MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN
SULEYMAN DEMIREL UNIVERSITY

ECOLOGY AND SUSTAINABLE DEVELOPMENT LECTURE BOOK

G.S BEKENOVA

Almaty 2014

CONTENT

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LECTURE BOOK

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The subject guide includes the topics based on the sample programme of the discipline “Ecology and Sustainable Development” and gives information about the objectives and functions of ecological science; anthropogenic factors of instability in biosphere; social ecological problems; they ways of appropriate use of natural resources and theoretical information on numerous processes focused on concept of the continuous development of the Republic of Kazakhstan; and seminars based on credit system along with the tasks for the independent work of the students. Apart from this there are consolidation exercises, practice tests and glossary.

This subject guide is intended for all the students of higher education institutions.

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PREFACE

The importance of ecological knowledge and training, which encourages the youth to be more conscious is increasing in the period when the global changes and steady development in the society took place in the Republic of Kazakhstan.

Because the complex interconnection in the system “nature-society-man” is getting worse year after year and the environmental problems might cause danger to human beings. Anthropogenic processes directly and indirectly caused the disappearance of various animals and plants. Numerous global ecological problems have appeared: greenhouse effect, the damage of ozone layer, the pollution of the Pacific Ocean, etc. Due to the extensive development in economics the environmental situation in Kazakhstan has also worsened: the damage of Aral system, the inappropriate condition in Caspian and Eastern Kazakhstan region; the territories near Semey testing area, unfertile lands and etc. A period of time according to Le Chatelier principal, the impact of a man to biosphere has been facilitated. But the anthropogenic changes might be noticed in all ecosystems of the planet. It means that the man contradicted the nature, and “biosphere-human being” system is deviating from balance, as a result the natural dynamic balance has been mutilated in many parts of the world. All these conditions have led to the worsening of biosphere, and caused damage to a man’s health and spiritual world. These issues were put in agenda in Rio de Janeiro in 1992 and Sustainable Development Conception was signed. The sustainable development in the system “society-nature” is the preservation of dynamic balance in social ecological systems. The earlier humanity realizes this and takes the right path, the earlier it can find opportunities to live longer on Earth. The ecological literacy plays an important role in solving this problem and it helps an individual build his own ecological knowledge; the basis of it is the discipline “Ecology and Sustainable Development”. The objective of the subject is to enable students to care about the environment and their personal health. Such viewpoint will help future specialists equipped with safe ecological knowledge to improve sustainable development of biosphere.

The recommended tutorial is based on the lectures of sample programme of the compulsory discipline “Ecology and Sustainable Development” and includes numerous theoretical information, consolidation tasks, practice tests and glossar

1.
2. THE THEORETICAL PART

1.1 Ecology and Its Role in Implementation of the Sustainable Development Concept

Ecology *i*s the study of the relationships of organisms with other organisms and with their physical environment. Ecology also includes study of the structure and functions of natural systems. The word *ecology* was first used in 1866 by the German biologist Ernst Haeckel (1834–1919), who based it on the Greek words *oikos,* meaning "household," and *logos,* meaning "study."

1.1.1 The Primary Objectives of the Science of Ecology

The Primary Objectives of the science of Ecology are as follows:

1. To study the life forms consistent pattern organization, also in the context of anthropogenic impact (human intervention or man impact) on environment and biosphere as a whole, including:

a) regularities of living organisms spacing;
b) change in organisms population;
c) *energy flows through the living systems, and* circuit of substance involving living organisms.

2. To develop a scientific basis for exploiting the biological resources, forecast changes in the nature as a result of human activities and management processes in the biosphere, and preserve human and other life forms environment;

3. To develop measures to ensure minimum use of chemical agents to control *organisms* considered *harmful*;

4. To control the population of living organisms;

5. To provide indication of environmental status and contamination of natural habitats.

All of the above mentioned objectives are focused on sustaining the biological diversity being a key factor of sustainable nature and society development.

1.1.2 Sections of Ecology

The science of Ecology is closely related with both natural and human sciences (chemistry, mathematics, physics, geography, medicine, economics, law, etc.).

Fundamentally, all lines of modern environmental science are based on biological concepts of the relationship between living organisms and the environment, that is how the environment impacts the organisms and vice verse are, because immediately the organisms have given rise to the existing

life environment. Future existence of a human will depend on this science progress.

Consequently, ***Biological Ecology*** studies the *conditions* of e*xistence of living* organisms and the relationship between organisms and ecological environment they are inhabiting in.

Idioecology (Autecology) studies such characteristics of the living organisms as adaptation to temperature, humidity, salinity and other environmental factors, as well as growth and reproduction, lifetime, growth rate, and also metabolism characteristics - composition and quantity of food, respiration rate, and photosynthetic rate.

Population Ecology or Demecology studies characteristics of the population consisting of species varying in quality, age, sex, and phenotype**.**

Sinecology or Community Ecology *studies* the community species composition, their spatial pattern, and communities change with time. The natural living space inhabited by the community is called a biotope (habitat) (in Greek, "bios" means life, "topos" - place). The biotope (habitat), together with the community builds the ecological system which maintains continuous interrelation of the animate and inanimate nature elements.

Complex of all earth ecosystems within three geospheres (lithosphere, hydrosphere and atmosphere), which interact with living organisms, creates the biosphere - the largest ecosystem on Earth (in Greek: "bios" means life, plus sphere). ***Global Ecology*** studies biosphere as a whole**.**

Environmental Engineering *investigates the interrelations* of the community and natural habitat with public production processes.

Human Ecology focuses on preservation and development/improvement of human health, with a glance to the relationship *between* human and his circumambient natural and social environment.

Social Ecology investigates the *nature-society* interactions; it is the science dealing with radical changes taken place in the technology structure and quality, the economy priorities, value paradigms and modern civilization culture, aimed at secure strategy and tactics of the human activities in the field of remaking of nature (transformation of nature**).**

Space Ecology being a totally new line of Human Ecology deals with the manned satellites as artificial ecosystems and also studying the impact of the space medium factors on human organism which is being a core of this system. In this context, interests of both space and medical ecologies are almost identical.

1.1.3 Ecology and its role in implementation of the sustainable development concept

Ecology is a fundamental science discipline with its targets of research, objectives and research methodology. And if the importance of this science is recognized (beyond question), its laws, concepts and terms should be adequately used. Ecological knowledge has always been of considerable importance in human life. Over the period of hunting and gathering the acquired *knowledge* about plants and animals lifestyle were transmitted orally from parents to children and enriched by means of experience and observation. Step by step, people began to accumulate knowledge about the optimal sowing time and season of harvest, soil and fertilizer characteristics, how plants exert an influence to each other, and what are nutritional needs of animals, etc. When in the early 20th century Ecology asserted itself as a science, its role from a practical point of view has increased considerably. It enabled to predict environmental effects and develop recommendations for developing the following sectors: agriculture and industry, hunting, fishing and oil-gas play, etc. avoiding depletion of natural resources and violation of natural communities. Natural resources utilization by people who have no idea of the nature law often leads to severe, irreversible implications. The *Aral Sea crisis* is a *vivid example* of what may happen. States have boundaries while nature possesses no one. Air masses and water freely travel over long distances.

Due to ecological illiteracy and in pursuit of here-and-now benefit, many people do not muse on the future. However, our unreasonable interference with the natural processes may result in ecological backlash, and sooner or later the human itself may smart for this.

