis and also causes harm to kidneys, bones, nerves and muscles.

The basic **soil chemical pollutants** are petroleum hydrocarbons, polynuclear aromatic hydrocarbons (such as naphthalene and benzo(a)pyrene), solvents, pesticides, fertilizers, acids, alkaline, lead, and other heavy metals.

Total **petroleum hydrocarbon** (TPH) is a term used for any mixture of hydrocarbons that are found in crude oil. Chemicals that occur in TPH include hexane, benzene, toluene, xylenes, naphthalene, and fluorine, other constituents of gasoline, of jet fuels, of mineral oils, and of other petroleum products. They are ozone depleting substances.

Long-term mental health effects from exposure to crude petroleum hydrocarbons exposure to petroleum hydrocarbons: psychological stress; depression; post-traumatic stress disorder among indigenous people; elevated rates of anxiety disorder.

These symptoms include: wheezing and breathlessness, wheezing apart from colds, nocturnal attacks of shortness of breath, chronic cough and phlegm, lower respiratory tract symptoms, oral medication usage.

Polycyclic aromatic hydrocarbons (PAHs), also known as poly-aromatic hydrocarbons or polynuclear aromatic hydrocarbons. As pollutants, they are of concern because some compounds have been identified as *carcinogenic, mutagenic, and teratogenic*.

High prenatal exposure to PAH is associated with lower IQ and childhood asthma. Exposure to PAH pollution during pregnancy is related to adverse birth outcomes including low birth weight, premature delivery, and heart malformations. Cord blood of exposed babies shows DNA damage that has been linked to cancer. There are higher level of developmental delays at age three, lower scores on IQ tests and increased behavioral problems at ages six and eight.

Fertilizer is any organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to a soil to supply one or more plant nutrients essential to the growth of plants. Regular use of fertilizers generally contribute to the accumulation of soil acidity in soils which progressively increases aluminium availability and hence toxicity.

The use of ammonium nitrate in inorganic fertilizers is particularly damaging, as plants absorb ammonium ions preferentially over nitrate ions, while excess nitrate ions which are not absorbed dissolve (by rain or irrigation) into runoff or groundwater. Nitrate levels in excess can cause 'blue baby syndrome' (acquired *methemoglobinemia*), leading to hypoxia (which can lead to coma and death if not treated).

A pesticide is generally a chemical or biological agent (such as a virus, bacterium, antimicrobial or disinfectant) that through its effect deters, incapacitates, kills or otherwise discourages pests. Target pests can include insects, plant pathogens, weeds, mollusks, birds, mammals, fish, nematodes (roundworms), and microbes that destroy property, cause nuisance, spread disease or are vectors for disease. Although there are benefits to the use of pesticides, some also have drawbacks, such as potential toxicity to humans and other animals. According to the Stockholm

Pesticides may cause acute and delayed health effects in workers who are exposed to it. Pesticide exposure can cause a variety of adverse health effects, ranging from simple *irritation of the skin and eyes* to more severe effects such as *affecting the nervous system, mimicking hormones* causing reproductive problems, and also causing *cancer*. Lymphoma and leukemia showed positive associations with pesticide exposure. Strong evidence also exists for other negative outcomes from pesticide exposure including *neurological, birth defects, fetal death, and neurodevelopmental disorder*.

Chlororganic pesticides are chlorinated polynuclear hydrocarbons such as dihlordife-niltrihloretan (DDT), β-hexachlorocyclohexane, mirex, aldrin, chlordane, lindane, pentachlorobenzene. Under the influence of DDT *kidney, central and peripheral nervous system damage, cirrhosis of the liver*, as well as the *long-term consequences* can be observed in humans.

Chlororganic pesticides are effectors of the endocrine system and disrupt the hormonal balance in the human body. They can mimic the action of natural hormones (estrogen in particular), change the structure of the enzymes that break down hormones and stimulate a strong hormonal response. The consequences of the impact of *effectors of the endocrine system* are a *violation of the reproductive function, sexual development in males, testicular cancer, prostate cancer, breast cancer and endometriosis in women, violation of children's psychomotor development, the development of metabolic syndrome, obesity*.

Phosphorusorganic pesticides are dibromo thiophos, metaphos, malathion, trichlorfon, and others. They can cause *neuropathies*. The main symptoms of poisoning by phosphorus organic pesticides are *bradycardia, contraction of the pupil, muscle twitching of the face, neck, hypertension, headache, disturbance of consciousness, convulsions, paralysis*. The clinical picture of chronic intoxication is manifested by *persistent headaches, dizziness, memory loss, sleep disturbances, lack of appetite, nausea, general weakness*.

Fluorine that is located in soils may accumulate in plants. Fluorine primarily accumulates in bones. Consequently, humans that are exposed to high concentrations of fluorine suffer from dental decay and bone degradation. Too much fluorine can also cause the uptake of food from the paunch to decline and it can disturb the development of claws. Finally, it can cause *fluorosis*.

There is also increasing *blastomogenic risk* of soil, which is associated with an increased content of benzo(a)pyrene near the airfields and along the corridors of planes. The increased content of carcinogenic substances in the soil is also observed near the thermal power stations with ineffective ash catchers, in the areas of forest fires, near highways, etc. From soil with drinking water, food and air exogenous chemical substances enter the human body by biological food chains.

Accumulated in soil chemicals are washed from its surface to surface waters or into ground water flow, thereby determining the qualitative composition of household and drinking water as well as food products of plant origin. The qualitative composition and the amount of chemicals in these products are largely determined by the type of soil and its chemical composition.

Recently, not only the natural soil endemic regions but also artificial **biogeochemical regions** and provinces are formed. Their appearance is associated with a variety of pesticides, fertilizers, plant growth stimulants, etc., as well as the accumulation in the soil of industrial emissions, effluents and wastes containing chemical substances belonging to different hazard classes. In artificial geochemical provinces increase in the *incidence, sometimes congenital malformations and developmental abnormalities, impaired physical and mental development of children* are marked. There are both *acute and chronic poisonings, allergic diseases*.

Medical value of biological pollutants of air, water and soil

Through the contaminated with microbial aerosols atmospheric air the infectious diseases of *viral, bacterial and fungal nature* can be transmitted to a person.

The airborne route of transmission of disease is ***airborne droplets*** and ***airborne dust***. Unstable viruses and bacteria are mainly passed by droplets at a close distance. A more stable and spore-forming bacteria are transferred from the dust particles over long distances.

Pathogenic viruses transmitted by the airborne route entering into the human body through the respiratory system cause *acute respiratory virus infection, influenza, parainfluenza, adenovirus infection, respiratory syncytial infection, measles, chicken pox, rubella, mumps, viral poliomyelitis, viral encephalitis, herpes, infectious mononucleosis*.

Pathogenic bacteria cause diseases such as *tuberculosis, pneumonia, meningitis, tonsillitis, diphtheria, scarlet fever, pertussis.*

Biological pollutants can be airborne and can have a significant impact on indoor air quality (table 3.5).

Table 3.5. Major Air-Born Diseases.

Disease Name	More Prevalent	Site of infection	Causative agent	Symptoms
Diphtheria (Bacterial)	children	tonsils throat nose	cornea bacterium diphtheria	infection of tonsils, throat toxemia
Tuberculosis (Bacterial)	human beings	respiratory disease	mycobacterium tuberculosis	loss of appetite, fatigue, night sweat
Rheumatic fever (Bacterial)	human beings	respiratory tract	streptococcus pyroxenes	inflammation and degeneration of heat valves
Common cold (Viral)	human beings	nose	rhinovirus	burning of nose
Influenza (Viral)	human beings	nose and throat	orthomyxo virus	head ache, nasal discharge, muscle pains, sore throat and general weakness
Measles (Viral)	human and children	respiratory tract	morbilli virus	fever, cough, cold and red blotchy skin
Mumps (Viral)	child hood disease	parotid glands and salivary glands	mumps virus	painful swelling of parotid glands and salivary glands
Cryptococcus (Viral)		human lungs	yeast cryptococcus	

Aspergillosis, Histoplasmosis and Coccidioidomycosis are examples of serious fungal infections of humans, initiated by spores deposited in the alveoli. They can be life-threatening diseases of immunocompromised people, when the fungi disseminate from the lungs to major organs of the body. However, in all cases the infection of humans is incidental to the fungus, playing no part in its normal biology. These are

fungi that grow naturally as decomposer organisms in soil, bird faeces or other organic substrates.

The diseases caused by the use of polluted water for drinking, cooking, bathing or inhalation of hydroaerosols, taking shower, the air conditioning, because the pathogens are able to save for a long time in the water viability and virulence (table 3.6).

Table 3.6. Characteristics of the most important waterborne pathogens.

Pathogen	Risk for health	Time of survival in water, day	Minimum infective dose, cells
Bacteria			
Shigella (4 species)	High	5-30	~10
Salmonella typhi	High	80-100	~10000
Vibrio cholerae	High	5-20	~1000
Salmonella (1700 types)	High	15-280	10000-1000000
Pseudomonas aeruginosa	Average	Can reproduce	>10000
Legionella pneumophilla	High	200-360	>10000
Viruses			
Enteroviruses (71 types)	High	20-200	1-10
Rotaviruses	High	10-70	1-10
Protozoa			
Giardia lamblia	High	20-80	60-100
Entamoeba histolytica	High	30-60	20-50
Cryptosporidium parvum	High	50-120	10-30

Coliform bacteria are commonly used bacterial indicator of water pollution, although not an actual cause of disease. Other microorganisms sometimes found in surface waters which have caused human health problems include:

- ✓ burkholderia pseudomallei;
- ✓ cryptosporidium parvum;
- ✓ giardia lamblia;
- ✓ salmonella;
- ✓ novovirus and other viruses;

- ✓ parasitic worms (helminthes).

Contaminants of biological nature in water can cause the following infection diseases:

- ✓ bacteria (a cholera, a belly typhus, a paratyphus, a dysentery);
- ✓ virus (infectious hepatitis, poliomyelitis);
- ✓ zoonoses (tularemia, brucellosis);
- ✓ protozoonoses (amebiasis, balantidiasis);
- ✓ helminthiasises (ascariasis);
- ✓ fungus (epidermophytosis).

A variety of classic and emerging **soil**-related bacterial and fungal pathogens cause serious human diseases that frequently presents in primary care settings.

Pollution of ground by biological agents can lead to development of the following infection diseases:

- bacterial (a belly typhus, a dysentery, legionellosis);
- virus (poliomyelitis, infectious hepatitis);
- parasitological (ascariasis, dochmiasis);
- protozoa (teniasis, amoebiasis, balantidifsis);
- fungal (dermatophytes, coccidioidomycosis, blastomycosis, sporotrichosis, aspergillosis).

Typically, the growth of these microorganisms is favored by particular soil characteristics and may involve complex life cycles including amoebae or animal hosts. Specific evolved virulence factors or the ability to grow in diverse, sometimes harsh, microenvironments may promote pathogenesis. In addition to the "classic" infections *tetanus, botulism, gas gangrene, Siberian ulcer, anthrax*, soil-related bacterial infections include *wound infections, gastroenteritis, and specific respiratory syndromes*. The systemic fungi are largely acquired via inhalation from contaminated soil and near-soil environments. These fungal infections are particularly life-threatening in those with compromised *immune systems*.

Tetanus and botulism are caused by the toxin-producing, anaerobic, spore-bearing, Gram-positive bacteria, *Clostridium tetani* and *Clostridium botulinum*, respectively.

The generalized form is most common and is characterized by tonic contraction of the skeletal muscles and intense intermittent muscle spasms. Classic findings include trismus (in approximately 50%), stiff neck, opisthotonus, a "sardonic" smile, abdominal rigidity, and periods of apnea.

More muscle groups become involved as the illness progresses and fractures of vertebrae or other bones may occur (sometimes triggered by relatively minor stimuli). Patients remain conscious during spasms and anxiety and pain may be significant. Signs of autonomic hyperactivity generally are present, and bradycardia and hypotension may lead to cardiac arrest.

Botulism is a serious disease characterized by weakness, paresis, and paralysis, classically presenting with acute bilateral cranial neuropathies and symmetrically descending weakness. Infant botulism typically involves upper airway obstruction, constipation, feeding difficulties, weak cry, drooling, and hypotonia.

Gas gangrene may be caused by one of several species of *Clostridium*, the spores of which are distributed worldwide in the soil. The clostridia usually are present in combination with aerobic bacteria or anaerobic streptococci. Gas gangrene typically follows infection of deep wounds that have been contaminated by soil or feces. *Clostridium perfringens* is ubiquitous in soil, from which it may be ingested into the gastrointestinal tract. It is associated with a variety of human diseases, including classic food poisoning.

Several species of **Legionella** cause pneumonia (and, rarely, extrapulmonary disease) and are associated with Pontiac fever, a febrile, nonpneumonic, influenza-like illness. The organisms exist in biofilms in the environment, often accompanied by other microorganisms, and survive and multiply within free-living amoebas. The amoeba may encyst during exposure to harsh environments to further promote survival of the parasitic *Legionella*. The primary route of infection by *Legionella pneumophila* is through inhalation of aerosolized contaminated water sources; however, there are reports of soil as an additional environmental source. These species may be found and persist in a variety of soils. *L. longbeachae* is not commonly isolated from water; instead, disease seems to be associated with potting mixes, composts, and soil products (particularly those subjected to high heat and moisture).

Most commonly, soil-related endemic fungi cause primary pulmonary disease, with the potential for dissemination, or primary skin disease in normal or immunocompromised hosts. Clues to fungal disease include exposure to endemic areas (with or without a specific history of soil contact), immunocompromise, nosocomial exposure, and pneumonia, which is unresponsive to appropriate empiric antibacterial therapy.

A variety of nondimorphic, soil-related **yeasts and molds** can cause significant local or systemic human infection, particularly in those who are immunocompromised. These include Rhizopus and Mucor (sinus, pulmonary, gastrointestinal, wound) and a variety of traumatic infections. The latter include the fungal causes of mycetoma, or "Madura foot," the etiologic agents of which inhabit tropical and subtropical regions typified by extremes of wet and dry conditions and temperature swings. This entity is most common among those working in fields, where infection is acquired in a manner similar to sporotrichosis. Mycetoma starts as a slowly progressive, painless subcutaneous nodule, usually on the foot, and progresses to a classic triad of induration, draining sinuses, and discharging granules that are collections of (in this case) fungal hyphae. Hands and other body parts may be the primary site. If unabated, deep tissue or visceral organ invasion may occur.

Infections caused by *Aspergillus* species (excludes allergic brochopulmonary aspergillosis) are usually in immunocompromised patients and include invasive pulmonary **aspergillosis** (cough, dyspnea, possible fever, chest pain, hemoptysis, wheezing); pulmonary or sinus fungus balls; chronic pulmonary aspergillosis (cavitary, fibrosing, subacute); sinusitis; endocarditis; and other superficial or disseminated forms.

The indicators of sanitary state of the soil are presented in the table 3.7.

Table 3.7. Indicators of sanitary state of the soil.

Indicator	**Degree of soil pollution**			
	pure	poorly polluted	polluted	strongly polluted
Coli-titer	> 1	1 – 0,01	0,009 – 0,001	<0,001
The titer of anaerobes	> 0,1	0,1 – 0,001	0,0009 – 0,0001	<0,0001
The number of helminth eggs per 1 kg	no	1 – 10	11 – 100	>100
The number of larvae and pupae of flies on 25 cm^2	no	1 – 10	11 – 100	>100
Sanitary number	0,98 – 1	0,85 – 0,97	0,75 – 0,84	<0,75
Multiplicity of MPC excess for exogenous chemicals	1	2 – 10	11 – 100	>100

It is possible to judge the degree of ground impurity on **sanitary number** which is the effect of humus nitrogen on the general organic nitrogen in the ground. At ground self-cleaning and mineralization of organic substances the amount of humus nitrogen increases and, hence, the sanitary number increases, coming nearer to 1.

Diagnostic, treatment and prevention of environmental pathology, caused by pollutants of human environment

To **diagnose** the environmental pathology caused by the pollutants of human environment a detailed anamnesis is collected by the interview method to reveal the hereditary changes which have been appeared under the influence of stressful, biological, chemical and physical pollutants of the environment, triggers of the environmental pathology, as well as the time of residence in the region, phenomena of elimination and re-exposure.

The patient is examined, the disorders of nutrition status is clarified, specific and non-specific signs which are characteristics of pollutants are established in the clinical picture, laboratory tests are appointed to determine the hormone status, processes of free radical oxidation, metabolites, chemical xenoboitics, and parasites.