Theory and practice have shown that the environmental component is an integral part of human development. From the viewpoint of ecology, sustainable development should ensure the integrity of both natural systems: biological and physical. ***Sustainable development*** means the kind of social development, which focuses on improving the people living condition and restrains of the environmental behavior within the economic capacity of the biosphere, so as to prevent the destruction of the natural basis of human activity. "*Sustainable development* is development that meets the *needs* of the present *without compromising* the ability of *future generations* to meet their own *needs*" (as it is said in the Millennium Development Goals (MDGs).

Of particular importance is the vital capacity of ecosystems on which the global stability of the entire biosphere depends. Moreover, the terms of "natural" systems and habitats can be broadly interpreted, including environmental structures created by a human, like cities.

Much attention is given to maintaining the self-restoring capacity of nature and dynamic adaptation of these systems to change, rather than conserving them in some "ideal" static condition. Natural resource

degradation, environmental mess and loss of biological diversity reduce the ability of ecosystems to regenerate.

Self Assessment Questions:

1. What does Ecology as a science study?
2. Please indicate the key objectives of Ecology.
3. Please indicate the key sections of Ecology.
4. How Ecology is related to other sciences?
5. What does "Sustainable development" mean?
6. What is the role/part of Ecology in the sustainable development of society?

1.2 Autecology (idioecology) or Individual Ecology.

Autecology focuses on establishing the limits for individual (organism) existence as well as on the physical and chemical limits chosen by the organism from the entire range of their values. Investigation of the organisms' response to the impact of environmental factors makes it possible to reveal not only these limits, but also physiological and morphological changes typical for these species.

1.2.1 Organism and Environment

Habitat is a part of the nature that surrounds a living organism and directly interacts with it. The components and properties of the environment are diverse and variable. Any living being inhabits in a complex and changing environment, continuously accommodating to it and adjusting its vital functions in accordance with changes to it.

On our planet, living organisms have domesticated four basic habitats being far different in their special conditions. The aquatic habitat was the first where life began and developed. Subsequently, living organisms took possession of the terrestrial and air environment; they created and populated the planting media. The living organisms themselves have become the fourth specific habitat, each representing the whole world for parasites or symbions inhabiting it.

Adaptation of organisms to the environment. *The ability to adapt* - one of the primary properties of life in general, because it provides the very possibility of its existence, the ability of organisms to survive and reproduce oneself. Adaptation is seen at various levels: from biochemistry of cells and behavior of some organisms to structure and functioning of communities and ecological systems.

1.2.2 Environmental Factors and Its classification

Some environmental properties or elements impacting the organisms are called *environmental factors.* Environmental factors are diversified. They may be needed to or, on the contrary, harmful to living things, promote or hinder the survival and reproduction. The environmental factors have different nature and principle. The environmental factors are divided into abiotic and biotic.

Biotic factors are the form of impact of living beings to each other. Any organism constantly experiences direct or indirect influence of other beings, comes into contact with representatives of their own species or other species: plants, animals, microorganisms, and depends upon them or makes an impact on them. Organic environment is a constituent part of any living creature environment.

Interdependence of organisms is the foundation for existing biocoenosis (ecological communities) and populations; it belongs to synecology.

Abiotic factors covers all the properties of inanimate nature, which directly or indirectly impact the living organisms: they include both physical and chemical factors.

Physical factors of inanimate nature are as follows: space, climate, terricolous, orographic and geological.

Climatic factors are the following: radiant solar energy, arrival and redistribution, absorption and reflection (albedo) of solar energy at various regions of the world, transparency of the atmosphere, lighting the earth's surface, length of daylight, humidity, precipitation, ventilation (wind).

Anthropogenic factors are forms of human society activities, which lead to a change in nature as a habitat of other species or have a direct impact on their lives. in the course of human history: first - hunting, later on agriculture, industry, transport have changed considerably our planet. Anthropogenic effects or human impacts on the whole living world of Earth continues to grow rapidly.

Although humans have impact on the wildlife through changes in abiotic and biotic relationships, activities of people on the planet should be allocated in a special power, which cannot be classified. Currently, the fate of the living cover of the Earth and of all species are being in charge of human society and depend on human impact on environment.

Environmental factors make various impacts on living organisms, i. e. they can act as excitators causing adaptive changes in physiological and biochemical functions; as constraints that may make impossible their existence in these conditions; as modifiers that may cause the anatomical and morphological changes in organisms; as signals being indicative of change in other environmental factors.

In spite of great variety of environmental factors, a *number of general laws* can be revealed in nature of their impacts on organisms and in the living beings response.

1.2.3 Law of Optimum

Each factor possesses only defined limits of positive effects on organisms. The result of the variable factor effect depends primarily on the extent of its manifestation. Both insufficient and excessive effects of the factor take toll on the species life-sustaining activity.

Favorable effect is called an area of optimum environmental factor or simply an optimum for the given species organisms. The greater the deviation from the optimum, the more this factor's suppressive effect on the organisms (pessimum area) (Figure 1.). Maximum and minimum tolerable values of the factor are critical points, beyond which the existence is no longer possible, death occurs. Tolerance limit between critical points are called ecological valence of living beings with regard to a particular environmental factor.

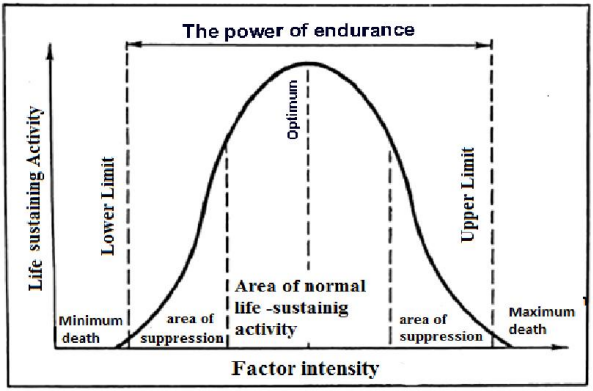

Figure 1. Effect of the factor intensity on the organisms' life-sustaining activity

1.2.4 Law of the Minimum and Shelford's Law of Tolerance

Patterns of the environmental factors impact on the organism are determined by ***Liebig's Law of the Minimum*** *and* **Shelford's *Law of* Tolerance.**

Law of the Minimum was formulated in 1940 by J.Liebig, the *German agricultural chemist*. According to this law, endurance of the organism is determined by the weakest link in a chain of its environmental requirements. The growth of organisms may be limited or restricted not only by lack but also by excess of one or another factor. Thus, demands placed by organism to environment can be characterized by two values in each factor: ecological minimum and ecological maximum (Chart 1). ***Limiting effect of maximum was set by V. Shelford*** in 1913 and is called Shelford's law of Tolerance. The range between the two values is called the range of tolerance (RT).

By virtue of the "ecology of tolerance" experiments limits of existence for many plants and animals became known. Theoretical justification of maximum permissible concentration (MPC) is based on the law of limiting factor. MPC means the accepted threshold values of a given factor, under which no irreversible pathological alterations can occur in the organism so far. These values are set experimentally.

Self Assessment Questions:

1. *What does Autecology study?*
2. *Please give definition of environmental factor*
3. *What is the habitat and which environments are inhabited by organisms ?*
4. *How is complex of inorganic environment factors called? Please describe these factors.*
5. *How is complex of effects of one organisms life-sustaining activity to other organisms life-sustaining activity called?*
6. *What are Liebig's Law of the Minimum and Shelford's* Law of *Tolerance?*
7. *What is meant under an organism range of tolerance?*

1.3 Population Ecology or Demecology

1.3.1 Concept of the Population

In order to gain an insight into the relation between the organisms and environment, their evolution and place in the biosphere and also to address some practical issues in connection with development of wildlife by human being, the concept of population is overwhelmingly important.

Population means the members of a species living together in a particular locality for a long time (a large number of generations) and able to interbreed freely (panmixia). Any population possesses the following features: 1) it exists over the time of many generations; 2) it possesses a certain degree of panmixia: species interbreed freely; 3) it is isolated to some extent.

Populations have certain environmental characteristics, which are not seen in some of its members, namely: 1) a distinct *niche occupied by the population; 2) abundance and biomass of the population; 3) dynamic characteristics of the population - fertility, growth rate, mortality, and survival*. ***Ecological niche is*** a set of all the requirements of populations to environmental conditions (structure and modes of environmental factors) and locations where these requirements are fulfilled. In other words, the ecological niche reflects the population functional role in the living organisms community.

1.3.2 Static Characteristics of the Populations

The population size can vary considerably in different organisms. Typically, population of large animals is relatively small and may consist of several hundred members; population of small organisms (invertebrates, unicellular organisms) can reach millions of species. Given the problem of *conservation* of some of our planet's most *rare* and *endangered species, one* needs to know that populations with small number of species are non-sustainable and can disappear if their living environment will change in a certain manner.

In general, the population size is subject to large fluctuations in time and impacted by both animate and inanimate natures. These fluctuations complicate the planning of exploitation of a given population, because annual exemption (shooting, fishing) of the same number of species may indicate that in one year 5% of species will be removed and in another year, when the population size will decrease, for example by 10 times - as much as 50% of the existing population. The population size is intimately associated with the ***population biomass***, which is its major characteristic. In particular, biomass of plants and animals is used by human being, that is why *the rate of biomass*

growth is critical for both organism and practical need. In agriculture and forestry the damage caused depends on phytivorous species numbers. Being unaware about actual number and condition of the rare and endangered species populations, it is impossible to take measures on their protection and reproduction. To compare the number of some populations or to register changes in the same population numbers at various periods of time (for example, at various years) one may use such indicator as density. ***Density - is*** the population size, per unit of space it occupies. For example, density of the moose and other large animal populations is determined by the number of individuals per 10 thou.ha, soil invertebrates population is calculated per 1 m2. Being aware of the density changes in time or space, one can reveal whether there is increase or decrease in the number of individuals or whether or not this population brings the threat to economic interests. The above listed ***characteristics are static***.

13.3 The Dynamics of the Population

It is a rare occasion when the population size remains constant in the nature.

Even if no changes occurs, the population remains in a steady state - natural loss of individuals is equal to their reproduction. *The dynamics of the population size* is seen at interaction of *four major population-dynamic processes*: *1) fertility ; 2) mortality; 3) immigration of new individuals from other populations; 4) emigration of some individuals outside of this population area.*

Fertility means *ability to increase the population or the number of offspring* produced by one female per 1 year. In human society fertility (birthrate) is expressed in number of births per 1,000/ year. Maximum birthrate is a theoretically maximum number of species produced under ideal conditions in the absence of limiting factors, and reproduction is limited to physiological factors. Ecological, or realized birthrate is birth of new species under actual environmental conditions. Anthropogenic impacts on the population can change the birthrate. ***Mortality means*** the death of individuals per time unit in the absence of limiting factors. Ecological, or realized mortality means the death of individuals per time unit under actual environmental conditions. The difference between fertility and mortality is a certain resulting parameter that determines the actual dynamics of a given population size. As the population grows, reduction of environmental resources available to each individual populations is seen. If resources peter out the population growth slows down and finally, ends up. Often, human being or anthropogenic factor (reduction in food supply, reducing the oxygen in the water in case of eutrophication, etc.) cause exhaustion of needed populations. Both mortality and fertility vary greatly with age. For this

purpose, the ecological mortality is determined for various environmental groups and survival curves, which are divided into 3 main types (Figure 2.) are drawn. The first type is characteristic to many mammals and humans and reflects a lower mortality rate in all age groups. The second type reflects high mortality in the early stages of development (*ontogeny*) (molluscs, butterflies, etc.). The third type characterizes a relatively constant mortality in all age groups (birds, mice, rabbits, etc.). The survival curve depends on the parental care level.

There are two types of growth of the population: exponential *(logarithmic) and logistics. Exponential growth* is represented by the J-shaped curve, and logistics by an S-shaped curve. Each population possesses reproductive potential typical for it, which is characterized by its population growth rate if unlimited space, abundance of food and other resources are available and if there is no limiting factors at all. In such ideal conditions, the number of individuals will increase exponentially, that is geometrically. However, neither of populations in nature is able to grow exponentially for a long time, because food or any other vital resource will appear used and the number of dying species should exceed those being-born. Sometimes the population size varies over time very sharply, however, from year to year the average value for majority of large populations varies slightly.

Survival curve

1. Highly convex

2. higly concave

3. intermediate

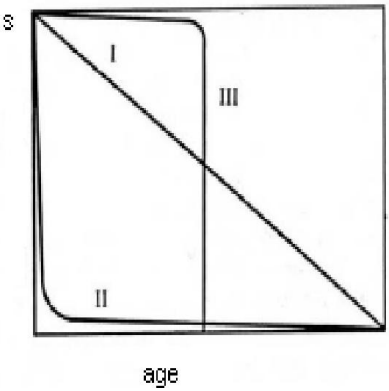

Figure 2. Survival curve

Changes in the population size are a sequence to changes in birthrate (fertility) and mortality. However, in most cases a key factor regulating the population size is a factor impacting the mortality. Factors impacting the population fertility and mortality act more effectively if there is increased population density. Such factors are called dependent on population density. They include, for example, lack of food, increase in the number of enemies,

and morbidity. If the population density is high, its members are physically weaker and smaller. This fact may lower their resistance to diseases and make more accessible to carnivores. In addition, often, when density is high the animals birthrate reduces, even if there is no food-deficiency. Various hormonal changes impacting sexual behavior of animals and increased aggressiveness may be seen. *Parental care* becomes weaker, pups leave the nest early, thus probability of their survival reduces. In plants, the number of seeds produced by each species, may also decrease if density increases. ***Migration*** (or expansion) is another factor depending upon density and which may impact the population density value. For example, aphids under high population density not only slows down reproduction, but many species develop wings allowing them to leave the plants which fed them. There are factors that are independent of the population density. The impact of *unfavorable weather* conditions (severe winters, droughts) and ***natural disasters*** (fire, earthquake, flood, hurricane, etc.) may serve an example. However, many factors, both dependent and independent of density, often enter into complex interactions.

In general, the population size and its growth rate (rate of its change, population dynamics) are instable parameters, which are highly sensitive to the effects of abiotic, biotic and anthropogenic factors. For this reason people should realize all the features of the population, which is somehow maintain, to ensure its sustainable long-term existence. The complexity of this problem increases in view of multiple links between populations of various species that inhabit one and the same territory.

Self Assessment Questions

1. Please list the main population criteria.
2. What are types of populations?
3. Static characteristics of the population.
4. Dynamic characteristics of the population.
5. Types of survival curves.
6. How the population size is regulated?