To **confirm the diagnosis** the following information is revealed:

- anthropogenic pollution of the environment;
- prolonged circulation of the etiological factor of low intensity on the territory;
- a long latent period with an increase in nonspecific morbidity;
- an increase in nonspecific diseases in persons with genetic sensitivity to pollutants;
- polysyndrome character and the various severity of the clinical course of the disease with the same pollutant;
- resistance to the standard treatment scheme at the exposure of the pollutant;
- the direct correlation of morbidity with the level of pollutants.

Treatment of the acute environmental diseases caused by the pollutants of human environment is carried out in accordance with the clinical protocols using traditional methods, including the use of pharmacological drugs, physiotherapy, diet therapy, and psychotherapy.

In the treatment of infectious diseases, etiotropic antibiotic therapy, topical antiseptic therapy and symptomatic therapy are prescribed.

Treatment of the patients with chronic environmental pathology includes detoxication, first of all, with the help of nutrition and phytopreparations, restoration of broken nutritional status, immunocorrection, specific desensitization, appointment of antioxidants, mediator precursors, the drugs which bind and eliminate contaminants, elimination of organ and system dysfunctions, increase in the resistance of the organism.

Individual **prevention** includes the consumption of uncontaminated air, water, food products obtained on unpolluted soil, the formation of a healthy lifestyle with an emphasis on preventive nutrition and drinking mode, the reduction of the time of contact with pollutants, the refusal of contaminated water, air and food products, the use of personal protection means, reception of adaptogens.

Doctors perform medical survey and prophylactic medical examinations, supervision of the population in out-patient-policlinic establishments. They also send the individuals of the risk group for rehabilitation to sanatorium treatment, conduct environmental education and training, participate in supervision of the morbidity, physical development, and demographic indicators in accordance to the program of social and hygienic monitoring. The maximum permissible concentrations and levels of environmental pollutants are developed.

Maximum permissible concentrations of harmful substances in atmospheric air of the occupied places are presented in table 3.8.

Table 3.8. Maximum permissible concentrations of harmful substances in atmospheric air of the occupied places.

Substance	**MPC, mg/m^3**	
	daily average	maximum single
sulphurus gas	0.05	0.5
nitrogen oxide	0.04	0.085
nitrogen dioxide	0.06	0.6
carbon oxide	3	5
inorganic dust with more than 70 % of silicon dioxide content	0.05	0.15

At the development of safety standards, there are **maximum single** (on volunteers threshold of smell, reflector reactions, irritation action) and **daily average** (on experimental animals for 3-4 month of daily inhalations)

maximum permissible concentrations of harmful substances which are standardized.

Maximum permissible concentrations of the harmful substances in water of water objects are standardized (table 3.9).

Table 3.9. Maximum permissible concentrations of harmful substances in water of water objects of economic-potable and cultural-domestic water use.

Substance	MPC, mg/dm^3
ampicillin	0.02
benzol	0.5
chlorophos	0.05
iron	0.3
nitrates	45
nitrites	3.3
sulfates	500
chlorides	350
lead	0.03

Objects, their separate buildings and constructions with the engineering processes which are sources of influence on human environment and health are divided with **sanitary-protective zones** from a residential zone. It is a buffer zone between the operating site and nearby residential areas. It is established for industrial facilities that emit pollutants into the atmosphere or have other environmental impacts. The purpose of it is to protect nearby people from harmful industrial impacts such as noise, dust and air emissions. The presence of residential areas, recreational zones, schools, hospitals or food production facilities is prohibited within the sanitary-protective zone of an industrial enterprise.

For the objects, its separate buildings with technological processes, which are sources of influence on the environment and human health, depending on the capacity, operating conditions, the nature and amount of toxic and odorous substances given out to the environment, noise emission, vibration and other harmful physical agents, as well as the foreseen measures to mitigate the adverse impact on their environment and human health while ensuring compliance with hygiene standards in accordance with the sanitary classification of enterprises, industries and facilities are established the following minimum sizes of buffer zones:

- enterprise of the First Class - 1000 m;
- enterprise of the Second Class - 500 m;
- enterprise of the Third grade - 300 m;
- enterprises of the Fourth Class - 100 m;
- enterprise of the Fifth Class - 50 m.

Clearing of household sewage is carried out by the **water drain system** – is a complex of nonproductive constructions and sanitary actions which provide *gathering, removal, clearing, disinfecting and neutralization* of sewage. Thus biological ponds, constructions of artificial biological clearing, biofilters are used. Disinfecting of sewage is done with the gaseous chlorine, sodium hypochlorite, ozone, UV-beams, electro pulses.

Clearing methods:

- mechanical (special lattices, petrotraps and sediment bowls for removal of the weighed particles);
- chemical (neutralization, oxidizing and regenerative methods);
- physical and chemical (coagulation, sorption, adsorption, ionic exchange);
- biological (use of microbes communities for transformation of complex ecologically dangerous substances in to simple, harmless).

Coagulation – is a process of consolidation of colloidal particles in a liquid due to electrostatic forces of intermolecular interaction.

A variety of coagulation is the process of **flocculation** - consolidation of fine particles due to electrostatic interactions under the influence of specially added polyelectrolyte - flocculants. In practice of water purification activated silicic acid and polyacrylamide (PAA) are widely spread. The dose of coagulants and flocculants depends on the compound of treated water and adjusted at treatment facilities.

Sorption is a method of deep cleaning of industrial waste water from dissolved organic and some inorganic contaminants.

The mechanism of **adsorption** is in the transition of the molecules of solute compound from the liquid volume on the surface of solid sorbent by the action of its force field. Different natural and artificial materials such as ash, coke breeze, peat, zeolites, and active clay are applied as sorbents.

Ion exchange – is an extraction of cations and anions from the dissolved in wastewater contaminants using ionites that are solid natural or artificial materials (for example, artificial ion-exchange resins).

Wastewater Treatment. Because water must be cleaned before it is released, most companies and municipalities maintain wastewater treatment facilities. Treatment of sewage is usually classified as primary, secondary, or tertiary. **Primary sewage treatment** removes larger particles by filtering through large screens and settling in ponds or lagoons. **Secondary sewage treatment** usually follows primary treatment and involves holding the wastewater until the organic material has been degraded by the bacteria and other microorganisms.

Primary and secondary facilities are the most common types of sewage treatment. The water discharged from these sewage treatment plants must be disinfected. The least costly method of **disinfection** is chlorination of the wastewater after it has been filtered and the organic materials have been allowed to settle. Using ultrasonic energy to break down waste mechanically may be less harmful and more effective, but it is also more expensive than chlorination.

Tertiary sewage treatment involves a variety of different techniques to remove dissolved pollutants left after primary and secondary treatments. The tertiary treatment of wastewater removes phosphorus and nitrogen that could increase aquatic plant growth. Tertiary treatment is very costly because it requires specific chemical treatment of the water to eliminate specific problem materials.

Organization of sanitary protection zone is an important action in water sources and potable water supply protection from pollution. **Sanitary protection zone** - is the area around the water sources and water facilities, where there is a special regime that excludes or limits the possibility of contamination or infection. Sanitary protection zones are established at all operating, under construction and planned water pipes and are divided into three zones with a special mode in each.

I belt - strict regime zone — is an area which includes the area of water intake, water lifting devices, headworks, water feeding channel. It is designed to protect the places of water intake and water intake structures from accidental or intentional contamination or damage. The first zone is shielded and protected, surrounded by a strip of green plants.

The boundaries of the first belt of water pipe from underground water source are set to the radius of 30-50 m. The boundaries of the first belt of water pipe from superficial water source are set at the distance of 200 m upstream, 100 m downstream and 100 m along the shore adjacent to the water intake from the water line.

Belt restrictions include the area for prevention of water pollution of water sources. Location of various objects in the area is controlled by the sanitary-epidemiological service. Within the second and third zones construction and water discharge are limited; water sports and other purposes are not permitted.

II belt — restricted area (time restrictions to protect against possible microbial contamination) — covers land, surface and underground run-off which can affect the composition and properties of the water supply source. The boundary of the second zone of superficial water source must be removed in the waters in all directions from the water intake to 3-5 km, and the lateral boundaries should be located at the distance of 500-1000 m from the water's edge at the summer-autumn high water.

Sizes of the second zone for underground water sources are determined by hydrodynamic calculations, based on the conditions that microbial contamination entering the aquifer outside of the second zone does not reach the water intake. The main parameter that determines the boundary of the second zone is the time of movement of microbial contamination to groundwater flow to the water intake. This time depends on the type of water intake, hydrological conditions, degree of protection of groundwater.

With the improvement of the epidemiological situation in our country ***III belt — restricted area*** (time restrictions to protect against possible chemical contamination) is necessary also. The boundary of the third zone is also determined by the hydrodynamic calculations taking into account the time of movement of chemical pollution to water intake. It is similar with the boundary of the second zone of superficial water source.

Maximum permissible concentrations of the harmful substances in soil are standardized (table 3.11).

Table 3.11. Maximum permissible concentrations of chemicals in the soil.

Substance	MPC, mg/kg
benzo (a) pyrene	0.02
benzol	0.3
benzine	0.1
toluene	0.3
nitrates	130
formaldehyde	7
hexachloran	0.1

karbofos	2
chlorophos	0.5
sevin	0.05
arsenic	2
zinc	23
vanadium	150
mercury	22.1
lead	32
cobalt	5
copper	3
polychlorinated biphenyls (total)	0.06

Larvae of flies, eggs of helminthes must not be in pure soil.

Special value in soil protection belongs to «Sanitary rules of keeping in order the territories of the occupied places» and clearing of the occupied places from garbage.

It includes ***gathering, removal, neutralization and recycling*** of liquid and firm dross. There are two systems of clearing of the occupied places from ***firm dross***: *plan-household and plan-room*. At plan-household system garbage is collected into metal containers and is regularly taken out to places of neutralization. At plan-room clearing garbage is collected by tenants in garbage trucks during certain time and is taken out.

For neutralization of firm garbage *technical* (burning, recycling factories) and *soil* (composting, instilling) methods are applied.

At the simplest level, the process of composting simply requires making a heap of wetted organic matter (garbage, leaves, "green" food waste) and waiting for the materials to break down into humus after a period of weeks or months. Modern, methodical composting is a multi-step, closely monitored process with measured inputs of water, air, and carbon- and nitrogen-rich materials. The decomposition process is aided by shredding the plant matter, adding water and ensuring proper aeration by regularly turning the mixture. Worms and fungi further break up the material. Aerobic bacteria manage the chemical process by converting the inputs into heat, carbon dioxide and ammonium. The ammonium is further converted by bacteria into plant-nourishing nitrites and nitrates through the process of nitrification.

There are two systems of clearing of the occupied places from ***liquid dross***: *export and floatable* (sewerage). So, for gathering of liquid garbage there are various types of lavatories and rubbish pits. Their device should

exclude pollution of soil, air, underground waters, and access of flies to sewage. At export system the collected liquid garbage is transported by special cesspit transport (tankers, motor vehicles-garbage trucks) to the special places for neutralization, at the floatable liquid excrements (sewage) are deleted on system of sewerage pipes.

Neutralization of liquid dross is possible by means of *soil method*, using ability of soil to self-cleaning. At this method a rich with organic substances sewage is mineralized, pathogenic microorganisms perish, and the soil is enriched by such elements as nitrogen, phosphorus, potassium. However pollution of agricultural crops with pathogenic bacteria and helminthes eggs is possible.

Such soil methods of neutralization of liquid garbage as fields of sewage *disposal and plowing* are more often used. The ground areas under sewage *disposal fields* are taken outside of settlement, 1 km from residential areas, are protected by ditches with earthen shafts and strips of green plantings. Sewage is poured out on the ploughed soil with equal layers. During the warm period of the year it is performed in 2-3 times with an interval in 1-1.5 months. After the last layer, this site is ploughed and left till the spring when it will be sowed. Each field of sewage disposal is filled with sewage once in three years. In the first year it is possible to grow up such agricultural crops which the population does not use in food in a crude kind for plowing.

Fields of plowing are arranged in the same principle as sewage disposal fields, but they are used only for sewage neutralization; here agricultural crops are not grown up.

To protect soil from pollution the **methods of waste disposal** are widely used. Our present waste-management systems are failing, and changes are needed. It is increasingly important that each community adapt an integrated waste-management approach that combines the following four methods in a way best suited to local needs and capabilities:

(1) landfills;

(2) incineration;

(3) source reduction;

(4) recycling.

A modern **sanitary landfill** is typically a clay-lined depression in which each day's deposit of fresh garbage is covered with a layer of soil. Selection of modern landfill sites must be based on an understanding of groundwater geology, soil type, and sensitivity to local citizens' concerns.

Once the site is selected, extensive construction activities are necessary to prepare the site for use. New landfills have complex bottom layers to trap contaminant-laden water leaking through the buried trash. In addition, monitoring systems are necessary to detect methane gas production and groundwater contamination. In some cases, methane produced by rotting garbage is collected and used to generate electricity. The water that leaches through the site must be collected and treated. As a result, new landfills are becoming increasingly more complex and expensive. A prolonged public debate over how to replace lost landfill capacity is developing where population density is and where available land is scarce.

Japan and many Western European countries have already moved away from land filling as the primary method because of land scarcities and related environmental concerns.

Incineration of refuse was quite common in North America and Western Europe prior to 1940. However, many incinerators were eliminated because of aesthetic concerns, such as foul odors, noxious gases, and gritty smoke, rather than for reasons of public health. Most incinerators are not used just to burn trash. The heat derived from the burning is converted into steam and electricity.

Most incineration facilities burn unprocessed municipal solid waste, which is not as efficient as some other technologies. About one-fourth of the incinerators use refuse-derived fuel-collected refuse that has been processed into pellets prior to combustion.

The newest means of incineration, a European concept, is called **mass burn.** In the mass-burn technique, municipal solid waste is fed into a furnace, where it falls onto moving grates and is burned at temperatures up to 1.300° C (2.400° F). The burning waste heats water and the steam drive a turbine to generate electricity, which is sold to a utility organization.

Incinerators drastically reduce the amount of municipal solid waste-up to 90 percent by volume and 75 percent by weight. Primary risks of incineration, however, involve air-quality problems and the toxicity and disposal of the ash.

Though mass-burn technology works efficiently in Europe, the technology is not easily transferable. North American municipal solid waste contains more plastic and toxic materials than European waste, thus creating air-pollution and ash-toxicity concerns. Modern incinerators have electrostatic precipitators, dual scrubbers, and fabric filters called bag-houses; however, they still release small amounts of pollutants into the

atmosphere, including certain metals, acid gases, and also classes of chemicals known as dioxins and furans, which have been implicated in birth defects and several kinds of cancer. The long-term risks from the emissions are still a subject of debate.

Ash from incineration is also a major obstacle to the construction of waste-to-energy facilities. Small concentrations of heavy metals are present both in the air emissions (fly ash) and residue (bottom ash) from these facilities. Because the ash contains lead, cadmium, mercury, and arsenic in varying concentrations from such items as batteries, lighting fixtures, am pigments, this ash may need to be treated as hazardous waste. The toxic substances are more concentrated in the ash than in the original garbage and can seep into groundwater from poorly sealed landfills. Many cities have had difficulty in disposing of incinerator ash, and there is still considerable debate about what is the best method of disposal.

The cost and placement of new incinerators are also major concerns facing many communities.

Source Reduction. The most fundamental way to reduce waste is to prevent it from ever becoming waste in the first place. Examples of source reduction are using less material when making a product or converting from heavy packaging materials to lightweight ones. Some packagers have converted to light-weight aluminum and plastic by reducing the thickness of packages and thus the amount of packaging waste.

Another way companies reduce waste is by making consumer products in concentrated form. These concentrated products can then be packaged in smaller containers. This approach requires consumers to concentrate when making purchasing decision.

Municipal composting is another source-reduction technique that could have substantial impact since 20 percent of material going into landfills is yard waste. Building a compost pile is a popular practice with many home gardeners because it turns waste into a useful soil additive. Many communities require separate collection of such yard waste as grass clippings, leaves, and even discarded Christmas trees. Such waste is either composted or shredded into wood chips. The by-products can then be used for landscaping at city parks, schools, golf courses, and cemeteries. Preserving space in landfills by municipal composting is gaining in popularity because it is cost effective and substantially extends a landfill's useful life.