1.4 Synecology - Community Ecology

1.4.1 Biocenosis, Biogeocoenosis and Consept of Ecosystem

Biocenosis (biotic community, biocoenosis (in Greek: Bio means life and coenosis means community) is the *community* of *populations of different species* living and interacting in a given habitat (K. Mobius, 1877). ***Biogeocoenosis*** is a set of homogeneous natural phenomena (atmosphere, intrusive rocks, vegetation, wildlife and microworld, soil and water conditions) on the earth's surface which has its own specific interactions of

its constituent components, and a certain type of substance and energy exchange between themselves and other natural phenomena and represents the internal contradictory unity that is in constant movement and development (Sukachev, 1940). ***Ecosystem*** (ecological system) is the community of all populations of different species living on the common territory and interacting with their environment (A. Tensli, 1935).

1.4.2 The State of the Species (population) Under Various Forms of Relationship

The state of the species (population) under various forms of relationship is indicated by conventional signs " – "an adverse effect, the body suffers harm, "+" - positive effect, "0" - no effect. All biotic links can be divided into six groups: 1) "++"- mutually beneficial*, symbiotic* relationships. In this group the following is isolated: a*) protocooperation* when cooperation is beneficial, but not necessarily (pollination of various meadow plants by bees); b) symbiosis or inseparable links (lichens - fungi + algae, termites, and flagellate intestinal, which produce an saccharolytic enzyme); c) *mutualism* when a partnership is mandatory (cembretum, feeding by cedar seeds and spreading them). 2)"+0"- useful and neutral, or commensalism (shark and sucker fish).The followings should be distinguished in his group: a) sponger when the host food remnants are used (lion and hyena), b*) commensal*, c) *tenant* (orchids, lichens, mosses live in trees).3) "0" - negative-neutral, or amensalizm (grass under the trees are suffering from severe shading). 4) "00 - neutral, or neutrality. 5) "+-"- useful and harmful; in this group the following may be distingushed: a*) carnivorism*, and b) *parasitism*. 6)"--"- mutually harmful, when species that have identical ecological requirements enter into *competition*. This type of interaction should be referred to the *Gause principle*. The principle asserts that if two competing species coexist in a stable environment, this occurs due to the differentiation of niches, that is, by dividing the realized niches of these species, however, if such differentiation does not occur, or if it hampered the environmental conditions, then one competing species will be eliminated or replaced by another".

1.4.3 Trophic Structure of Biocenosis

*T*wo major components: *autotrophic* and *heterotrophic* may be identified In biocoenosis or ecosystem. ***The autotrophic*** component ("self feeding") consists of green plants, which, by using solar energy synthesize organic matter of their cells (biomass) from the mineral components of environmental and is a major supplier of organic matter and related to its energy in biocenoses and ecosystems. In ecology, these organisms are ***called producers,*** while organic material they created is called primary production. ***Heterotrophic*** component ("eating others") consists of organisms that derive

their energy from food resulted from destructed organic matter, originally created by producers. *Heterotrophic organisms are divided into two major groups*: *consumers and decomposers.* ***Consumers*** are organisms that consume the finished organic matter (all animals, parasitic and insectivorous plants). ***Decomposers*** are heterotrophic organisms (fungi and bacteria) that subsist on dead organic matter and during their vital activities decompose it to inorganic. Thanks to them, the most important nutrients contained in dead organisms go back into the biological cycle and are repeatedly used in the metabolism of living organisms. Joint effect of these three groups of organisms maintains a relatively endless circle of matter in ecosystems and biogeocenoses. In the "Man and Biosphere" context, functional classification of all living organisms stresses the fact that in nature, absolutely all organisms can be considered as continuous links of biogeochemical or ecological belt conveying to each other atoms of elements forming organisms, thus, indicating that there is no "extra" or "useless" species and organisms.

Food chains and trophic levels (trophic status, feeding level). Matter and energy have been transferring through a series of organisms, and each previous organism supplies the subsequent one with raw material and energy in the form of food. Such chain of organisms is called a food chain, and each of its link - a trophic level (*Greek word "*trofos" means "food"). *Producers, or autotrophs rank first at the trophic level. First order consuments, second order consuments, etc. rank second, third, etc. levels.*

Food chains are divided into two main types: pasture chain and detrital *chain*:

1. Pasture chain starting with green plants transfer to organisms feeding plants, and then to the predators, feeding herbivores, or to parasites;
2. Detrital chain starting from dead organic matter of dead organisms or their parts, then transfer to organisms feeding these dead organic matter (detritus), or their consumers (predators - hyena, condors, etc.).

Trophic chain in its totality, can be united to form food (trophic) networks

Ecological pyramids. Efficiency of ecological systems and the ratio of producers, consumers, decomposers are typically expressed graphically in the form of pyramid, first proposed by Charles Elton and it is called a pyramid of Elton. Ecological pyramids exist in several types: *pyramid* of *biomass* characterizes the total weight, *pyramid of numbers* of *organisms* represents the number of distinct populations of organisms or groups of diverse populations of the same trophic level, the pyramid of energy flow

(productivity) shows the magnitude of energy flow or the amount of productivity in successive trophic levels.

Productivity of biocenoses. There are primary and secondary productivity of biocenoses. ***Primary productivity*** is called the rate at which solar energy is absorbed by the body-producers (green plants) in the process of photosynthesis through accumulation in the form of organic substances of synthesized biomass. *There are two types of primary production: gross and net*. One ought to bear in mind that consumers constantly eat away part of the produced biomass. Consequently, productivity is usually higher than the observed biomass growth rate.

Gross primary productivity is the overall rate of photosynthesis, including the rate of formation of the organic matter, which is spent by plants to breath in the course of measurement. Net primary productivity is the rate of substance accumulation by environment minus substance spent to breath. Productivity (or product) of consumers is called secondary productivity.

1.4.4 Energy flow and Circulation of Chemical Elements in the Ecosystem

Any ecosystem consists of biotic and abiotic components, which closely interact with each other, exchanging matter and energy: living organisms consume matter and energy from the environment and give them back into the environment during the life-sustaining activity. All living organisms appear to be consumers of food, that is of matter and energy. In the process of respiration of energy from its rich substances obtained from food releases. In process of breathing energy appears to release from energy-rich matter received from food. The first law of thermodynamics says: "Energy can be neither created nor disappeared". It exists in various forms: light, chemical, mechanical, acoustic, thermal, electrical, etc. And all of these forms can be transformed into one another. Energy can be defined as an ability to do work. All living organisms can be considered as working "machines" that require a constant flow of energy from outside.

Living organisms can only use two forms of energy*: photoenergy and chemical energy*. All organisms are divided *into phototrophic and chemotrophic* depending on the energy source. Organisms synthesizing all necessary organic matter by means of light energy (photosynthesis) belong to ***a phototrophic group,*** it includes all plants and cyanobacteria. ***Chemotrophic organisms*** synthesize organic matter through the energy of chemical bonds of various substances. This includes all animals and bacteria. As a result of photosynthesis, all green plants capture 1% of entire solar energy registered on he Earth's surface and this energy supplies life-sustaining activity of all living organisms on the planet (the 1% energy law). When energy flows

from the one to another trophic level, 90% of energy is spent to life-sustaining activity and entropy. Consequently, when flowing from one to another trophic level of the ecological pyramid on the average 10% of biomass energy or matter in the energy terms (the Lindemann law) is consumed. Hence, the energy pyramid objectively reflects the energy flow in ecosystems, and always is of a regular shape. Dynamic processes in the ecosystem. The primary property of ecosystems is stability and balance of processes of matter and energy exchange between all the components. It is typical of the ecosystem to be in the state of dynamic balance or homeostasis (Greek homeo - like, stasis - state). Homeostasis is provided by the feedback mechanisms. The feedback approach means that a certain controlling component of a certain system receives information from the controlled components using this information to make allowances to a further control process. All the time, balance is maintained in ecosystems, which exclude irreversible destruction of any given links in trophic chains (food chains). All the time any ecosystem is balanced or stable (it means that homeostasis maintains). Population of predators maintains a certain prey population level (a *positive* feed*back*). Under certain circumstances a negative feedback, that is transfer of information can be violated for some reason. Violation of a balanced system can be reversible or irreversible. Human activities may cause such violation. Violation of stability or disintegration of the entire ecosystem depends upon the extent and time of impact of the anthropogenous factor. A large body of research with the application of the mathematical analysis approach showed that the more complex ecological systems the more stable they are in time and space. Stability of the community should be determined by the number of links between species in the food chain (trophic chain).