On an individual level, we can all attempt to reduce the amount of waste we generate. Every small personal commitment from each of us could have the cumulative result of a significant reduction in municipal solid waste.

Recycling. Recycling initiatives have grown rapidly during the past several years. For example, North America recycles only a small percentage of the municipal solid waste generated. In contrast, Japan recycles about 45 percent of its municipal solid waste, including half the paper, about 55 percent of glass bottles, and 66 percent of food and beverage containers. Residents separate waste into several categories, which are collected on different days. Some benefits of recycling are readily recognizable, such as conservation of resources and pollution reduction.

Recycling is a viable alternative to land filling or the incineration of municipal solid waste, recycling presents several problems.

People who grow their own food can keep excess nitrogen and phosphorus out of the soil by choosing crops that do not need as many nutrients from the soil, by applying fertilizer during the growing season to replenish the soil, by shortening the grazing season / cattle density, by using organic compost, by keeping the surface moist and mulched, and by choosing fruiting crops like tomatoes, squash, peas and corn. Gardens should be situated away from old painted buildings and roadways. Outer leaves of lettuce should be discarded and all vegetables should be washed before eating.

Question for self-control

1. Pollution of environment.
2. The basic sources of pollution and pollutants of air, water and soil.
3. Medical value of physical pollutants of air, water and soil.
4. Medical value of chemical pollutants of air, water and soil.
5. Medical value of biological pollutants of air, water and soil.
6. Diagnostic, treatment and prevention of environmental pathology, caused by pollutants of human environment.

Chapter 4.

MEDICAL VALUE OF INDOOR HABITAT

Indoor habitat, its value

The modern man up to 90% of his time spend in conditions of internal, closed artificial environment space of residential, public, administrative, educational, sports and other buildings which significantly differ on their parameters from outdoor urban environment. The characteristic feature of indoor habitat is its *multicomponential and multifactorial effects* on humans.

Indoor habitat is characterized by:

- living area;
- ceiling height;
- air cube;
- microclimate;
- insolation;
- chemical, physical and biological factors of air;
- equipment;
- decorating materials.

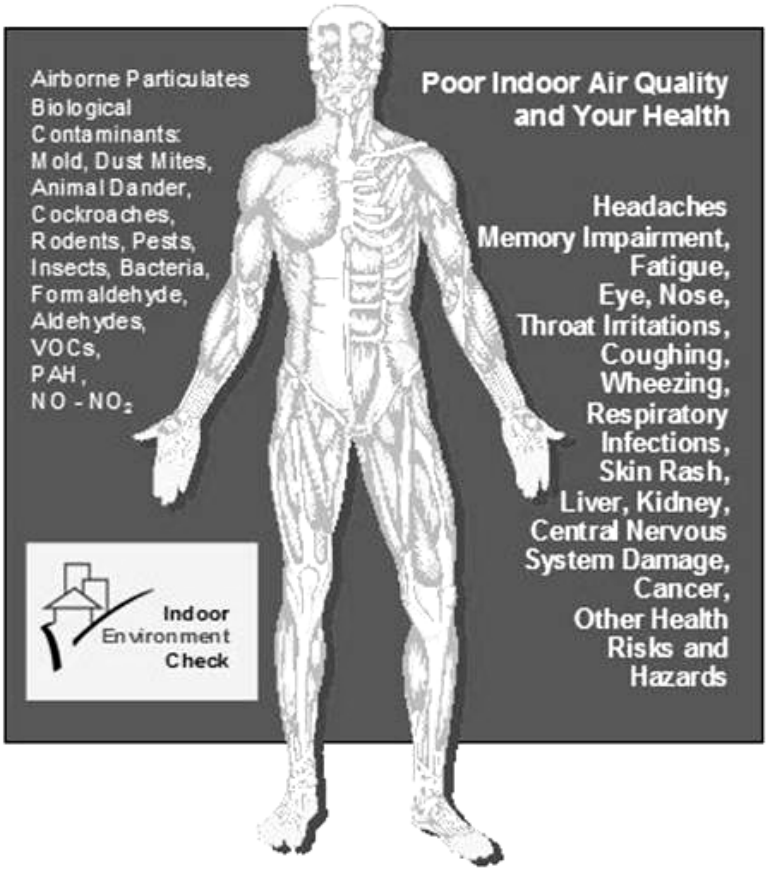
The optimum size of the inhabited area, microclimate, life and communication with environment create "housing comfort". It promotes preservation of human health and active participation in industrial activity and public life.

Crude and cold rooms play a certain role in etiology of catarrhal diseases, quinsy, rheumatism. Lack of light of dwelling has negative effect on photoperiodicity, diurnal rhythms. Sources of noise, vibration, high air temperature, electromagnetic radiations are subjects to home appliances. In modern dwellings the polymeric and synthetic materials owing to what air becomes polluted with toxic substances are widely used. Increased level of electrostatic electricity can cause adverse changes in organism, inflammatory disease, allergic and other character.

A growing body of scientific evidence indicates that the air within homes and other buildings can be more seriously polluted than outdoor air in even the largest and most industrialized cities. The concentrations of toxic air pollutants are consistently higher than outdoors – up to twenty

times higher for some toxins. Furthermore, people generally spend more time inside than out and therefore are exposed to higher doses of these pollutants. These levels of indoor air pollutants are especially harmful because people spend as much as 90 percent of their time living, working, and playing indoors. Inefficient or improperly vented heaters are particularly dangerous. Many indoor air pollutants and pollutant sources are thought to have adverse effects on human health. These pollutants include pollutants of chemical, physical and biological nature (picture 4.1).

Poor indoor air quality can cause or contribute to the development of infections, lung cancer, and chronic lung diseases such as asthma. In addition, it can cause headaches, dry eyes, nasal congestion, nausea and fatigue. People who already have lung disease are at greater risk.



Picture 4.1. Influence of poor indoor air quality on human health.

A recent contributing factor to the concern about indoor air pollution is the weatherizing of buildings to reduce heat loss and save on fuel costs. In older homes, there is a complete exchange of air every hour. This means that fresh air leaks in around doors and windows and through cracks and

holes in the building. In a weatherized home, a complete air exchange may occur only once every five hours. Such a home is more energy efficient, but it also tends to trap air pollutants. Even though we spend almost 90 percent of our time indoors, the movements to, reduce indoor air pollution lag behind regulations governing outdoor air pollution.

In contrast to the atmospheric (outdoor air), the air of dwellings contains a significantly larger number of chemicals, often in concentrations of 2 - 10 times higher than the concentration of the same substances in the atmospheric air. *The air of residential and public buildings* is a dynamic combination of chemical compounds as penetrating into the air outside the home so forming inside the home.

The man inside the dwelling is exposed to the majority of known chemical, physical and biological factors of air in various combinations. The chronic influence of low-intensity and high degree of exposure is characteristic for these factors. In most cases, factors are not the direct cause of occurrence and development of the environmental diseases but the cause of the nonspecific prepathological states. It complicates chronic diseases and delays recovery. However, the certain factors or their combination in conditions of indoor habitat can be as direct etiologic factors of allergic, cancer and neurological diseases.

Dwelling is a complex system of natural and artificial created environment, in which the factors of physical, chemical and biological nature render the complex influence on humans. The optimum size of the inhabited area, microclimate, life and communication with environment create "housing comfort". It promotes preservation of human health and active participation in industrial activity and public life.

In the last few years polymer materials have been widely used in the construction of apartment houses and public building, in the production of sanitary appliances for such buildings, for water installations, and in the manufacture of household products (food packaging, tableware, toys, etc.). Materials based on synthetic resins are also replacing traditional raw materials in the manufacture of furniture and in clothing and footwear, for which kapron and the polyurethanes (porolon) tend to be more and more used. The effects on the human organism of static electricity, odors, or thermal discomfort from these materials may be small in themselves, yet their continuing influence on an organism may induce a series of *nonspecific deviations* from the normal physiological state of the organism and a

possibly greater susceptibility to the effects of other factors, including infectious agents.

The basic sources of pollution and pollutants of indoor habitat

There are ***external and internal pollution*** of indoor air. Insufficient ventilation capacity together with the use of synthetic building materials for manufacture of furniture, wall and floors coverings, the huge number of tools and equipment create a problem of *internal air pollution.* Internal pollution of dwelling is a significant source of human exposure; about 60% of pollutants are formed due to it.

Indoor air pollution of residential and public buildings depends on the level and nature of outdoor air pollution, the degree of saturation of premises with polymeric materials and household chemicals, the presence of gas appliances, the number of room inhabitants and the duration of their stay, service life of buildings, air temperature, air exchange rates.

The **internal pollutants** are:

A. *Pollutants of chemical nature:*

- compounds released from the structures of buildings and the soil under them;
- the products of degradation of polymeric materials used in construction and finishing of the premises (formaldehyde, asbestos;
- the products of incomplete combustion of domestic gas;
- anthropotoxins allocated in the course of human life;
- the products produced by tobacco smoking (nicotine);
- substances formed during cooking (carbon monoxide, volatile organic compounds, ammonia);
- substances released from household chemicals;
- pesticides used in everyday life;
- compounds formed in the process of self-employment;
- pollutants of shoes and outdoor clothing, primarily labor;
- hydrogen sulfide, radon and other volatile substances contained in tap water;
- perchloroethylene (associated particularly with dry cleaning);
- paradichlorbenzene (from mothballs and air fresheners).

B. *Pollutants of physical nature* (electric and magnetic fields (electrosmog), air ions).

C. *Pollutants of biological nature* (bioaerosols).

The **external pollutants** are:

1) *pollutants of physical nature* (noise, dust);

2) *pollutants of chemical nature* (oxides of sulfur, nitrogen, carbon, products of photochemical reactions (photo-oxidants), the products of vehicle exhaust, lead and other metals);

3) *pollutants of biological nature* (pollen, fungal spores).

In premises with high concentration of organic substances various odors can be detected. Effects that have been reported by people include nausea, headaches, retching, difficulty breathing, frustration, annoyance, depression, stress, tearfulness, reduced appetite, being woken in the night and embarrassment in front of visitors. All of these contribute to a reduced quality of life for the individuals who are exposed. The important parameter for estimation of air clearness is **air oxidability** - the quantity of oxygen in mg which is required for oxidizing of organic substances in 1 m^3 of air. Air oxidability normal value is 4 mg/m^3.

People can develop physiological effects from odour even when their exposure is much lower than that typically required to cause direct health effects. This effect is sometimes termed 'odour worry' and is due to the perception that if there is a smell it must be doing physical harm.

Perception of odor and of irritation is unique to each person, and varies because of physical conditions or memory of past exposures to similar chemicals. A person's specific threshold before an odor becomes a nuisance depends also on the frequency, concentration, and duration of an odor. Health effects and symptoms vary, including eye, nose, or throat irritation, cough, chest tightness, drowsiness, and mood change; all of which decrease as an odor ceases. Odors may also trigger illnesses such as asthma, depression, stress induced illness, or hypersensitivity.

The other important parameter for estimation of air clearness is **carbon dioxide** content. In carbon dioxide concentrations up to 1% (10.000 ppm), it will make some people feel drowsy. Concentrations of 7% to 10% may cause suffocation, even in the presence of sufficient oxygen, manifesting as dizziness, headache, visual and hearing dysfunction, and unconsciousness within a few minutes to an hour.

Medical value of chemical pollutants of indoor habitat

Air of premises can polluted with products of a person's physiological exchange processes, combustion of gas, washing of linen and clothes, cooking and destruction of polymeric finishing materials (table 4.1).

Table 4.1. Indoor air pollutants and their influence on human health.

Pollutant	Possible effect of pollutants on human health
carbon monoxide	headache, nausea , loss of consciousness , death
nitrogen oxides	headache, nausea , pulmonary edema
asbestos	asbestosis , lung cancer , mesothelioma
radon	lung cancer
formaldehyde	eye and respiratory tract irritation, headache, nausea, sensibilization, cancer
organic compounds	eye and respiratory tract irritation, headache, nausea, cancer
dust and bioaerosols (pollen, fungi, bacteria, viruses)	allergic reactions , eyes and top respiratory tract irritation, aerosol infections

Smoking is the most important air pollutant source in terms of human health. There are people die each year from emphysema, heart attacks, strokes, lung cancer, or other diseases caused by tobacco smoking. Banning smoking probably would save more lives than any other pollution-control measure. Second-hand smoke causes many of the same diseases as direct smoking, including cardiovascular diseases, lung cancer, and respiratory diseases.

Chemical reactions that occur during the combustion of tobacco cause the air pollution of the premises by carcinogenic, mutagenic, hemato- and hepatotoxic chemical compounds. The products of tobacco burning get into the human body by inhalation. The very high temperature of smoldering tobacco (up to 900^0C) contributes to its more complete combustion, causing the ingestion of 3-5% of carbon monoxide, 8-11% of carbon dioxide and 12-16% of oxygen.

Nicotine is the harmful, addictive substance found in all tobacco products. When you smoke a cigarette, chew tobacco, or otherwise ingest nicotine, the effects are immediate:

- ✓ Nicotine travels through the body in the bloodstream and heads straight for the brain, arriving in 7 to 15 seconds.
- ✓ In the brain, nicotine boosts the “reward center,” releasing chemicals that cause a pleasant, happy feeling.
- ✓ Adrenaline is then released, increasing heart rate and blood pressure, and making breathing rapid and shallow. As nicotine use contin-

ues, these effects can damage your heart, arteries, and lungs, increasing the risk for heart attack, stroke, and chronic lung disease.

Nicotine adversely affects every major system in the human body. As it builds up from regular use, it can lead to weakened immune function, fatigue, decreased healing time, and long-term diseases including cancer. In fact, nicotine prevents the body from properly disposing of damaged cells, thereby allowing cancer cells to develop.

- **Brain:** Nicotine disrupts normal neurotransmitter activity, causing chemical changes and addiction. Other neurological symptoms caused by nicotine include light-headedness, sleep disturbance, dizziness, and tremors.
- **Heart and Arteries:** Nicotine increases heart rate and raises blood pressure when it stimulates the release of adrenaline. Short term, this means your body is less efficient when you exercise. It has to work harder getting the blood and oxygen to cells that need it, preventing the body from reaching its maximum potential. Long term, the stress on the heart and arteries can lead to increased risk of heart attack and can even lead to a stroke and/or aneurysm.
- **Eyes:** Nicotine reduces the ability to see at night by stopping the production of pigments in the eyes specially designed for low-light vision. Adrenaline released by nicotine reduces peripheral vision, and in the end, nicotine accelerates the degeneration of the eyes.
- **Metabolism:** Nicotine increases calories burned but decreases endurance by wasting energy in the effort.
- **Reproductive System:** Nicotine prohibits proper blood circulation and is a leading cause of erectile dysfunction (impotence) for men under 40. Nicotine also increases the risk of infertility and miscarriage. And if babies exposed to nicotine in utero do make it to birth, they tend to have low birth weights, be born prematurely, and have increased risk for lung problems.
- **Bones:** When used over time, nicotine alters cellular structures and has been found to increase risk for fractures while contributing long-term to the development of weakened bones (osteoporosis).

Smokers are at an additional risk because nicotine is present in their lungs. Nicotine causes rapid and shallow respiration, leading to quicker fatigue during exercise or combat. Over time, nicotine permanently damages the cells in the lungs by changing their structure. This leads to increased risk for lung disease, lung cancer, emphysema, pneumonia, and bronchitis.

Smoking during *pregnancy* is especially dangerous, because the number of spontaneous abortions and premature birth, probability of destruction of a fetus, possibility of a birth of the child with low body weight and **sudden infant death syndrome** (SIDS) increase.

From the substances contained in tobacco smoke, the digestive tract, teeth and mucous membrane of the mouth are also suffered.

Millions of children are breathing in secondhand smoke in their own homes. Secondhand smoke can be especially harmful to children's health because their lungs still are developing. Infants have a higher risk of SIDS if they are exposed to secondhand smoke. Children have a higher risk of serious health problems, or problems may become worse. Children who breathe secondhand smoke can have more:

- ear infections;
- coughs and colds;
- respiratory problems, such as bronchitis and pneumonia;
- tooth decay.

Children of smokers cough and wheeze more and have a harder time getting over colds. They miss many more school days too. Secondhand smoke can cause other symptoms including stuffy nose, headache, sore throat, eye irritation, and hoarseness.

Children with asthma are especially sensitive to secondhand smoke.

Children who grow up with parents who smoke are themselves more likely to smoke. Children and teens who smoke are affected by the same health problems that affect adults. Secondhand smoke may cause problems for children later in life including:

- poor lung development (meaning that their lungs never grow to their full potential);
- lung cancer;
- heart diseases;
- cataracts (an eye disease).

Anthropotoxin is a toxic substance produced by the lungs and body surface of human beings. When this substance is given off in excess, the affected individual's health worsens and his working capacity as well as mental activity decreases. Anthropotoxin may also lead to the loss of consciousness.

Anthropotoxin can be of following groups of chemical compounds on hazards:

Class 2 - highly dangerous substances (dimethyl - and diethylamine, hydrogen sulfide, benzene, indole, mercaptan);

Class 3 - moderately dangerous substances (phenol, ammonia, organic acids, methanol and other alcohols homologous series, methyl styrene, vinyl acetate);

Class 4 - low dangerous substances (acetone, methyl ethyl ketone, butane, methyl and butyl).

Anthropotoxins accumulation rate factors:

- size of the air cube;
- ceiling height;
- number of people and time of their stay in the room;
- air temperature.

Most anthropotoxins have irritating effects on the eye mucosa and upper respiratory tract, leading to conjunctivitis and chronic pharyngitis. Even in small concentrations, these substances cause headaches, dizziness, nausea.

Natural gas and its combustion products – is a source of many pollutants. It includes the compounds which are directly present in the gas (odorants, gaseous hydrocarbons, toxic organometallic complexes, radioactive radon gas) and the products of incomplete combustion (carbon oxides, nitrogen dioxides, aerosol organic particles, polycyclic aromatic hydrocarbons, volatile organic compounds).

Odorants that are added to natural gas to detect it, even at subthreshold concentrations, can cause nausea and headaches. Polycyclic aromatic hydrocarbons have an adverse effect on the respiratory system, are carcinogens and can lead to chronic intoxication in sensitive people.

Nitrogen dioxide can induce inflammation of the pulmonary system and decrease in the vital function of the lungs, asthmatic-like respirating symptoms, decrease in resistance to bacterial diseases of the lungs (bronchitis, lung inflammation are more common), allergic reactions to other components. Long stay in the presence of nitrogen dioxide in the air leads to the tracheitis, bronchitis, pneumosclerosis, anemia.

Volatile organic compounds (VOCs) include a variety of chemicals, some of which may have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. VOCs are emitted by a wide array of products numbering in the thousands. Examples include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions.

One of the most acutely toxic indoor air contaminants is ***carbon monoxide*** (CO), a colourless, odourless gas that is a byproduct of incomplete combustion of fossil fuels. Common sources of carbon monoxide are tobacco smoke, space heaters using fossil fuels, defective central heating furnaces and automobile exhaust. Improvements in indoor levels of CO are systematically improving from increasing implementation of smoke-free laws. By depriving the brain of oxygen, high levels of carbon monoxide can lead to nausea, unconsciousness and death.

Inadequate ventilation can lead to the build-up of small amounts of contaminants which are difficult to identify and test, so ***carbon dioxide*** (CO_2) levels are used as an indicator of adequate ventilation in a room. Carbon dioxide levels above normal can cause slightly intoxicating, breathing and pulse rate increase, nausea, headaches and sight impairment, unconscious, further exposure death.

Hydrogen sulphide in a small amount in the air indoor leads to eye irritation, nasopharynx, with prolonged exposure can lead to the tracheitis, bronchitis. Moderate levels cause headache, dizziness, cough and difficulty in inhalation, high levels - can lead to shock, convulsions, coma, death.

Policomposition compound of ***polymeric materials*** is determined the diversity of chemicals released into the air of premises. During construction and finishing of buildings and premises especially dangerous are the cases of unauthorized replacement of authorized materials to random polymers which have not passed the hygienic assessment.

There are complains of headaches, general bad state of health, chronic fatigue, a feeling of suffocation and other symptoms that are usually nonspecific at humans under the influence of *compounds released from polymeric materials*. Chronic effect of indoor air pollutant substances, even at low concentrations, reduces the immune status of organism, may be the cause of allergic diseases.

The most significant in terms of the potential adverse effects on human health are substances released from the polymeric materials such as formaldehyde, styrene, benzene, toluene, phenol, acetone, ammonia, cyclohexane and butyl. They are characterized by ***polymorphism of toxic effects***. Many of them are highly toxic compounds (benzene, styrene, formaldehyde), which are capable to induce changes of various systems and functions in tenths and hundredths mg.

Asbestos are found in older homes and buildings, but occurs most commonly in schools and industrial settings. It was once widely used in shingles, fireproofing, heating systems, floor tiles, and ceiling tiles in older

buildings. When asbestos-containing material is damaged or disintegrated, microscopic fibers are dispersed into the air. Inhalation of asbestos fibers over a long period is associated with increased incidence of lung cancer, in particular the specific form mesothelioma. A non-flammable mineral that can produce microscopic fibers, that when inhaled into the lungs can cause asbestosis (scarring of the lung tissue), lung cancer and another cancer called mesothelioma. The symptoms of the disease do not usually appear until about 20 to 30 years after the first exposure to asbestos. Removal of asbestos-containing materials is not always optimal because the fibers can be spread into the air during the removal process.

Chlorinated drinking water releases ***chloroform*** when hot water is used in the home.

Organic chemicals are widely used as ingredients in household products. Paints, varnishes, and wax all contain organic solvents, as do many cleaning, disinfecting, cosmetic, degreasing, and hobby products. Fuels are made up of organic chemicals. All of these products can release organic compounds during usage, and, to some degree, when they are stored. Testing emissions from building materials used indoors has become increasingly common for floor coverings, paints, and many other important indoor building materials and finishes.

In the residential environment ***formaldehyde*** exposure comes from a number of different routes; formaldehyde can off-gas from wood products, such as plywood or particle board, but it is produced by paints, varnishes, floor finishes, use of un-vented, fuel-burning appliances, like gas stoves or kerosene space heaters and cigarette smoking as well.

Formaldehyde levels in building environments are affected by a number of factors. These include the potency of formaldehyde-emitting products present, the ratio of the surface area of emitting materials to volume of space, environmental factors, product age, interactions with other materials, and ventilation condition.

Formaldehyde, a colorless, pungent-smelling gas, refers to substances with pronounced toxicity. It causes watery eyes, burning sensations in the eyes and throat, nausea, and difficulty in breathing in some humans exposed at elevated levels (above 0.1 ppm). High concentrations may trigger attacks in people with asthma, bronchitis, encephalopathy. There is evidence that some people can develop sensitivity to formaldehyde. In 10% of the population, formaldehyde can lead to the skin allergic reactions and respiratory damage. It is proved that formaldehyde breaks the menstrual cycle, reduces immunity, has embryotoxic, teratogenic effects, and is a

carcinogen and a mutagen. MPC of formaldehyde - 0.01 mg/m^3. Formaldehyde exposure on the person depends on its concentration in air (table 4.2).

Table 4.2. Dose-dependent effects of formaldehyde.

Effect	Formaldehyde concentration, ppm
no effect	0-0.05
neurophysiological effects	0.05-1.5
olfaction threshold	0.05-1.0
lacrimation, headache	0.01-2.0
irritation of the upper respiratory ways, nausea	0.1-25
irritation of the lower respiratory ways, nausea, vomiting	5-30
pulmonary edema	50-100
death	>100

Radon (Rn) is a noble gas produced by the radioactive decay of radium, found in uranium ores, phosphate rock, and a number of common minerals. It is an invisible, odorless, and tasteless gas that seeps up through the ground and diffuses into the air. Because it is inert, radon itself does not pose a hazard. However, it undergoes radioactive decay producing a series of short-lived progeny, often called daughters that can emit alpha, beta, or gamma particles and are electrically charged, readily attaching to air-borne particles. Alpha particles can travel only a short distance and cannot go through your skin. Beta particles can penetrate your skin, but they cannot go all the way through your body. Gamma radiation, however, can go all the way through your body.

The radiation released during the process of decay passes into lung tissue and causes lung damage. Long-term exposure to radon and radon daughters in air increases your chances of getting lung cancer. When exposures are high, noncancer diseases such as thickening of certain tissues of the lungs may occur. This usually occurs within a few days or weeks after exposure to radon. Cancer due to radon exposure takes several years before effects become apparent.

The usual concentration of radon is 30 Bq/m^3 in air in homes.

Medical value of physical pollutants of indoor habitat

At the present stage of society development energy saturation of residential premises increases. Variety of appliances (refrigerators, television sets, lighting equipment, washing machines, vacuum cleaners, electric, microwave ovens, heaters, heated floors, computers, communications equipment, power cables, wiring) are sources of electric and magnetic fields of different frequencies that impact on human and can cause of different pathology.

Electric and magnetic fields (EMFs) are invisible areas of energy, often referred to as radiation, that are associated with the use of electrical power and various forms of natural and man-made lighting (picture 4.2). EMFs are typically characterized by wavelength or frequency into one of two radioactive categories:

- ***non-ionizing:*** low-level radiation which is generally perceived as harmless to humans (sources are microwave ovens, computers, house energy smart meters, wireless (wifi) networks, cell phones, bluetooth devices, power lines);
- ***ionizing:*** high-level radiation which has the potential for cellular and DNA damage (sources are ultraviolet light, x-rays, gamma rays).

EMFs emitted by computers, mobile phone handsets, cordless telephones, can lead to the following symptoms: hair loss, severe headaches, memory loss, insomnia, dizziness, heart palpitations, tinnitus and digestive problems.

The totality of electromagnetic fields is called ***electrosmog***. Electromagnetic fields in all frequency bands have a high biological activity. The most sensitive systems of the human body are nervous, immune, endocrine and reproductive. The earliest clinical manifestations of the impacts of electromagnetic radiation on humans are functional disorders of *nervous system*, manifested in the form of *neurasthenic and asthenic syndrome* (weakness, irritability, fatigue, memory loss, sleep disturbances).

Picture 4.2. Sources of electromagnetic fields.

Disorders of *cardiovascular system* appear as *neurocirculatory dystonia* (lability of the pulse rate and blood pressure, tendency to hypotension), pain in the heart. Phase changes of blood (lability of indicators) with the leukopenia, neutropenia, erythropenia are observed.

Electromagnetic fields affect the *immunological* reactivity. Violation of immunogenesis, often in the side of the oppressed, autoimmunity, immunodeficiency occurs. Under the action of electromagnetic fields stimulation of pituitary-adrenal system is accompanied by increase of adrenaline content in blood.

Thus, a person even in a room is constantly exposed to a variety of factors of different nature, usually of small intensity. However, their mixed effect can lead to the various diseases.

Asthenic syndrome can be also caused by ***static electricity***. Static electric fields with a potential of 3000 V arise when electric charges accumulate on synthetic surfaces (linoleum, plastic, carpet coverings, curtains, wallpaper, varnish, polishing).

The greatest danger among artificial emissions in the rooms belongs to ***the radiation created by various video devices***. As a result of exposure to secondary radiation of ***TV*** (microwave, X-ray, ultraviolet, electron radiation, and other electromagnetic fields) the activity of the central nervous system, visual analyzer, heart, thymus gland, asthenic, asthenic and vegetative syndromes, asthenopia can be developed. ***Personal computers*** are sources of electric fields, electromagnetic and X-rays. For human health,

the monitor is more dangerous. LCD monitors are less dangerous in this regard.

Frequent and unreasonable use of a mobile phone that creates electric and magnetic radiation can lead to headaches, weakening of memory, impaired attention, braking of mental abilities, irritability, sleep disturbance. In the long term, changes in the immune system, suppression of its functions, increased growth of DNA mutation, increased risk of brain tumor, vestibular and auditory nerves, the development of Alzheimer's disease and Parkinson's disease, progresses acquired dementia, reproductive disorders in men, fetal development pathology.

The health of people in residential and public buildings is affected by the degree of air pollution with chemicals and bioaerosols, but also the degree of **air ionization** and its ionic composition effects. At the same time both insufficient and excess ionization has negative effects. Concentration ratio (number of ions per 1 cm^3) and the polarity of the ions in the air space have large values.

Air ions have positive (heavy ions) and negative (light ions) charges.

Heavy ions are molecules deposited on tiny particles. They have the ability to adversely affect the human body.

Light ions have positive physiological effect.

Typically, the ions concentration is from several hundreds to thousands per cm^3 (table 4.3).

Table 4.3. Specifications of light and heavy ions contents in air indoor.

Levels	**Number of aero ions in 1 cm^3 of air**	
	the positive	the negative
Minimum necessary	400	600
Optimum	1500-3000	3000-5000
Maximum admissible	50000	50000

The effect of negative ion depletion (or an excess of positive ions) varies from person to person. The least fortunate can suffer migraine, asthma and even severe depression. Ions act on our capacity to absorb and utilize oxygen. Negative ions in the bloodstream accelerate the delivery of oxygen to our cells and tissues, whereas positive ions slow down this delivery of oxygen, producing symptoms markedly like those in anoxia (or oxygen starvation). The body chemical serotonin, which scientists have identified to be linked with stress and changes in mood, is also influenced by air ion levels. Too many positive ions alter the levels, causing stress and

discomfort whereas increasing the negative ion concentration helps bring relief.

Negative ions may stimulate the reticulo-endothelial system, a group of defense cells in our bodies which marshal our resistance to disease. Organizations that have installed negative air ionization equipment have found that their employees are less likely to get colds, report absent less frequently and are generally more cheerful and alert. Some studies suggest that exposure to high concentrations of negative ions produces biochemical and physiological changes in some people that have a relaxing effect, reduce tension and headaches, improve alertness and cut reaction time. These effects could be due to the suppression of the neural hormone serotonin (5-HT) and of histamine in environments loaded with negative ions; these factors could affect a hypersensitive segment of the population.

Ionized air possesses the biological activity. It was found by observation that with proper selection of the number of ions and their polarity ionized air breathing increases the stability of the organism to hypoxia, cold, physical effort and action of toxic substances. Good therapeutic effect in the treatment of bronchial asthma by ionized air is known.

Medical value of biological pollutants of indoor habitat

Indoor air usually contains hundreds of types of biological contaminants, known as *bioaerosols*. Some of them get into the house from the outside, while others are formed indoors. Bioaerosols are often represented by pollen, dust mites, human and animal dandruff, excretions of insects, spores and mycelium of fungus, bacteria and viruses.

Most of the bioaerosols are non-pathogenic, but with prolonged exposure it can cause allergic reactions in sensitized people. Pathogenic microorganisms contained in the air indoor can lead to the occurrence and spread of airborne or airborne-dust infections (influenza, measles, chicken pox, mumps, legionellosis, tuberculosis).

Biological pollutants:

- bacteria,
- molds,
- pollen,
- viruses;
- animal dander;
- particles from dust mites and cockroaches.

These may cause infections, provoke allergic symptoms or trigger asthma attacks.

These contaminants may breed in stagnant water that has accumulated in ducts, humidifiers and drain pans, or where water has collected on ceiling tiles, carpeting, or insulation. Sometimes insects or bird droppings can be a source of biological contaminants. Physical symptoms related to biological contamination include cough, chest tightness, fever, chills, muscle aches, and allergic responses such as mucous membrane irritation and upper respiratory congestion.

Molds and other allergens can arise from a host of means, but there are two common classes: (a) moisture induced growth of mold colonies and (b) natural substances released into the air such as animal dander and plant pollen. Moisture buildup inside buildings may arise from water penetrating compromised areas of the building envelope or skin, from plumbing leaks, from condensation due to improper ventilation, or from ground moisture penetrating a building part. In areas where cellulose materials (paper and wood, including drywall) become moist and fail to dry within 48 hours, mold mildew can propagate and release allergenic spores into the air.

There are some varieties of mold that contains toxic compounds (mycotoxins). However, exposure to hazardous levels of mycotoxins via inhalation is not possible in most cases, as toxins are produced by the fungal body and are not at significant levels in the released spores. The primary hazard of mold growth, as it relates to indoor air quality, comes from the allergenic properties of the spore cell wall. More serious than most allergenic properties is the ability of mold to trigger episodes in persons that already have asthma, a serious respiratory disease.

Mold is always associated with moisture, and its growth can be inhibited by keeping humidity levels below 50%. Moisture problems causing mold growth can be direct such as a water leaks and/or indirect such as condensation due to humidity levels.

According to the Centers for Disease Control and Prevention, the most common indoor molds are:

- Cladosporium;
- Penicillium;
- Aspergillus;
- Alternaria;
- Stachybotrys chartarum (also known as black mold).