1.4.5 Succession of Geobiocoenosis

Homeostasis, or balance of the mobile ecosystems is not something fixed. Any ecosystem undergoes changes both in time and space, in addition, changes are seen in the biocenosis structure, ecosystem structure and its productivity. Continuity of biocenoses occurring on the same territory as a result of impact of natural factors or human activities, is called succession (Latin word: successio means succeed). Changes of biocenoses occur by virtue of the ecological law on successional substitution: "Natural biotic communities successively form a logical series of ecosystems, leading to climax which is the most stable state under such conditions (“climax” in Greek means stairs)". Climax means the final, relatively stable state of alternated ecosystems (biocenoses) arising as a result of succession and being in compliance with environmental conditions of the given area.

Agriculture represents a special case of anthropogenic succession. Any farm after plowing a virgin land and seeding it, gathers the harvest, which is represented by plants with assimilated soil nutrients, atmosphere oxygen and carbon received from the ecosystem.

Ecological pyramid (by Willie K. and B. Dete, 1986). Figures on the right show the ratio of biomass at different levels of the food chain.

An example of the food chain in an oak forest, represented as Eltonian pyramid (or a pyramid of numbers).

Self Assessment Questions

1. What are the ecosystem and biogeocoenosis.What is the difference?
2. Please give examples of specific and space structure of biocenosis?
3. What types of relationships exist between organisms in the community?
4. How does energy flow in the ecosystem?
5. What is the trophic structure of biocenosis?
6. What types of food chains exist? Please give examples?
7. What does the ecological pyramid reflect?
8. What determines the productivity of ecosystems?
9. What determines the stability of ecosystems?
10. What is homeostasis of ecosystems and ecological succession?
11. Please give examples of natural and anthropogenic successions?

1.5. Biosphere and Its Stability

1.5.1 Doctrine of Biosphere

The start of the doctrine of biosphere is related to a famous French natural scientist Jean-Baptiste Lamarck (1744-1829). However, the term biosphere was introduced by Eduard Suess, the Austrian geologist in 1875 in his work on geology of the Alps. However, he did not disclose the content of the concept of biosphere. Only V.I. Vernadsky created an orderly doctrine of biosphere. V.I. Vernadsky understood a thin mantle of the Earth at the interface of three geological spheres – the lithosphere, the atmosphere and the hydrosphere, where all process take place under direct impact of living organisms, to mean the biosphere. In the atmosphere, higher layers of life are determined by an ozone screen (the largest concentration of ozone is O_3) located at the height of 16-20 km. The hydrosphere is transfused by life up to the deepest oceanic trenches (in the Pacific Ocean the Mariana Trench is about 11 km deep). The life penetrates up to 3 km in a hard part of the Earth

(bacteria in oil deposits). The lower border of life is related to the increase of temperature in the earth interior, the temperature reaches 100 ^{o} C at the depth of 3 km.

1.5.2The living Matter of the Biosphere and Its Functions

A major peculiarity of the biosphere is an available living matter, the aggregate of all living organisms being a powerful geological force. The appearance of the Earth transforms under their influence. They participate in forming various mineral rocks, fresh water, and the atmosphere. All living organisms are solar energy converters, and they have an influence on geological processes. There is a continuous circulation of various matters taking place in the biosphere due to the activity of living organisms. However, as far as the biosphere receives energy from outside, then it is an open system. A dead component of the biosphere is represented by these parts of the three geological earth mantles that are connected with a living matter of the biosphere by complex migration processes of matter and energy. The borders of the biosphere are borders of life.

The living matter of the biosphere fulfills the following functions: *energy, destructive, concentration, and environment-forming.*

The energy function is fulfilled by green plants, which in the process of photosynthesis accumulate solar energy in the form of various chemical compounds. This energy is distributed within the ecosystem as food amongst animals. Finally, this energy dissipates in the environment. However, its part may be accumulated in an extinct organic substance and transform into a fossil forming deposits of the following fossil fuels: peat, mineral coal and oil being the energy base for human society.

The destructive function lies in degradation and mineralization of a dead organic matter, chemical decomposition of rocks and involving formed minerals in a biological cycle. The dead organic matter decomposes into simple inorganic compounds: carbon dioxide, water, hydrogen sulfide, methane, ammonia and others which are used again in the initial chain of the cycle. Special organisms – decomposers or destructors are engaged in this process.

The concentration function implies that within their life activities, organisms accumulate selectively atoms of matters dissipated in the nature. One of a characteristic feature of a living matter is the ability to concentrate chemical elements from diluted solutions. The most active concentrate is microorganisms. Fulfilling this function induced formation of deposits of natural minerals (chalkstone, limestone etc).

The environment-forming function lies is transformation of physical and chemical parameters of the environment (the atmosphere, the lithosphere and the hydrosphere) in conditions favourable for life of organisms. This

function is a joint result of all three functions reviewed above of the living matter of the biosphere. Due to this function the living matter has established and maintains the balance of the matter and energy in the biosphere, maintains the stability of organisms' life. The living matter is able to restore conditions and habitats destroyed as a result of natural disasters or business activities of people. This ability of the living matter to regenerate natural environmental conditions is manifested by the Le Chatelier principle taken from the field of thermodynamic equilibrium, the essence of which is as follows: the change of any variables in the system as a response to external disturbance proceeds as compensation of fulfilled disturbance. An analogous phenomenon is called negative feedbacks in the theory of management. Due to these relations the system maintains its stability and returns to its initial state if the generated disturbances do not exceed the threshold values. As a result of the environment-forming function, in the geographical envelope of the Earth, the following important events: transformation of gas composition of the primitive atmosphere, the change in the chemical composition of water in the primary ocean, formation of the sedimentary rock mass in the lithosphere, formation of a topsoil (fertile soil layer) on the surface of the earth took place. The basis of the living matter functioning in the biosphere is a biological cycle of matters which is provided by interrelations of three functional groups. The driving force of this cycle is solar energy.

Evolution of the biosphere led to the advent of ***noosphere (***from a Greek word noos meaning mind), the sphere of mind, "an intellectual envelope". The founder of the doctrine is V.I. Vernadskiy. Key provisions of Vernadskiy's concept of the noosphere are as follows: *the Mankind is a great geological force; this force is the mind and will of a human being as a creature socially organized; the appearance of the planet has been changed to a greater extent that its biogeochemical metabolism is affected; the mankind evolves towards isolation from other biosphere.* V.I. Vernadskiy thought that the biosphere must turn to the noosphere as a natural result, and cognizing laws of nature and developing engineering a human being must add new features thereto being the features of a higher organization.