Symptoms stemming from mold spore exposure may include:

- nasal and sinus congestion;

- eye irritation;
- blurred vision;
- sore throat;
- chronic cough;
- skin rash.

Dust mites are the main cause of allergic diseases of man. 1500 - 2000 mites can be found in each gram of house dust. In 10-15% of people there are allergic reactions to the mites themselves, 20% to their protein components, 80% to their feces. Allergen, in contact with the mucous membrane of the nose, conjunctiva, bronchi, induces the release of mediators of allergic inflammation, leading to the development of *asthma or hay fever*.

After contact with certain molds, individuals with chronic respiratory disease may have difficulty breathing, and people who are immunocompromised may be at increased risk for lung infection.

One indoor bacterium, *Legionella*, has caused both Legionnaire's Disease and Pontiac Fever. The primary route of exposure is through the creation of an aerosol effect, most commonly from evaporative cooling towers or showerheads. A common source of Legionella in commercial buildings is from poorly placed or maintained evaporative cooling towers, which often release water in an aerosol which may enter nearby ventilation intakes.

There are many ***bacteria*** of health significance found in indoor air and on indoor surfaces. Among the most important bacteria known to occur in indoor air are *Mycobacterium tuberculosis, Staphylococcus aureus, and Streptococcus pneumoniae*.

Sick building syndrome

Sick building syndrome is closely connected to indoor air pollution. **Sick building syndrome** (SBS) is used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified. A 1984 World Health Organization report suggested up to 30% of new and remodeled buildings worldwide may be subject of complaints related to poor indoor air quality. Sick building causes are frequently pinned down to flaws in the heating, ventilation, and air conditioning systems. Other causes have been attributed to contaminants produced

by out gassing of some types of building materials, volatile organic compounds (VOC), molds, improper exhaust ventilation of ozone (byproduct of some office machinery), light industrial chemicals used within, or lack of adequate fresh-air intake/air filtration .

The most common symptoms associated with SBS are sleepiness, weakness, poor health, headache, irritation of the conjunctiva, mucous membranes of the nose and throat, runny nose, back pain, neck, taste disorders, increased sensitivity to odors and other (table 4.4).

Table 4.4. The symptoms connected to «sick buildings syndrome».

Group of symptoms	Signs
Sensory irritation	reddening and irritation of eyes, dryness in nose or throat, pain in throat, hoarseness of voice and change of its timbre
Skin irritation	reddening of integuments, dryness of skin, itch, feeling of burning, pain
Asthenic reactions	undue fatigability, memory impairment, impossibility to concentrate, block, drowsiness, headache, dizziness, nausea
Specific reactions	cold, lacrimation, the asthmatic phenomena at not asthmatics, rattles in lungs

Pathogenesis of «sick buildings syndrome» is multifactorial, including the whole complex of factors of the internal environment of premises co-operating among themselves, and also synergism effect of toxic action of substances of various chemical classes which many times over can surpass effect of harmful action of separately taken chemical substance.

Diagnostic, treatment and prevention of environmental pathology, caused by pollutants of indoor habitat

To **diagnose** the environmental pathology caused by the pollutants of indoor habitat, including «sick buildings syndrome», a detailed anamnesis is collected by the interview method to reveal the hereditary changes which have been appeared under the influence of stressful, biological, chemical and physical pollutants of the indoor environment, triggers of the environmental pathology, complications and long-term consequences of the patho-

logical process, as well as the time of residence in the dwelling, phenomena of elimination and re-exposure.

The patient is examined, specific and non-specific signs which are characteristics of pollutants are revealed in the clinical picture, laboratory tests are appointed to determine the hormone status, processes of free radical oxidation, metabolites, chemical xenoboitics, and parasites.

To **confirm the diagnosis** the following information is revealed:

- pollution of the indoor environment with physical, chemical and biological pollutants;
- prolonged circulation of the etiological factor of low intensity on the territory;
- a long latent period with an increase in nonspecific morbidity;
- an increase in nonspecific diseases in persons with genetic sensitivity to pollutants;
- polysyndrome character and the various severity of the clinical course of the disease with the same pollutant at the patients which live in the same dwelling;
- resistance to the standard treatment scheme at the exposure of the pollutant;
- the direct correlation of morbidity with the level of pollutants.

Treatment of the acute environmental diseases caused by the pollutants of indoor human environment is carried out in accordance with the clinical protocols using traditional methods, including the use of pharmacological means, physiotherapy, diet therapy, and psychotherapy.

Treatment of the patients with chronic environmental pathology, «sick buildings syndrome» includes detoxication, first of all, with the help of nutrition and phytopreparations, restoration of broken nutritional status, immunocorrection, specific desensitization, appointment of antioxidants, mediator precursors, the drugs which bind and eliminate contaminants, elimination of organ and system dysfunctions, increase in the resistance of the organism.

Doctors perform medical survey and prophylactic medical examinations, supervision of the population in out-patient-policlinic establishments. They also send the individuals of the risk group for rehabilitation to sanatorium treatment, conduct environmental education and training, participate in supervision of the morbidity, physical development, and demographic indicators according to the program of social and hygienic monitoring. The maximum permissible concentrations and levels of indoor environmental pollutants are developed.

Individual **prevention** includes the formation of a healthy lifestyle, the reduction of the time of contact with pollutants, the use of personal protection equipment, adaptogens.

Residents should monitor the sanitary and technical state of the dwelling, maintain cleanliness and order in the apartment. If a "sick building syndrome" is identified, a change of dwelling is recommended.

The correct placement of territory for construction and expansion of settlement promotes improvement of sanitary well-being and populations' life conditions. It will help to prevent the environmental diseases, caused by poor indoor habitat.

The territory for habitation should not be boggy and flooded, ground should not be polluted. The level of standing of subsoil water must be low (2 m from surfaces and not less than 0.3 m from a sole of the base). The ground should have favorable physical, chemical and biological factors and should not contain pollutants of physical, chemical and biological nature.

The choice of territory under construction occurs in view of a lay of land, it must be from 10 % to 20 %. Presence of artesian pools is necessary to supply the residents with good quality water. To place settlement, it is necessary to choose upstream rivers above sources of possible pollution.

Territory is chosen so that sources of air pollution are leeward side from settlement, and settlement territory is windward side in relation to sources of air pollution. The territory should be protected from cold and hot dry winds.

Sites where there are cattle graves, dumps and cemeteries were, should not be used for building, but are recommended for gardening.

Residential areas, public centers with administrative, scientific, educational, medical and sports buildings must be located in the *residential zone* of a city. There must be the sanitary and protective zone of 50-1000 m between the residential and industrial zones of a city. The building must be placed on distance of 50 m from red line of street and 30-50 m from the other buildings.

The basic structural element of residential zone is **micro district** with 6000-18000 residents, which includes:

- residential buildings;
- preschool centers, schools;
- drugstores;
- food shops;
- green area with platforms for populations' rest, employment by physical culture and sports;

- garages for parking of individual vehicle, etc.

Residential area with population 100000-200000 persons consists of 3-8 micro districts and public centre with establishments and service enterprises.

Residential area establishments are:

- polyclinics;
- sports halls and pools;
- cinemas;
- libraries;
- supermarkets, shops;
- public feed establishments.

In residential areas and micro districts creation of favorable conditions of microclimate, insolation, aeration, protection against noise and pollution sources, organization of rest and employment by physical culture and sports, accomplishment and gardening of territory are provided.

These are some *types of inhabited buildings*: one-room one-storey, one-room two-storey (cottages), multiroom low-rise, multiroom many-storey and high-rise buildings.

A microdistrict area makes 4-5 hectares on 1000 inhabitants (**40-50 m^2 on 1 person**).

For good insolation and aeration of dwellings between facades of buildings discontinuities should not be less than 2-2.5 heights of the highest building and between ends of buildings should not be less than 1 height.

The **area of building** should not be more than **25 %**, and **green planting area** - should not be less than **40 %** of the area of all territory.

In microdistrict, children's playgrounds and platforms for gymnastics, volleyball, tennis, basketball are arranged. Their total area should be made not less than **1 m^2 per 1 inhabitant**. In microdistrict, there is a sports centre with stadium and swimming pool.

There are some differences between city and rural populated areas planning such as:

- **area of building** should not exceed **5-6 %**;
- 20-25 inhabitants on 1 hectare (**400-500 m^2 on 1 person**);
- plane, not flood territory, sandy or loamy soil;
- area should not be crossed with highway or railroad track;
- 2 zones:

1. **inhabited** with public centre with village council, mails, houses of culture, table, shop, hotel (inhabited quarters with residential buildings and

private plot with area of 0.25-1 hectares, cultural-community and treatment-prophylactic establishments, green plantings of general using, street);

2. **industrial** (constructions of industrial appointment united in industrial complexes: preparation of forages and preprocessing of agricultural products, mechanical-repair objects, complexes on manufacturing of building materials, warehouses, economic court yard cattle-breeding, poultry-farming);

- low-rise buildings, presence of private plots and premises for cattle and bird;
- compact building facilitates allow to reduce the price of water pipe, water drain, central heating, gasification;
- residential buildings are usually settled down in 100 m from a reservoir;
- there is sanitary-protective zone (100-300 m) between inhabited and industrial zones.

Dwelling's basic element is an apartment.

There are five parameters of dwelling lay-out:

- set of rooms;
- area of rooms;
- its interrelation;
- windows orientation on world parts;
- corridor lay-out.

The area of apartment is **9-13 m^2** per one person and intended for single family.

The ceiling height is **3 m**.

The air cube per 1 student is **37.7 m^3** per one person.

Planning of apartment should provide good insolation of living rooms. It can be one- and bilateral. The bilateral planning with premises on two sides of house is the most expedient.

Apartment structure is:

1. inhabited rooms (bedroom, children's room, office and hall);
2. auxiliary rooms (lobby-hall, dining room, kitchen, bathing, toilet and pantries);
3. open rooms (loggias, balconies, verandahs).

An apartment structure usually includes inhabited, subsidiary and open premises. Inhabited (living) premises include bedroom, children's room, office and hall, subsidiary – lobby, dining room, kitchen, bathing, toilet and pantries, and opened – loggias, balconies, verandahs.

All rooms, except hall, should be isolated. Kitchen must be separated from living rooms. Lavatory with bathroom and toilet are placed in one place for convenience of water pipe and water drainage systems. The minimum size of kitchen with a gas stove should be 7, lobby - 6, toilet – 1.5, bathroom – 2.5 m^2. Bedrooms, children's rooms are oriented on southern, kitchen - on northern directions.

Electro supply and other necessary engineering communications are also arranged in dwelling residence.

Houses are provided with the following elements of **sanitary and technical accomplishment**:

1. ventilation;
2. heating;
3. illumination;
4. water supply;
5. solid and liquid waste clearing.

Ventilation is a system of sanitary-engineering devices and constructions for decontamination from premises of polluted air, supply of pure air and maintenance of optimum temperature, humidity and rate of air movement.

Ventilation is divided into:

- *principle of operation*: local and general exhaust (air excision), input (air supply), exhaust - input;
- *on character of dynamics*: natural and artificial;
- *on organization* - providing organized and full exchange (exhaust - input natural, or aeration, and exhaust - input mechanical), providing organized, but partial exchange of air (recirculation) and providing full, organized, stable exchange of air (air-conditioning).

Natural ventilation is an airing of premises through windows, doors, window leaves and transoms.

Artificial ventilation is applied in the kitchen where window fans, mechanical fans and ventilating cowl above gas cooker and electric stoves and also in lavatories. Ventilation rate in living rooms is not less than 3, in kitchens - not less than 60 m^3/hour per 1 m^2 on exhaust. In bathroom, toilet, kitchen ventilation with prevalence of exhaust over input is arranged.

Heating system is a complex of the equipment intended for reception, transport and transfer of warmth to warmed premises. It consists of the oscillator (source), the heat pipe-line, the heater. The heat transport is carried out by means of heat-transfer agent (heated water, steam, air).

Heating classification: *local* - at which all elements of heating are combined into one device and warm one premise (oven, gas, water, electric), and *central* - when a number of premises from one source is warmed (water, air, steam, radiant-panel).

Radiant-panel heating is the optimum type as the heating devices are located in walls, floor or ceiling, temperature differences across and verticals are minimum, residences feel "the thermal comfort" in lower than the optimum air temperature (17^0).

There is natural and artificial illumination.

Natural illumination is an illumination of premises by direct solar beams or diffused light.

Depending on light direction, lateral, overhead and combined daylight illuminations are divided. Daylight illumination level in premises depends on geographical latitude of region, seasons and days, orientation of premises on the cardinal directions, shadow zone owing to opposing buildings or trees, sizes of windows, their form and design, purity and character of window glasses, paintings of ceiling and walls. Insolation regime depends on these factors.

Insolation regime - a time of illumination of certain premises by direct solar beams which can be minimum (3 hours), moderate (3-5 hours) and maximum (more than 5 hours).

In mid-latitudes the best natural illumination of premises is observed at southeast, southern and southwest orientation.

Parameters of natural illumination:

- light factor – should be1/7-1/8;
- angle of light incidence - should not be less than 27^0;
- aperture angle - should not be less than 5^0;
- factor of natural illumination - should not be less than 0.5 %.

Artificial illumination on a functional purpose is divided into routine, emergency, evacuation and security.

Artificial illumination is provided in all premises. It is better to use fixtures of ***diffused*** and ***reflected*** light which provides uniform soft illumination without shades and blinding action.

For maintenance of higher level of light exposure on a desktop, local illumination is applied. Fixtures of ***local*** illumination must have protective armature which provides the 30° shielding angle for the purpose of the prevention of blinding effect. ***General*** illumination is provided by means of the fixtures in regular intervals distributed on some certain premises. They are necessary for creation of sufficient light exposure at production

facilities and passageways. Set of local and general illumination is ***combined*** illumination. The recommended artificial light exposure is 200-400 lux.

Dwelling should be provided with cold and hot **water** for the economic-drinking purposes. Water consumption is 30-60 dm^3 a day per person at settlements without internal waterpipe (decentralized water supply system). Water consumption is 250-350 dm^3 a day per person at settlements with waterpipe, water drain, baths (centralized water supply system).

For the collecting and disposal of solid waste, in particular, household garbage **plan-household, or container** system is applied. Systems of clearing of the occupied places from liquid dross is **export** at country sides and **floatable (canalization)** at cities are arranged.

Microclimate - a climate of the limited area.

Comfortable microclimate has beneficial effect on health, and *discomfortable* (with high humidity at normal, low and high temperature), variable (at work on opened air), heating (with predominance of radiation warmth), cooling (with subnormal (from +10° to -10°C) and low (lower than -10°C) air temperatures) leads to disturbance of heat exchange processes of organism. Temperature of air ($18\text{-}22^0$) and surfaces, relative humidity (30-60 %), and mobility of air (0.25 m/s) are key parameters of dwelling microclimate.

In summer, heating is possible. It is negatively reflected in state of health of inhabitants, creates adverse conditions for house employment, rest, dream. To reduce heating of premises, proper orientation of windows on the cardinal directions, increase of thickness of insolated walls and increase of premises' height are planned. Walls and windows can be protected from solar beams by verandahs and green plantings. For the best reflexion of solar beams, external walls are painted in white colors. Windows are equipped with shutters, jalousie or curtains.

Dampness in inhabited rooms can arise owing to wrong choice of territory for building, insufficient waterproofing of walls, application of hygroscopic building materials, and also inefficient heating and ventilation. Dampness results in decrease of organism resistance, increase of sick rate level of respiratory ways, aggravation of tuberculosis, rheumatism and other chronic diseases. For prevention of dampness waterproofing of foundation and walls, drainage of site before building, warm walls, rational heating and ventilation are arranged.

Required conditions of temperature, humidity, movement and cleanliness of air indoors can automatically be maintained by **conditioners**

which combine in it heating and ventilation functions. Air is heated or cooled, humidified or dried, got the certain mobility of air, cleared from dust, deodorized, ozonized, ionized by means of conditioners.

Foundation should be moisture-proof.

Walls should have sufficient sound-proof properties, fire resistance, minimal weight, low factor of heat transfer, good thermal stability.

The interflat and interroom *partitions* are made of easy concrete, brick, plaster-concrete. They should create sound insulation between apartments not less than 48 dBA, between rooms - not less than 40 dBA. The partitions protecting the bathroom and the kitchen should have sufficient moisture resistance.

Overhead slabs are arranged with sufficient sound-, heat-, waterproof properties and resistance to gas.

There are two types of *roofs:* combined and not combined with ceiling. The combined roof is able to supply heat to the top to superheat the top floor in summer and overcool it in winter.

For *internal furnishing* of houses or rooms, materials allowed by the state sanitary supervision of the Republic of Belarus in house construction are used. It is necessary to paper *walls* of inhabited rooms or to paint by paint. The rooms with damp mode must be covered with water-resistant materials such as ceramic tile. The *ceilings* in inhabited rooms with usual mode must be performed with cretaceous or lime whitewashing. *Floors* should be warm, smooth, suppose easy clearing, and should not be slippery. Wooden floors are more acceptable, and from them parquet floor is the most perfect.

A hostel is intended for residing of single workers, pupils of technical schools and students.

There are some features of hostel’s planning:

- big quantity of beds;
- area per person is underestimated;
- presence of reading rooms, rooms of day stay and other premises of the general using;
- there are wardrobe, kitchens, still-rooms, pantries for storage of personal things, lavatories, washing room, etc.;
- presence of isolator (1 cot on 40 residents).

In hostels-complexes on 1500 and more places, the general premises for studies, cultural-mass and sports actions, consumer services and public catering are provided which are placed in separate block or building with warm transition. In such hostels, medical aid station including lobby, doc-

tor's office, treatment room, physiotherapy office, dental surgery, room of medical personnel and isolator are arranged.

Hostels are built in the form of separate buildings or hostels-complexes in territories having convenient communication with a place of work and educational institutions. The hostel area on one resident depends on its capacity (50 persons - 45 m^2; 100 persons - 35 m^2; 200 persons - 30 m^2; 400 persons - 25 m^2; 600 persons - 20 m^2; 1000 persons - 17 m^2).

On a hostel ground area, platforms for rest, games and employment by physical culture are provided.

Living rooms of hostels are built on 2-3 persons with 6 m^2 per 1 resident. Rooms are grouped, providing lavatories with toilets, shower and washroom, and also kitchen, room for employment and rest room for each group of rooms. The area of premises for students and pupils makes 0.3 m^2 on 1 person, for workers – 0.15 m^2 on 1 person.

Natural illumination is provided in hostels. The factor of natural light exposure for living rooms makes 0.5 %, light factor - 1/4.5-1/8. Recommended artificial light exposure in hostel premises is 100-300 lux.

Air temperature in living rooms should be in limits 20-22^oC at relative humidity 30-45 % and speed of air mobility 0.1-0.15 m/s during the cold period of year and 22-25^oC at relative humidity 30-60 % and speed of air mobility no more than 0.25 m/s during the warm period of year.

Frequency rates of air exchange in hostels are accepted: for living rooms exhaust ventilation is 3, for kitchens - 60-90 m^3/h on 1 m^2 of area. In all hostels exhaust ventilation from premises of kitchens, toilets, bathrooms, shower through ventilating channels should be provided.

In basement storey, it is supposed to place pantries for storage of dirty linen, sports and economic stock, washing room, premises for clothes and footwear drying, technical premises.

Parameters of living rooms of hostels are: width – 2.2 m, height – 2.5 m, depth - 6 m.

From each room exit to corridor directly or through sluice-lobby is provided. Doors of living rooms should be opened inside. Living rooms are equipped with wardrobe for storage of house clothes, linen and footwear, and also hangers for street clothes.

In rooms of cleaning and ironing of clothes, lavatory basin, tables for ironing and wardrobe for storage of accessories are provided. Washing room is separated from corridors by sluice.

Kitchens are equipped by cookers, sinks, tables-cases, cases.

All premises of hostel are daily cleaned by the damp way. Floors are washed 2 times per week and as required. General cleaning of all premises is spent 1 time per month. All premises of hostels, especially sleeping rooms, should be aired through window leaves or transoms in winter and through windows in summer during 20-30 min in the morning, in the afternoon during cleaning and in the evening before a sleep.

In a hostel current disinfection should be spent regularly. Premises of toilets should be cleaned several times in day by the damp way, and in the end of day carefully washed out by 0.5 % solution of chlorinated lime. Stock for cleaning of toilets is disinfected by boiling or chemical way and stored separately.

Question for self-control

1. Pollution of environment.
2. The basic sources of pollution and pollutants of air, water and soil.
3. Medical value of physical pollutants of air, water and soil.
4. Medical value of chemical pollutants of air, water and soil.
5. Medical value of biological pollutants of air, water and soil.
6. Diagnostic, treatment and prevention of environmental pathology, caused by pollutants of human environment.

Chapter 5.

MEDICAL VALUE OF FOODSTUFFS POLLUTION

Foodstuffs, their composition and value

Foods, or foodstuffs, are products which chemical composition and physical properties are used to provide physiological, biochemical, energetic, plastic and other human needs. Foods contain nutrients, antialimentary factors, non-food contaminants, nutritional supplements.

Food stuffs are divided into products ***of animal and vegetable origin***, as well as *mass-consumption products of traditional technology*, *products of mass use with modified chemical composition*, *medical products (dietary)* and *baby foods*. All food products are characterized by nutritional, biological, energetic value, as well as biological efficiency.

Nutritional value of products is the fullness of their useful properties, first of all, the chemical composition.

The indicator of the quality of food proteins (the degree of correspondence primarily of essential amino acids to the needs of the organism) is called as ***biological value***.

The indicator of the quality of food fats (the content of polyunsaturated fatty acids) is called as ***biological efficiency***.

The amount of energy, which is released from the foodstuff into the human body, is called as ***energy value***.

Requirements for value and biological efficiency are used for meat, meat products, poultry and eggs, milk and dairy products, fish, fish and other seafood products, bakery and flour-and-cereals, vegetables, melons, fruit, berries and products of their processing and other product groups.

Nutritional substances are groups of organic and inorganic compounds which are part of food stuffs and are involved in the substances and energy metabolism.

These include nutrients represented by proteins, fats, carbohydrates, vitamins and minerals, and flavoring substances.

Nutritional substances carry out plastic, energy, regulatory, informational, protective, adaptive, signal-motivational, rehabilitation and other functions and are divided into ***replaceable*** (some amino acids, fats,

carbohydrates) and ***irreplaceable*** (some amino acids, polyunsaturated fatty acids, microelements, vitamins).

Proteins are complex organic nitrogenous compounds consisting of carbon, hydrogen, sulphur and occasionally phosphorous. Proteins are required for body building, repair and maintenance of body tissues. These are required for biosynthesis of plasma proteins, haemoglobin, antibodies, enzymes and hormones. These play an important role in the constitution of all tissues including body fluids e.g., blood. These provide energy and heat. These are responsible for the cell-mediated immune response.

The most important source of energy for the body is **fats**, containing carbon, hydrogen and oxygen. The main functions of fats include participation in plastic processes (they are a structural part of cells and their membrane systems). In addition, vitamins A, E, D dissolve in fats (which contribute to their assimilation), phosphatides (lecithin), polyunsaturated fatty acids, sterols and other biologically active substances enter the body with fats.

Carbohydrates are the compounds of carbon, hydrogen and oxygen. They provide energy and heat. This act as a protein spares. Excess of carbohydrate is converted into fats. These are required for synthesis of certain non-essential amino-acids. They provide 4 kcal per gram of carbohydrate.

Minerals are inorganic compounds necessary for the growth of vital body-functions and for repair of tissues. Their normalize water-mineral metabolism, perform plastic, buffer, regulatory role. The mineral composition of food includes more than 60 major nutrients and trace elements.

Vitamins are complex organic compounds required for vital metabolic functions in the body and are needed by the body in small quantities. Vitamins are biological catalysts of various biochemical processes, they take part in metabolism, control the functions of cell membranes and subcellular structures.

Sources and pollutants of foodstuffs. Detoxification of xenobiotics

In addition to the fact that nutrition is the cause of well-known alimentary diseases, it can serve as a factor that reduces or increases the adaptive capacity of an organism. The composition of food products can

include not only nutrients, but also xenobiotics - potentially toxic substances of anthropogenic origin, which are a current public health problem.

Xenobiotics or xenobiotic compounds are man made chemicals that are present in the environment and pollute the environment when present in high concentrations. The word **"xeno"** means **foreign**. A compound that is normal to one organism may be a xenobiotic to another. For example, antibiotics can be referred as xenobiotics in a human body because human body does not contain them or produce them naturally.

Xenobiotics are any alien chemical compounds that are found in a living organism, but which are foreign to that organism, in the sense that it does not normally produce the compound or consume it as part of its diet. They can cause certain changes in a human body, including diseases and destruction. For example, in humans, most drugs are part of this category, since people don't produce them naturally, or consume them under normal circumstances. Xenobiotics can also be defined as substances that are present in higher-than-normal concentrations, or ones that are entirely artificial and did not exist before they were produced synthetically by humans.

Xenobiotics can be:

- exogenous - the foreign molecules which are not normally ingested or utilized by the organism but they gain entry through dietary food stuffs, or in the form of certain medicines/drugs used for a therapeutic cause or are inhaled through environment (drugs, food additives, pollutants, insecticides, chemical carcinogens etc.).
- endogenous – though they are not foreign substances but they have effects similar to exogenous xenobiotics; these are synthesized in the body and are produced as metabolites of various processes in the body (bilirubin, bile acids, steroids, eicosanoids and certain fatty acids).

Xenobiotics of natural origin, formed in the human body under the certain conditions, entering the body as a result of the receipt, processing and storage of food are distinguish.

The main distinctive feature of xenobiotics is that their effect on the person is carried on for a long time in small concentrations, which can only be detected by the most sensitive modern methods.

Xenobiotics entering the body from foods possess ***hepatotoxicity***, i.e., causing structural and functional disorders of the liver. The ultimate effect of chronic pathological processes occurring in the liver under the

influence of xenobiotics is liver fibrosis - ***a syndrome of portal hypertension***.

Xenobiotics can produce a variety of biological effects including (picture 5.1):

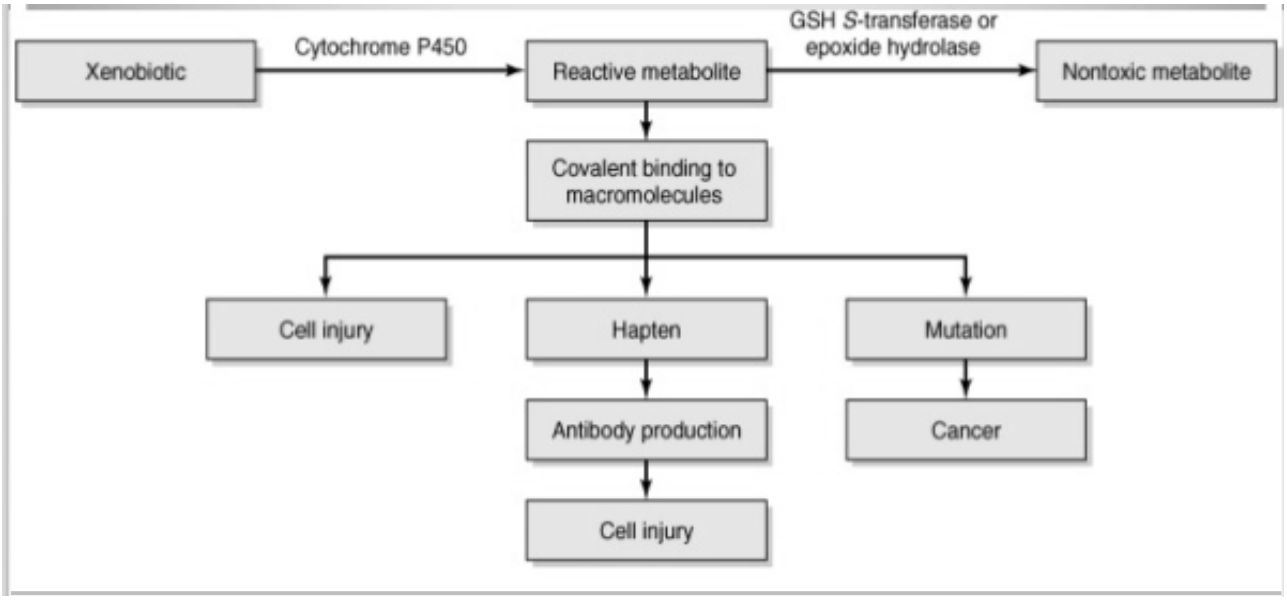
- pharmacological responses;
- toxicity;
- immunological responses;
- cancer.

Metabolism of a xenobiotic can result in cell injury, immunologic damage, or cancer.

Cell injury (cytotoxicity), can be severe enough to result in cell death. These macromolecular targets include *DNA*, *RNA*, and *protein*.

The reactive species of a xenobiotic may bind to a protein, altering its *antigenicity*. The resulting *antibodies* can then damage the cell by several immunologic mechanisms that grossly perturb normal cellular biochemical processes.

Reactions of activated species of chemical carcinogens with *DNA* are of great importance in *chemical carcinogenesis*. Some chemicals (eg, benzo[α]pyrene) require activation by monooxygenases in the endoplasmic reticulum to become carcinogenic (they are thus called *indirect carcinogens*).



Picture 5.1. The effects of xenobiotics.

The products of the action of certain monooxygenases on some procarcinogen substrates are *epoxides*. Epoxides are highly reactive and mutagenic or carcinogenic or both. Epoxide hydrolase — like cytochrome P450 acts on these compounds, converting them into much less reactive dihydrodiols.

For the human body as an open self-regulating biological system protection from external influences is realized in the form of a number of universal mechanisms. The basic cellular protective and adaptive mechanisms are currently known and studied:

a) system of biotransformation of xenobiotics;

b) antioxidant protection.

The concept of xenobiotic biotransformation encompasses not only the enzymatic chemical conversions, but also the transmembrane transport, tissue distribution, deposition and elimination.

The body typically deals with a foreign compound by making it more soluble in water, to increase the rate of its excretion through the urine. There are many different processes that can occur, the pathways of xenobiotics metabolism can be divided into phase I and phase II.

Xenobiotics can undergo one of four potential biotransformations:

1. active xenobiotics to inactive metabolite;
2. active xenobiotics to active metabolite;
3. inactive xenobiotics to active metabolite;
4. active xenobiotics to toxic metabolite (biotoxification).

As a result of these transformations xenobiotics and their metabolites are neutralized and prepared for safe removal from the body (evolutionarily current situation). However, in the modern environmental situation there is a "weak link" in this protective system: the most of synthetic xenobiotics (pesticides, polychlorinated biphenyls, a number of drugs) can be transformed into products and compounds are more dangerous than the original. This phenomenon is called metabolic activation (lethal synthesis).

In the case of formation of electrophilic products as a result of the metabolic activation the main risk is their high reactivity on the modification of structural macromolecules with the development of so-called long-term or remote effects due to sensitization, the membrane disorders, hereditary information and cell proliferative processes.

All the biochemical reactions involved the conversion of foreign, toxic and water insoluble molecules to non toxic, watersoluble and

excretable forms are called **detoxification or biotransformation reactions**.

The overall purpose of the two phases of metabolism of xenobiotics is to increase their ***water solubility (polarity)*** and thus excretion from the body. In certain situations these reactions may instead increase the toxicity of a foreign compound, then these are called **entoxification reaction**.

Metabolism of hydrophobic poisons, drugs, carcinogens, steroid hormones, lipids occurs in ***microsomal system***.

Liver is the main organ involved. Hepatocytes contain wide variety of enzymes to process xenobiotics. Enzymes are present in cytosol, endoplasmic reticulum and to lesser extent in other organelles. Each enzyme represents a large family of gene product. Each gene product may be induced by different xenobiotics.

Factors affecting biotransformation of xenobiotics:

- prior administration of the drug or co administration of other drugs;
- diet;
- hormonal status;
- genetics;
- disease (e.g., decreased cardiac and pulmonary disease);
- age and developmental status;
- functional status of liver and kidney.

Xenobiotics are metabolized in two phases.

Phase 1 reactions can limit the toxicity of xenobiotics and include the following ones.

The major reaction of phase 1 is hydroxylation catalyzed by a variety of monooxygenases, also as the cytochrome P450s.

Oxidation - a large number of foreign substances are destroyed by oxidation in the body (oxidation of methyl group containing compounds).

Reduction does not occur extensively in human beings (reduction of Aldehydes).