The current period of the biosphere's development is characterized by a global contamination of the environment that leads to changes of its physical and chemical parameters and, as a result to reduction of a biological diversity and worsening the health of a man.

Self Assessment Questions

1. Who is the author of the Doctrine of biosphere?
2. What did V.I. Vernadskiy mean as biosphere?
3. What are distinctive features of geological spheres of the Earth?

4. What is the power of the biosphere and by what are its borders conditioned?
5. What is a living matter of the biosphere and what are its functions?
6. What is the planetary (geological) role of the living matter in the biosphere?
7. What is the driving force of global biogeochemical cycles?
8. What is the noosphere?

1.6 The Concept of Sustainable Development

1.6.1 History of the Establishment of the Concept of Sustainable Development

Sustainable development (sustainable development is a sustained development) is such development of society in which living standards of people are improved, and the impact on the environment remains within the limits of the biosphere's assimilating capacity, thus the natural basis of the mankind functioning is not destroyed. At sustainable development the needs and requirement are satisfied without damage for future generation.

The concept of a sustainable development is a logical transfer from ecologization of scientific knowledge and social and economic development that rapidly started in seventies of the 20 century, when the mankind came across global ecological problems. The response to the concerns was establishing international nongovernmental scientific organizations to study global processes on the Earth. The following organizations were established: the International Federation of Institutes for Advanced Study (IFIAS), The Club of Rome (with its famous report *Limits to Growth*), International Institute for Systems Analysis and others.

In 1972, in Stockholm (Sweden), the UN conference on the environment was conducted, at which the United Nations Environment Programme (UNEP) were developed that marked the involvement of the world community in solving environment issues on governmental level, which began to hamper and constrain social and economic development. Environment policy and diplomacy were devised and they started to develop, the environmental law was introduced, a new institutional component as ministries and departments of environment protection appeared.

In eighties of the 20^{th} century, such issues as environment development, development without destruction, the necessity of sustainable development of ecological systems were placed on the agenda of the World Community. The World Strategy of Nature Defense (WSND) was accepted in 1980, for the first time the international document stated sustainable development. The second edition of the WSND was called *Caring for the*

Earth: A Strategy for Sustainable Living, it was published in October 1991. It emphasized that development must be based on preservation of wildlife, protection of the structure, functions and diversity of natural systems of the Earth, on which biological species depend. For this purpose it is necessary to carry out the following activities: to preserve systems of life support (livelihood), preserve biological diversity and provide sustainable use of resources. Researches of ecological safety as a part of national and global safety have appeared.

In eighties of the 20th century, the United Nations Environment Programme (UNEP) called for the necessity to transit to *development without destruction*. In 1980, for the first time the concept of sustainable development received wide publicity in the World Strategy of Nature Defense (WSND) developed at the initiative of the UNEP, International Union for Conservation of Nature and Natural Resources (IUCN) and the World Wildlife Fund (WWF). In 1987, in the report *Our Common Future* the World Commission on Environment and Development (WCED) gave special consideration to the necessity of sustainable development, at which meeting the needs and requirements of the current times does not destruct the ability of future generations to satisfy their own needs. The wording of the concept of sustainable development is widely used as basic in many countries of the world at present. At the conference of the UN on the environment and development in Rio de Janeiro (1992) a detailed analysis of the environment situation in the world was presented. Heads of states and governments took part in the conference, who were forced for the first time to make a difficult decision on the change of the mankind's world outlook. It was recognized that the increasing well-being level of economically developed countries is unachievable for developing countries of Asia, Africa and Latin America. It was recognized that development of developing countries as per the way, which was followed by the developed countries to their well-being, is impossible as the nature will not stand such growth of consumption. As a result of discussions it was declared that the world community had to set out on a path of sustainable development. The basis of decisions was the work of the Brundtland Commission (1987) setting forth the idea of sustainable development (in English to sustain means to maintain). The aim set in the Commission's report was to establish the world order satisfying the needs of present times not damaging the ability of future generations to satisfy their needs. However, the results of the decade passed after the UN Conference in Rio de Janeiro certified that the problem of implementing the model of sustainable development was much more complicated that it had been supposed in the past.

The theory and practice have shown that an ecological component is an integral part of human development. A new triune concept of sustainable (ecological and social and economic) development (Diagram 11) was taken as a basis of the activities of the International Commission on Environment and Development and its final report. In 2002, the World Summit of the UN on sustainable development (intergovernmental, nongovernmental and scientific forum) confirmed the devotion of the world community to the ideas of sustainable development (livelihood) for long-term satisfaction of main human needs while preserving the systems of life support of the plant Earth. The concept of sustainable development coincides to a large extent with the concept of noosphere suggested by the academician V.I. Vernadskiy in the middle of the 20th century.

1.6.2 Main Factors of Sustainable Development

Main factors of sustainable development are economic, social and ecological factors being the basis of the triune concept of sustainability. ***An economic component*** implies optimal use of natural resources and environmentally friendly technologies, including production and processing raw materials, manufacturing environmentally acceptable products, minimization, processing, waste management and waste destruction. ***A social component*** of sustainable development is directed to a human being and aimed at maintaining stability of social and cultural systems, including reduction and mitigation of the number of destructive conflicts amongst people. An important aspect of this approach is a fair distribution of benefits. It is desirable to preserve cultural capital and diversity on a global scale, and also wider use of the practice of sustainable development available in non-dominant cultures. In order to achieve sustsinability a modern society must develope a more effective system of making decisions with due account for historical experience and promoting pluralism. It is important to achive justice not only within generations but it is important to achieve justice amongst generations. Within the bounds of the concept of human development a human being is not an object but is a subject of development. Relying on selecting a human being as a main value, the concept of sustainable development implies that a man must participate in processes forming his livelihood, promote making decisions and implementing them, exercise control over their execution. ***An ecological component*** must provide the integrity of biological and physical nature system. The vital capacity of ecological systems is of special significance, on which global stability of the whole biosphere depends. Moreover the notion “nature” systems and habitats may be understood widely, including the environment created by a human being, such as, for example, cities. Main focus is paid to preserving the capacities to self-restoring and dynamic adaptation of such systems to

changes, and not to conserving them in some "ideal" statistic condition. Degradation of natural resources, pollution of the environment and loss of biological diversity reduces the capacity of ecological systems to self-restoring.

Coordination of these factors of sustainable development and translating them into specific measures which are the means of achieving sustainable development is a very complicated task, because all three elements of sustainable development must be viewed in a balanced way. The mechanisms of these three concepts' interrelation are also of significance. Economic and social elements interacting with each other generate such new tasks as achieving justice within one generation (for instance, in relation to distribution of income) and providing poor layers of the population with earmarked aid. The mechanism of interrelation of economic and ecological elements generated new ideas regarding the cost estimate and internalization (accounting in financial reporting of enterprises) of external impacts on the environment. Finally, the relation of social and ecological elements arouses interest in such issues as intra-generation equality and equality among generations, including observing rights of future generations and participation of population in the decision-making process.

Self Assessment Questions

1. Defining the concept of "Sustainable Development".
2. Preconditions of emerging of the concept of sustainable development.
3. What international documents were taken as the basis of the concept of sustainable development?
4. State main international organizations engaged in nature preservation activities.
5. The role of the international research center the *Club of Rome* in developing the concept of sustainable development.
6. Factors of sustainable development.
7. The triune concept of sustainable development.