Hydrolysis reactions - certain therapeutic compounds undergo hydrolysis (Acetyl Salicylic acid into Acetic acid + Salicylic acid).

They are also called **hydroxylation reactions** since they introduce or expose a functional group (e.g., -OH) that serves as the active center for sequential conjugation in a phase 2 reaction.

In addition to hydroxylation, a wide range of reactions also takes place including:

- deamination;

- dehalogenation;
- desulfuration;
- epoxidation;
- peroxygenation;
- reduction.

Phase 1 reactions can also convert xenobiotics from inactive to biologically active compounds (**metabolic activation**). In this instance, the original xenobiotics are referred to as «prodrugs» or «procarcinogens».

In phase 2, the hydroxylated species are conjugated with a variety of hydrophilic compounds such as glucuronic acid, sulfate, or glutathione. The combined operation of these two phases renders lipophilic compounds into water-soluble compounds that can be eliminated from the body.

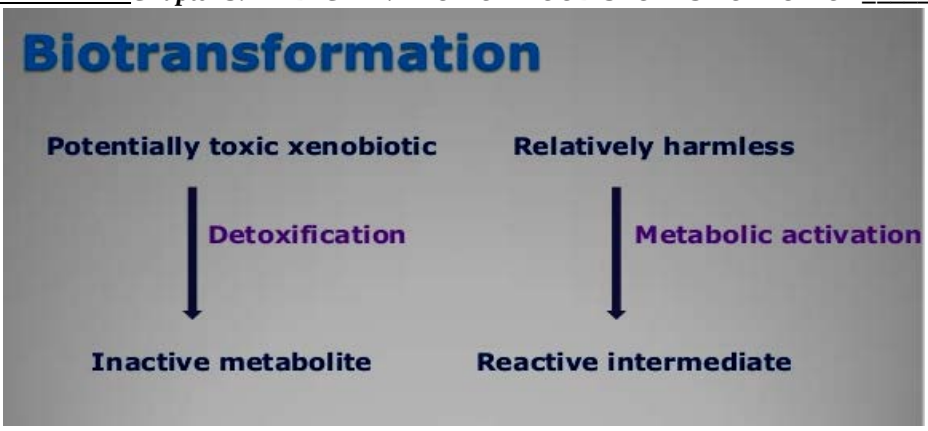
The hydroxylated or other compounds produced in phase 1 are converted by specific enzymes to various polar metabolites by **conjugation** with glucuronic acid, sulfate, acetate, glutathione, or certan amino acids, or by methylation.

Conjugation is a process by which the foreign molecules and their metabolites are coupled with a conjugating agent and are converted to soluble, non-toxic derivatives that are easily excreted in urine. Conjugation reactions can occur independently or can follow phase 1 (hydroxylation) reactions.

Conjugation takes place primarily in liver but can occur in kidney also. After conjugation, the products are generally rendered nontoxic but in certain conditions, they are left unchanged or become more toxic.

1. Glucuronidation
2. Sulfation
3. Acetylation
4. Methylation
5. Conjugation with Amino acids
6. Conjugation with G-SH

Conjugation reactions can convert the active products of phase 1 reactions to less active or inactive species, which are subsequently excreted in the urine or bile. In a very few cases, conjugation may actually increase the biologic activity of a xenobiotic (**metabolic activation**) (picture 5.2).



Picture 5.2. Biotransformation of xenobiotics.

The central mechanism of neutralization of products of metabolic activation is **antioxidant protection system**.

There are two types of antioxidant protection mechanisms: ***enzymatic and non-enzymatic***.

In the first case free radicals of oxygen are neutralized by enzymes. In non-enzymatic type the antioxidant mechanisms are associated with action of the natural antioxidant α-tocopherol and adaptation antioxidants α-retinol and β-carotene. The study of the role of ascorbic acid, bioflavonoids and calcium in the development of adaptive response is of great importance now. For example, calcium is a universal regulator of intracellular processes that ensures the stability of the main protective and adaptive systems.

Medical value of xenobiotics of natural origin, formed in the human body and raw materials and products obtained by chemical and microbiological synthesis

Consumption of food and foodstuffs rich in *oxalic acid*, leads to disruption of oxalates metabolism and oxaluria (fatigue, increased urine output, pain in the stomach).

Anthraquinones often lead to diarrhea.

Consumption of *essential oils* from the peel of lemons and oranges cause headache, lethargy, skin inflammation, carcinogenic effect.

Mint oil, containing menthol, has a narcotic effect, causing tachycardia if it enters the gastrointestinal tract in large amount.

Theophylline, theobromine and *caffeine* act on the central nervous system, cause excitation, sleeplessness, tachycardia, arrhythmia in high doses.

Serotonin, contained in walnuts, bananas, tomatoes causes hypertension.

Many natural xenobiotics possess carcinogenic activity, but their effect is offset by the effect of other anti-cancer compounds in food (ascorbic acid, β-carotene, tocopherols, limonene).

Formed in the human body under certain conditions, biogenic amines - histamine, serotonin, adrenaline are biologically active substances and have a multifaceted influence on the physiological functions of the body.

Serotonin is a chemical nerve cells produce. It sends signals between nerve cells. Serotonin is found mostly in the digestive system, although it's also in blood platelets and throughout the central nervous system. Serotonin is made from the essential amino acid tryptophan. This amino acid must enter the body through your diet and is commonly found in foods such as nuts, cheese, and red meat. Tryptophan deficiency can lead to lower serotonin levels. This can result in mood disorders, such as anxiety or depression. Serotonin affects every part of body, from emotions to motor skills. Serotonin is considered a natural mood stabilizer. It's the chemical that helps with sleeping, eating, and digesting. Serotonin also helps:

- reduce depression;
- regulate anxiety;
- heal wounds;
- stimulate nausea;
- maintain bone health.

Here is how serotonin acts in various functions across the body:

Bowel movements: Serotonin is found primarily in the body's stomach and intestines. It helps control bowel movements and function.

Mood: Serotonin in the brain is thought to regulate anxiety, happiness, and mood. Low levels of the chemical have been associated with depression, and increased serotonin levels brought on by medication are thought to decrease arousal.

Nausea: Production of serotonin rises to push out noxious or upsetting food more quickly in diarrhea. The chemical also increases in the blood, which stimulates the part of the brain that controls nausea.

Sleep: This chemical is responsible for stimulating the parts of the brain that control sleep and waking.

Blood clotting: Blood platelets release serotonin to help heal wounds. The serotonin causes tiny arteries to narrow, helping form blood clots.

Bone health: Serotonin plays a role in bone health. Significantly, high levels of serotonin in the bones can lead to osteoporosis, which makes the bones weaker.

Sexual function: Low levels of serotonin are associated with increased libido, while increased serotonin levels are associated with reduced libido.

If the metabolism of serotonin is disturbed, myocardial infarction, peptic ulcer, and certain mental illness may occur.

Histamine is released at the mucosal surfaces as a result of exposure to foreign particles. This histamine release causes the capillaries to become more permeable to white blood cells, which move into the capillaries and proceed to target and attack foreign bodies in the affected tissue. The increased permeability of the capillaries causes fluid to move out of capillaries, which gives rise to the classic symptoms of allergy such as a runny nose and watery eyes. As the foreign antigens bind to IgE-sensitised mast cells in the mucous membranes, several responses occur. Sensory neural stimulation associated with the histamine release leads to sneezing; the glandular tissue secretes fluids and nasal congestion occurs due to the vascular engorgement caused by increased vasodilation and capillary permeability.

Non-mast cell histamine is released in the brain where it acts as a neurotransmitter. The histamine neurons are found in the tuberomammillary nuclei of the posterior hypothalamus. From there, they extend throughout the brain into the cortex and medial forebrain bundle. These neurons increase wakefulness and also prevent sleep.

In the stomach, histamine stimulates the parietal cells to produce the gastric acids required for digestion.

Adrenaline is an important part of your body's ability to survive, but sometimes the body will release the hormone when it is under stress, but not facing real danger. This can create feelings of dizziness, light-headedness and vision changes. Also, adrenaline causes a release of glucose, which a fight-or-flight response would use. When no danger is present, that extra energy has no use, and this can leave the person feeling restless and irritable. Excessively high levels of the hormone due to stress without real danger can cause heart damage, insomnia and a jittery, nervous feeling.

In products produced with the help of microbiological synthesis, tyramine, histamine is formed. High content of **tyramine** in foods such as cheese, chocolate, sauerkraut, and also some alcoholic beverages can cause the hypertension. Significant content of **histamine** in some varieties of wine. It can lead to acute poisoning, accompanied by spasms of smooth muscles and severe headaches.

Transgenic, or genetically modified, products can disrupt the metabolism and physiological functions of the human body. Microorganisms modified by genetic engineering methods cause allergic reactions. Passing their genes to other microorganisms, they contribute to the resistance to antibiotics. *Recombinant growth hormone,* which is used to increase milk production, once entered in the body, increases the level of insulin-like factor, induces acromegaly in children and adolescents and increases the risk of malignant tumors of breast and colon in adults.

Medical value of xenobiotics that enter in foodstuffs from initial raw food material and food processing

The heavy metals toxins that are entered in human organism with foodstuffs are listed below.

1. **Mercury**. Mercury from the intestine is absorbed in small amounts. For humans, its compounds are most dangerous, which are neuro-, gonado- and nephrotoxic, and also have embryo- and teratogenic effects.

Long intake of methylmercury can lead to ***Minamata disease.*** Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision, and damage to hearing and speech. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms. A congenital form of the disease can also affect foetuses in the womb.

Common symptoms of mercury poisoning include ***peripheral neuropathy*** (presenting as paresthesia or itching, burning or pain), ***skin discoloration*** (pink cheeks, fingertips and toes), ***swelling***, and ***desquamation*** (shedding of skin). A person suffering from mercury poisoning may experience profuse sweating, tachycardia (persistently faster-than-normal heart beat), increased salivation, and hypertension (high blood pressure).

Daily consumption of mercury should not exceed 0.05 mg.

2. **Copper**. It possesses hepatotoxic action, causes autoimmune reactions, functional frustration of nervous system, liver, kidneys, ulceration and punching of nasal partitions.

Wilson's disease *or* ***hepatolenticular degeneration*** is an autosomal recessive genetic disorder in which copper accumulates in tissues, this manifests as neurological or psychiatric symptoms and liver disease. It is treated with medication that reduces copper absorption or removes the excess copper from the body, but occasionally a liver transplant is required.

Daily consumption of copper should not exceed 30 mg.

3. **Strontium**. It is nervous and muscular poison. The human body absorbs strontium as if it were calcium. Due to the chemical similarity of the elements, the stable forms of strontium might not pose a significant health threat - in fact, the levels found naturally may actually be beneficial – but the radioactive ^{90}Sr can lead to various bone disorders and diseases, including bone cancer.

4. **Zinc**. Although zinc is an essential requirement for good health, excess zinc can be harmful. Excessive absorption of zinc suppresses copper and iron absorption. It causes bony rarefication, possesses mutagenic and cancerogenic activity, renders gonadotoxic action.

5. **Iron**. Iron-deficiency anemia is a common anemia (low red blood cell or hemoglobin levels) caused by insufficient dietary intake and absorption of iron, and/or iron loss from bleeding which can originate from a range of sources such as the intestinal, uterine or urinary tract. At long storage of smth in tin-coated flaskes diseases of iron overload, like ***haemochromatosis*** *or* ***haemosiderosis***, and iron deficiency, like iron deficiency anemia is possible. ***Siderosis*** is the deposition of iron in tissue. Organs commonly affected by haemochromatosis are the liver, heart, and endocrine glands.

Haemochromatosis may present with the following clinical syndromes:

- cirrhosis of the liver;
- diabetes due to pancreatic islet cell failure;
- cardiomyopathy;
- arthritis (iron deposition in joints);
- testicular failure;
- tanning (bronzing) of the skin;
- joint pain and bone pain.

6. **Aluminium** enters the body from aluminium utensils and packing material. At superfluous consumption bone tissue formation is slowed down, motility of gastro enteric path is weakened. Nanoparticles of aluminum are infinitely more reactive and can easily penetrate the brain. Of special concern is the effect of these nanoparticles on the brain and spinal cord, as a growing list of neurodegenerative diseases, including ***Alzheimer's dementia, Parkinson's disease, and Lou Gehrig's disease*** (ALS) are strongly related to exposure to **environmental aluminum.**

7. **Lead.** Long-term intake of lead into the human body causes chronic intoxication, which is accompanied by *asthenic syndrome* (weakness, sleep disturbance, headaches, memory and attention loss, depression), *asthenic and neurotic syndrome* (persistent red dermographism, increased tendon reflexes, tremor of fingers, bradycardia), *anemia* (appearance of reticulocytes in peripheral blood, basophilic granularity of erythrocytes), *gastrointestinal syndrome* (feeling of heaviness in the epigastric region, diarrhea and constipation in turns, increased peristalsis of the intestine).

With prolonged intake of lead into the body, ***nephropathy*** can develop, leading to *renal insufficiency, osteoporosis, paralysis, and visual impairment*.

Pesticides entering the organism possess *carcinogenic, neurotoxic and hepatotoxic effects*.

Nitrates and nitrites are added to meat and some fish products in order to improve their taste and smell, color stabilization, to prevent the growth of pathogenic organisms. Plants absorb nitrates from the soil through the root system, the irrational use of nitrogen mineral fertilizers increases their content. Nitrites can be found in a number of foods, but are found predominantly in the processes of pickling, salting and curing. The consumption of nitrates causes alimentary nitrate methaemoglobinaemia.

There are obvious sources of **nitrosamines**; nitrite preserved food like luncheon meats, bacon or smoked fish. But there are non obvious sources as well; some beers contain nitrosamines from the brewing process, and any food item that is in a non breathing container. Nitrosamines are chemical compounds, most of which are carcinogenic. Nitrosamines cause many types of cancer, most notably along the gastrointestinal tract. The maximum permissible concentration of nitrosamines is 10 mkg/kg. The maximum permissible concentrations of nitrates in foodstuffs are listed in the table 5.1.

In agriculture during growing of animals for meat various **medical drugs** are applied. Surplus of preparations can be accumulated in the certain bodies of animal (liver, meat) and enter to human organism during meat consumption of such animals, causing various health infringements (antibiotics, sedative preparations, glucocorticoids, vitamins).

Table 5.1. The maximum permissible concentration of nitrates in foodstuffs.

Foodstuffs	Nitrates content, mg/kg
potato	150
white cabbage	400
carrots	200
tomatoes	100
cucumbers	150
spring onions	400
garden radish	1500
eggplants	300
beetroot	1400
large onions	80
sheet vegetables (salad, sorrel, parsley, fennel, celery, etc.)	1500
melons	90
water-melons	60
pepper sweet	200
vegetable marrows	400
grapes	60
apples	60
pears	60
products of children's food (vegetables preserved)	50

Food additives are compounds purposely added to foodstuff in the limited quantities at different production phases, storages and transportations for the purpose of the certain properties giving to food at storage, etc.

They generally provide five main reasons for why chemicals must be added to our foods:

1. To improve shelf life or storage time.
2. To make food convenient and easy to prepare.
3. To increase the nutritional value.

4. To improve the flavor of foods.

5. To enhance the attractiveness of food products and improve consumer acceptance.

Food additives are substances added to food to preserve flavor or enhance its taste and appearance. Some additives have been used for centuries, for example, preserving food by pickling (with vinegar), salting, as with bacon, preserving sweets or using sulfur dioxide as in some wines. Food additives disrupt metabolism, have allergenic properties, many are carcinogens. Those with immediate effects may cause headaches or alter energy level, or they may affect mental concentration, behavior, or immune response. Those with long-term effects could increase risk of cancer, cardiovascular disease and other degenerative conditions.

To regulate these additives, and inform consumers, each additive is assigned a unique number, termed as "E numbers", which is used in Europe for all approved additives.

E numbers are codes for substances which can be used as food additives for use within the European Union and Switzerland (the "E" stands for "Europe"). They are commonly found on food labels throughout the European Union. Safety assessment and approval are the responsibility of the European Food Safety Authority.

Food additives and their health risks:

1. Hydrogenated Fats - cardiovascular disease, obesity.

2. Artificial Food Colors - allergies, asthma, hyperactivity; possible carcinogen.

3. Nitrites and Nitrates - these substances can develop into nitrosamines in body, which can be carcinogenic.

4. Sulfites (sulfur dioxide, metabisulfites, and others) - allergic and asthmatic reactions.

5. Sugar and Sweeteners - obesity, dental cavities, diabetes and hypoglycemia, increased triglycerides (blood fats) or candida (yeast).

6. Artificial Sweeteners (Aspartame, Acesulfame K and Saccharin) - behavioral problems, hyperactivity, allergies, and possibly carcinogenic.

7. MSG (monosodium glutamate) - common allergic and behavioral reactions, including headaches, dizziness, chest pains, depression and mood swings; also a possible neurotoxin.

8. Preservatives (BHA, BHT, EDTA, etc.) - allergic reactions, hyperactivity, possibly cancer-causing; BHT may be toxic to the nervous system and the liver.

9. Artificial Flavors - allergic or behavioral reactions.
10. Refined Flour - low-nutrient calories, carbohydrate imbalances, altered insulin production.
11. Salt (excessive) - fluid retention and blood pressure increases.
12. Olestra (an artificial fat) - diarrhea and digestive disturbances.

Currently, the production of beer, alcohol, juice, canned food, in the bakery, fish and meat processing industry to accelerate dough formation, maturation of meat and fish, the juice out of the fruit and vegetables, starch fermentation and other processes *enzyme preparations* are commonly used, which are obtained by microbiological synthesis. Such enzymes are products of microorganisms from the nutrient medium. Their entering in the body leads to dyspepsia and allergic reactions.

Medical value of xenobiotics that enter in foodstuffs from utensils, inventory, containers, packing materials and as a result of food processing

Xenobiotics which enter in foodstuffs at contact to polymeric and other materials (utensils, container such as heavy metals, plasticizers, polyvinyl chloride).

The most common migrating chemicals from utensils, containers, packaging materials, equipment into food products are *salts of* ***copper, zinc, lead and other heavy metals***.

Recently, the food industry uses ***a variety of synthetic materials contacting to the food products*** (adhesives, materials for the production of edible utensils, film, polyvinyl acetate, polystyrenes, rubber-containing components, ion exchange resins, organic glass, fluoroplastics enamel coating equipment and containers).

Products of **polyvinyl chloride (PVC)** are widely used as packaging materials for food. PVC is produced from vinyl chloride, which, when inhaled, can have carcinogenic action, causing gemangiosarkoma (fast-growing malignant tumor of blood vessel walls). Receipt of polyvinyl chloride in food is only possible in the case of use of packaging materials for other purposes. For example, when bottles and cans made of PVC are used for storing of vegetable oils, vinegar, fruit juices and mustard.

The risk of polyvinyl chloride entering the human body is that it has a *carcinogenic, mutagenic and teratogenic effect*. ***Polyethylene terephthalate*** contained in plastic utensils and containers, when ingested,

causes *vascular damage*, accompanied by pallor, blue skin, tingling in the limbs.

During the heating process in cooking, carbonyl groups of sugars combine with amino groups of proteins, forming glycylated complexes that are toxic products with carcinogenic and mutagenic activity (products of the "Mallard reaction"). The compounds that are formed at influence of culinary processing and chemical interaction are ***lizilalanin, benzo (a) pyrene and nitrosamines*** (at cooking of meat in alkaline water - lizilalanin, at smoking - benzo (a) pyrene and nitrosamines).

When cooking, side toxic and mutagenic products appear. ***Benzo(a)pyrene***, formed in smoking products and grilling in the case of fat heating on hot charcoal, possesses mutagenic and carcinogenic action.

As a result of heating, some ***amino acids (tryptophan, glutamic acid)*** and proteins containing them, can produce carcinogenic products (heterocyclic amines - GCA). These compounds are mainly formed during cooking of meat, and the higher the temperature and duration, the higher the GCA in the final product. ***Heterocyclic amine*** is associated with a malignant tumor of the breast and bowel.

Diagnostic, treatment and prevention of environmental pathology, caused by pollutants of foodstuffs

To **diagnose** the environmental pathology caused by the pollutants of foodstuffs - ***food poisoning with xenobiotics*** - a detailed anamnesis is collected by the interview method. The doctor should reveal the hereditary changes that have been appeared under the influence of stressful, biological, chemical and physical pollutants of foodstuffs, triggers of the environmental pathology, complications and long-term consequences of the pathological process, as well as the time of consumption of the polluted foodstuffs, phenomena of elimination and re-exposure.

The patient is examined, specific and non-specific signs that are characteristics of pollutants are revealed in the clinical picture, laboratory tests are appointed to determine the hormone status, processes of free radical oxidation, metabolites, chemical xenoboitics, and parasites.

To **confirm the diagnosis** the following information is revealed:

- pollution of the food stuffs;
- prolonged circulation of the etiological factor of low intensity on the territory;

- a long latent period with an increase in nonspecific morbidity;
- an increase in nonspecific diseases in persons with genetic sensitivity to pollutants;
- polysyndrome character and the various severity of the clinical course of the disease with the same xenobiotic at the patients;
- resistance to the standard treatment scheme at the consumption of xenoboitics;
- the direct correlation of morbidity with the level of food stuffs pollution.

Treatment of the acute food poisoning with xenobiotics is carried out in accordance with the clinical protocols using traditional methods, including the use of pharmacological drugs, physiotherapy, diet therapy, and psychotherapy.

Treatment of the patients with chronic food poisoning with xenobiotics includes detoxication, first of all, with the help of nutrition and phytopreparations, restoration of broken nutritional status, immunocorrection, specific desensitization, appointment of antioxidants, mediator precursors, the drugs which bind and eliminate contaminants, elimination of organ and system dysfunctions, increase in the resistance of the organism.

Individual **prevention** includes the consumption of clean, high-quality and safe food products obtained on unpolluted soil, the formation of a healthy lifestyle with an emphasis on rational and preventive nutrition, drinking mode, the refusal to consume contaminated food, and the reception of adaptogens.

Rational nutrition should be *adequate, balanced, safe and diverse*. In terms of preventive nutrition, it is necessary to restrict or exclude from the diet the products that accumulate pollutants (vegetables, fruits, berries, mushrooms, meat, fish), perform the culinary and technological processing of food stuffs, and limit the consumption of food stuffs obtained in contaminated areas.

When xenobiotics get into the organism, it should be done the following steps:

1) Limitation of their absorption according to the principles of competitive substitution and binding.
2) Acceleration of their excretion.
3) Saturation of the organism with natural antioxidants to protect the cells and intracellular structures.

4) Enhancement of the adaptive and compensatory capabilities of the organism.

Taking into account ***the principle of competitive substitution***, it is recommended to include into the diet the following food stuffs: potatoes, prunes, tea, nuts, beans, wheat, rye, milk and dairy products, eggs, chives, dill, parsley, turnips, horseradish, meat, fish, rye bread, sunflower seeds, apples and other products containing elements that compete with pollutants and reduce their absorption.

Taking into account ***the principle of binding pollutants in the gastrointestinal tract***, it is recommended to include into the diet the food stuffs which are rich in *pectin* (apples, pears, black currants, carrots, beets, eggplants, cucumbers, peppers, pumpkin, marmalade, marshmallow), *phytates* (leguminous plants), *anthocyanins* (chokeberry, plum, black currant, grapes, cherries and other dark-colored fruits and berries).

To accelerate the removal of pollutants from the organism, it is recommended to use coarse bread, cabbage, beetroot, carrots, prunes, buckwheat, oatmeal, millet and other foods containing dietary fibers which strengthen the intestinal peristaltic, to pass bile and urine passage by consuming of additional amount of tea, juices, fruit drinks, compotes, infusions of chamomile, immortelle, mint, dog rose, dill and other herbs with a diuretic and choleretic effect, stimulate lymphatic drainage by consuming of oats, oatmeal flakes, rosehip, plantain leaves, marigold flowers, corn stigmas.

The protection of cells and intracellular structures is ensured by the consumption of products containing *vitamin C* (rose hips, black currants, sweet peppers, sea buckthorn, chokeberry, strawberries, tomatoes, cabbage, onions), *vitamin E* (sea buckthorn, corn, beans, unrefined vegetable oils, buckwheat, seeds of sunflower, cereals), *vitamin A* (beef liver, butter, egg yolk), *beta carotenes* (carrots, sweet peppers, parsley, sorrel, celery), *iodine* (seafood, fish, beans, buckwheat, garlic, beets, cucumbers, chokeberry, iodized salt), *zinc* (corn, walnuts, oatmeal, rice, peas, beans, sunflower seeds and pumpkins, potatoes, beets, carrots, sorrel, egg yolk, liver, beef, herring, pikeperch), *copper* (nuts, apples, beets, potatoes, peas, beans, soy, oatmeal, buckwheat, cheese, liver, fish, meat), *selenium* (garlic, rice, barley, oats, fish), *cobalt* (sorrel, pear, dill, beets, green onions, black currants, fish, carrots, cranberries, mountain ash, nuts, peas, beans), as well as the exception from the diet of rhubarb, red currant and other products containing pro-oxidants.

For enhancement of the adaptive and compensatory capabilities of the organism it is necessary to consume *grains of germinating wheat*, which contain a significant amount of antioxidants and immunomodulators, *spirulina* containing all essential amino acids, most vitamins and minerals, biologically active additives, ginseng, eleutherococcus, zomanicum and other adaptogenes, polyvitamin and mineral phytopreparations, to carry out massage, hydrotherapy, light therapy, electrotherapy, heat mud treatment, hydrotherapy and other prevention physiotherapy.

As **public prevention** doctors perform medical survey and prophylactic medical examinations, supervision of the population in out-patient - policlinic establishments. They also send the individuals of the risk group for rehabilitation to sanatorium treatment, conduct environmental education and training, participate in supervision of the morbidity, physical development, and demographic indicators according to the program of social and hygienic monitoring. The maximum permissible concentrations and levels of pollutants in foodstuffs are developed.

The producer carries entirely responsibility for the quality of food and control is carried out by the authorized government agencies (State sanitary epidemiological servises, State sanitary veterinary servises, State Inspectorate for Quality) in the order of the current supervision. All food sold in specialized network of trade and public catering must comply with the quality requirements. Proof of this is the availability of manufacturer's quality certificates, sanitary-epidemiological conclusion and the certificate of conformity for each party food.

The following are methods of foodstuff examination:

1. organoleptical (color, smell, appearance, consistence, taste);
2. physical (temperature, density, humidity);
3. chemical (pH, extraneous impurity, chemical compound);
4. microscopic (morphological structure, parasites);
5. bacteriological (degree and character of microbial pollution);
6. biological (toxicity on animals);
7. radiometric (pollution by radioactive substances).

Food, entirely corresponding to the safety standards, can be made of either high quality raw food, or with use of the special processing method that can reduce the concentration of xenobiotics in the food. Considering the complexity of the ecological environment and intense way of modern agricultural production, it is necessary to recognize the critical importance of food decontamination technology. Based on the fact that the polluted

territory on the open ground is not possible to obtain entirely safe food products, it must be subjected to various technological processing.

The assessing of quality of raw food material can be recognized as either *unconditionally suitable for food without restrictions* (at corresponding of all quality parameters to regulations), or *unconditionally not suitable for food* (if it is contaminated with pathogens of especially dangerous infections, highly toxic compounds or high levels of xenobiotics) or *suitable for food under appropriate processing conditions* (thermal, chemical, mechanical methods).

Processing of raw food material involves the possibility of reduction the residual amounts of alien substances till the maximum permissible levels in the process of technological impact. At this process xenobiotics can be destroyed into non-toxic compounds, inactivated, extracted from the product, mechanically removed from inedible parts.

For example, in pickling and marinating foodstuffs the amount of heavy metals, radionuclides and nitrate will be twice smaller in the resulting product than in the original fresh food (without use of brine or marinade in food). At milk processing heavy metals and radionuclides pass in dairy products inversely proportional to their fat content. Thus, their lowest concentration will be marked in the butter, cream, cheeses, fat cottage cheese, sour cream. The opposite situation will be when milk is contaminated with lipophilic xenobiotics (organochlorine pesticides, polychlorinated biphenyls).

Different methods of culinary processing can reduce the nitrate content in them (table 5.2).

These methods include:

- cleaning and removal of most "nitrate" parts of plants (cucumber – peel, cabbage - upper leaves, veining, cabbage stalk);
- washing and soaking of the product;
- boiling (up to 80% of nitrates and nitrites passes in the broth especially in large amount of water, reduction of nitrates into nitrites occurs due to enzyme nitrate reductase inactivation);
- frying, stewing of vegetables (nitrates content is reduced to 15%).

It is believed at the rigid heat treatment nitrates not only are leached away, but also are partly broken to nitrogen oxides and oxygen.

Thus, in the ready vegetable dishes nitrates content is less on 20 - 25% in the average than in the original product.

Table 5.2. Reduction of nitrates content in vegetables at the different methods of culinary processing, %.

Method of culinary processing	Pota-toes	Beet	Cab-bage	Carrots	Cucum-bers	Mar-rows
cleaning	to 10	to 10	to 10	to 4	to 50	to 10
soaking during 2 hours	25-30	25-30	25-30	20-30	—	—
boiling in water	50-80	40-60	50-70	50-70	—	—
stewing, frying	10	6	10	10	—	—
salting	—	—	50	—	50	—
pickling	—	50	—	—	50-70	—
canning:						
at single-component recipe	25-30	20-25	25-30	25-30	—	10-20
at multi-component recipe	—	35-60	40-80	40-80	—	30-50

It is necessary to choose the sequence and the amount of processing to ensure the compliance with regulatory requirements and do not seek to completely removal of contaminants. This is due to a significant reduction in the nutritional value of foods by using of the full volume of processing resulting in the loss of vitamins, minerals, amino acids, dietary fibers.

In any case it is necessary to process the products to begin with washing under warm running water, using a solution of baking soda. Before washing of some vegetables (cabbage, onions, garlic) it is advisable to remove the top, the most contaminated leaves.

The only preferred method of heat treatment of products, obtained on the contaminated territories, is boiling. This is due to the fact that considerable part of xenobiotics enters into broth at boiling. Obviously, the primary broth (bouillon) is not recommended to use. Boiling the product in slightly boiling water with the closed lid for 5 - 10 minutes, the water must be drained, and boiling in new portion of water should be continued to brew or the other way of culinary processing should be used (quenching, frying, roasting, etc.).

The salt composition and pH of water affect the exit of contaminants in broth (bouillon). Thus, heavy metals are released into the tap water with lactic acid calcium in 1.5 times more than into the ordinary tap water and in 3 times more than into the distilled water. The presence of salt in the amount, providing normal flavor characteristics of cooked peeled potatoes

(6 g / dm^3), increases the number of passed into broth alien substances into 3 - 5 times.

Primary frying and stewing of contaminated products with thermostable xenobiotics (heavy metals, radionuclides, organochlorine pesticides) can not be recommended, since they all remain in the finished product, and due to the evaporation of the liquid their concentration even increases. The similar processes occur at drying, smoking and curing of the contaminated products.

Currently, there are some recommendations on ways of cooking of products obtained individually as a result of growing in the garden and gathering (mushrooms, berries) in terms of ecological trouble (table 5.3).

Table 5.3. Reduction of heavy metals and radionuclides content in food depending on the method of culinary processing, %.

Foodstuff	Method of culinary processing	Degree of xenobiotics
potatoes	peeling	30-40
	boiling in salted water	50
beet	peeling	30-40
	boiling	60
cabbage	boiling	60-80
sorrel	boiling	45-50
meat	boiling	50-70
	boiling after soaking	80-90
fish	removal of scales, viscera	16
	boiling	70-90
milk	preparation of cottage cheese	60-80
	preparation of cheese, sour cream	60-90
	preparation of cream, butter	50-99
	washing under running water	15-30
mushrooms	soaking of dried mushrooms for 2 hours	70-80
	boiling once for 10 min	70-80
	boiling twice for 10 minutes	85-97

If you can not get the safe finished product (dish) at home cooking methods you should completely abandon the use of raw food, replacing it with a similar, but meet the hygienic requirements.

Question for self-control

1. Food stuffs, their composition and value
2. Sources and pollutants of foodstuffs. Detoxification of xenobiotics.
3. Medical value of xenobiotics of natural origin, formed in the human body and raw materials and products obtained by chemical and microbiological synthesis
4. Medical value of xenobiotics that enter in foodstuffs from initial raw food material and food processing
5. Medical value of xenobiotics that enter in foodstuffs from utensils, inventory, containers, packing materials and as a result of food processing.
6. Diagnostic, treatment and prevention of environmental pathology, caused by pollutants of foodstuffs.

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