1.7 Natural Resources and their Rational Use as One of Aspects of Sustainable Development

1.7.1 Classification of Natural Resources

Natural resources are the basis of life for any human society. Means of people living that are not the result of their labour are qualified as natural resources. They are water, soil, plants, animals, microorganisms, mineral products, cosmic resources (solar energy). We may distinguish energy

products (mineral coal, oil, gas, oil shales) and mineral resources used directly or processed resources (dressing various ores) among mineral products. There are various classifications of natural resources. For example, with regard to the use the natural resources are divided into industrial, public health, aesthetic, scientific etc.); and in terms of their belonging to any components of nature, they are divided into land, water, forest, mineral, energy etc.

The most general classification of natural resources is by their exhaustibility. According to this classification, all natural resources are divided into exhaustible and inexhaustible. The exhaustible resources, in their turn, are divided into renewable and nonrenewable resources. A living component of the biosphere falls under the category of renewable (for example, salts precipitating in lakes and sea lagoons), and also soil, fertility of which is formed within a lengthy period and is the most deficit resource. However, the rates of using the renewable resources must be conformance with the rates of their restoration; otherwise the renewable resources may become nonrenewable. Subsoil of the Earth is qualified as the nonrenewable resources, which are not renewed or renewed much more slowly compared to their consumption. The nonrenewable resources are mining resources having been formed in specific physical and geographical conditions, and such mineral products as mineral coal, oil, natural gas which are dead organic matters and having been formed within million years. Cosmic, climatic and water resources fall under the category of the renewable resources. The cosmic resources are solar radiation and energy of access and recess of the sea caused by the impact of the Moon on our planet. The quantity of solar radiation received on the surface of the Earth depends on the state of the atmosphere and the extent of its contamination. Climatic resources are the atmospheric air, atmospheric precipitation, wind. Water resources are water reserves of the Earth. This resource is inexhaustible on a global scale, but on a local scale it may be exhausted (for example, the Aral Sea).

From the very first days of his existence the human being began to exploit the nature. However, in a modern world the consumer's attitude went beyond all reasonable limits. Starting from the Bronze Age the man began to extract mineral products on a systematic basis. Up to the 18^{th} century the mankind used about 30 chemical elements; in the beginning of the 20^{th} century over 50 elements were processed in industrial way, and at present over 100 elements of Mendeleev's table are used by the mankind. The needs for mineral products are increasing steadily, and the demand for them is caused, first of all, by a demographic increase. Starting approximately since fifties of the 20^{th} century the developed countries consume mineral raw materials more than the whole world within the pre-war time. For the last

thirty years there were explored and extracted more mineral products than for the whole history of the mankind.

Kazakhstan ranks first in the world in terms of the reserves of the mineral products. In relation to the reserves of lead, zinc, chromites, silver, tungsten, bismuth, vanadium and other non-ferrous metals our country ranks first amongst the ex Soviet republics, and with respect to copper, asbestos, iron, baking coal, oil our country ranks first in the world. Wide-scale rates of production and use of mineral resources contribute to contamination of the environment by such elements as zinc, copper, lead, nickel, arsenic, molybdenum, selenium, antimony, cadmium, mercury, and tungsten. According to many experts, the total toxicity of these elements exceeds the summary toxicity of radioactive and organic contaminants. Accumulating in the environment and coming by a food chain in human organism these elements create a serious threat to the health causing not only physiological changes but damaging a genetic material (mutagenic effect).

As a result of diverse and very often thoughtless activities of people the number of animal species (the leatherback, the Caspian seal, the Siberian tiger, the bustard and others) and plants (ginseng, wormwood tsitvarnaya and others) decreases. These biological resources of the Earth are of paramount value, because, first of all, they determine the biological basis of the people's vital activities. In terms of quantity the biological resources are renewable (through reproduction), but in terms of quality they are nonrenewable practically, because the loss of the species or ecosystem is irretrievable.

Genetic resources fall under the category of biological resources being inherited genetic information embedded in the genetic code of living matters. The loss of genetic resource cannot be replenished, because it is impossible to recreate the extinct species with its genetic complex.

1.7.2 Rational Use of Natural resources

Under current conditions rational nature management is such a system of business activities of society, at which it is possible to achieve inexhaustible energy and raw base combined with preserved parameters of the habitat required for the human being as a biological species and a reasonable social being. The rational nature management has twofold aim, it is necessary to attain the preservation of nature with all its diversity and provide the growth in prosperity of the population.

The rational nature management provides for the transition of industry and agriculture to resource saving technologies: 1) a more complete use of extracted mineral products; 2) repeated use of waste of production and consumption; 3) mastering sources of clean energy; 4) strict limitation of emissions within the limits of norms, installation of cleaning filters and structures.

It is necessary to remember that the natural resources are a part of ecosystems, in which all ecological components are interrelated. This is why use of already one natural resource has an influence on another resource. For example, when irrigating fields, water resources of one or another water basin reduce that inevitably will have influence on the fishery, navigation, hydropower engineering etc. Watering also will change the level of underground water, the content of species in soil microorganisms. This is why when using any natural resources one must consider the impact of such use on the ecosystem as a whole and separate natural resources in particular.

Self Assessment Questions

1. What are natural resources?
2. The principles of natural resources classification
3. What natural resources are classified as renewable and nonrenewable?
4. What is the significance of the natural resources for the human being?
5. How do you understand the rational nature management, give examples?
6. What ecologically clean sources of energy do you know?

1.8 Anthropogenous Factors of Instability in Biosphere Arising

1.8.1 The History of Anthropogenous Ecological Crisis and Carrent Environmental Problems

A number of periods could be distinguished in history of interrelations of the man and nature. The biogenic period covers the Paleolithic. Major activities of an early man were gathering and hunting large animals. At that time the man fitted in biochemical cycles, worshipped the nature and was its organic part. By the end of the Paleolithic the man became a species-monopolist and exhausted resources of his habitat: he extirpated the basis of his nutrient budget, large mammals (mammoths and large hoofed animals). It led to the first ecological and economic crisis: the mankind lost exclusive state, its number drastically reduced. The only thing that could save the mankind from the total extinction was to change the ecological niche that meant to change the living habits. Since the Neolith Age a new agrarian period began in the interrelations of the mankind with the nature. The mankind did not stop to evolve only because he began to create new artificial biogeochemical cycles, he invented farming and animal breeding, and in so doing he changed his ecological niche qualitatively. It should be stated that having overcome the environmental crisis by means of the neolith revolution

the man distinguished himself from the other nature. If in the Paleolithic he fitted well into the natural cycle of matters, then having mastered farming and animal breeding, mineral products he began to interfere actively in this cycle, involve matters accumulated earlier in the cycle. Namely from the agrarian period in history the technogenic epoch (man-caused) started. The man actively transformed the biosphere, used the laws of nature for achieving his objectives. In the Neolith Age the number of mankind increased from millions to tens of millions. At the same time the number of domestic animals (cattle, horses, donkeys, camels) and synanthropic species (a domestic mouse, black and Norway rats, dogs, and cats) increased. Expanding agricultural land our ancestors burnt forests. However, due to aimless farming the land became nonproductive very quickly, then new forests were burnt. The reduction of forestland led to the reduced levels of rivers and groundwater. All this entailed changes in the life of whole communities and their destruction: forests were replaced with savannas, savannas were replaced with prairies, and prairies were replaced with deserts. Thus, an ecological result of Neolithic cattle breeding was the advent of the Sahara Desert. Archeologists' researches showed that ten thousand years ago there was a savanna on the territory of the Sahara desert, where hippopotamuses, giraffes, African elephants, ostriches lived.

Because of overgrazing of cattle and sheep the man turned the savanna into the desert. It is important to emphasize that desertification of large territories in the Neolithic Age was a reason of the second ecological crisis. The mankind went out of the crisis by two ways as follows: going to the north as glaciers melt, where new territories became empty; mastering irrigated farming in the valleys of great south rivers – the Nile, the Tigris and the Euphrates, the Indus River, the Huang He. Namely there the most ancient civilizations appeared (Egyptian, Sumerian, ancient Indian, ancient Chinese). The agrarian period ended with the epoch of Great geographical discoveries. Discovery of the New World, isles of the Pacific Ocean, invasion of Europeans in Africa, India, China, and Central Asia transformed the world, led to new encroachment of the mankind on the wildlife. The next period, the industrial period included the period from 17th century up to the middle of 20th century. By the end of that period the number of the mankind drastically increased achieving five billion people. If in the beginning of the period natural ecosystems could resist anthropogenic impacts, then by the middle of the 20th century, due to the increase of the population, rates and scales of industrial activities, the capacity of ecological systems to self-restoring were exhausted. The situation was created, in which further development of production became impossible due to the depletion of nonrenewable natural resources (reserves of ores, fossil fuels). Ecological crises aggravated and

became large-scale ones, because human activities changed cycles of matters. The mankind came across a number of global ecological problems: drastic changes of the environment, destruction of habitats led to the threat of extinction of two thirds of existing species, the area of the "planet's lungs" – unique rainforests and Siberian boreal forests was decreasing rapidly, the fertility of soil worsened and reduced due to salinization and erosion, huge quantities of industrial waste were discharged in the atmosphere and hydrosphere, accumulation of which was a threat to the life of a majority of species, including a human being. At present, however, there are intentions to transfer from industrial to information and ecological or post-industrial period in interactions between the society and the nature that is characterized by green-thinking, environmental awareness, understanding the scarcity of natural resources and capacities of the biosphere to restore ecosystems. It became evident that the only way to survive for the mankind is rational and environmentally conscious nature management.

In the process of evolution ecosystems undergo various changes that finally lead to the state of a relative (dynamic) equilibrium. Natural systems try to maintain a stable balance under the influence of a large variety of internal compensating mechanisms of self-regulation. Self-regulation or homeostasis characterizes the capacity of the ecosystems to resists changes of its abiotic and biotic components and to preserve its inherent equilibrium of production and decomposition of an organic matter within a significant period. Finally, any human intervention having harmful effect on the population results in the death of this population. For example, overfertilization of soils leads to the death of earthworms or forces them to leave the field. Any pressure on the ecosystem causing stress induces arising of compensatory processes. The natural system resists actively to factors of technogenesis. For example, construction of an irrigation network in the valleys of desert rivers of Kazakhstan is followed by gradual silting of channels that in due course may lead to stoppage of the melioration system operation. However, this opposition has its limits.

The stability of ecosystems is destroyed drastically as a result of various critical (crisis) situations induced usually by the impact of external anthropogenous factors. For example, destroying the stability of the ecosystem of the Aral Sea influenced by the reduced river runoff, and as a consequence of this the lowering of the water level in the water body led to formation of a new geological system - saline neodesert on the seafloor. For the first time a critical state of the Aral Sea was observed in 1961, when unalterable change in the system structure of this closed water body began under the influence of the nature. As it has already been stated the destruction of the ecological equilibrium is caused mainly by the anthropogenous factors,

the impact of which may be in the form of a direct short-term impact (for example, volley of industrial waste in the river system) or a prolonged impact (for example, permanent run-offs of chemical fertilizers in the river.

As a whole the biosphere is an ideal well-functioning system of self-purification and self-restoring of the environment. To reduce pollution of the environment by industrial waste it is necessary to model and borrow these mechanisms from the nature. The notion close by the content and functioning of the biosphere and self-purification of the environment gives an idea of a closed manufacturing cycle – repeated use of material resources in production (for example, recycling water supply). In the process of the closed manufacturing cycle environmentally friendly and sound state of the environment is provided.

Ecological problems started to arise from the first days of the mankind's existence. However, only within the last two centuries, especially beginning from fifties of the 20^{th} century ecological problems became a threat to the existence of the biosphere. The ecological problems are caused, first of all, by the pollution of the environment, air and the World Ocean, depletion of natural resources. The ecological problem including the issues of the environment protection and rational nature management is a global problem affecting the interests of all six-billion population of our planet, interests of all states, interests of each person without exception. This is why any economic and political decisions violating scientifically justified medical, ecological or other requirements to the environment are in principle unacceptable.

All organisms discharge decomposition products formed in the process of their life in the environment. They are CO_2, turds, roughage etc. The decomposition products make the environment less favourable for the living organisms forming them. However, in the balanced ecosystem excrements of one organism are food for another one, this is why the decomposition products are not accumulated in the environment. The environment is contaminated in cases, when excrements are not destroyed with the same rate as they are formed. Contamination is an excess of the natural level of various matters in the environment and introduction of new ones not characteristic for the environment.

In terms of their impact on living organisms contaminants are divided into physical, chemical and biological. Radioactive elements, heat pollution (excess of temperature), noise and low frequency vibration (infrasound) fall in the category of *physical contaminants.* Carbon derivatives, sulfur, nitrogen, fluorine, solids, washing agents, detergents, plastics, pesticides, mineral fertilizers, organic matters, and heavy metals are classified as

chemical contaminants. Pathogenic organisms, viruses, seaweeds etc fall in the category of biological contaminants.

The following industries as metallurgy, chemical, cellulose and paper, petroleum-refining contaminate surface water to a greater extent. Main contaminants in the industrial sewage are oil, oil products, non-ferrous metals, and complex chemical compounds. Oil and oil products are poorly biodegradable, have negative influence on development of roe and spawn, on the number and composition of water ecosystems. Various washing agents (surface active, synthetic matters being poorly biodegradable by microorganisms), detergents, production of which is developing rapidly in all countries; hold a specific place amongst the contaminants of the water. As a result of using detergents the quantity of phosphates in rivers and water bodies increases that leads to intensive development of vegetation in water ecosystems, reproduction of weeds, and depletion of oxygen in the water mass. All this leads to the so called "flowering" of water bodies (eutrophication).

Water basins are polluted with city domestic sewage water to a greater extent. However, if the quantity of industrial sewage and the number of contaminants may be reduced by changing the process of manufacturing, then with regard to city sewage water, it is typical that the quantity is increasing on a permanent basis caused by the population development.

In the process of evolution of the Earth a certain background atmosphere composition was formed as follows: N_2- 78 %, O_2- 21 %, CO_2- 0.028 %, inert gases (for example, argon) – 1 %. These components do not hold reflected infrared (heat) rays, and in doing so create optimal conditions for life on the Earth. However, at present, anthropogenic activities contribute to excessive generation and accumulation of secondary gases and other admixtures and increase of CO_2. The percentage background content of CO_2 in the atmosphere increased from 0,028 % (1950) up to 0,034 % (1985). This increase of CO_2 results in the imbalance of the atmospheric composition.

Many contaminants are very high toxic and cause various disorders in living organisms, in particular of a man, leading to various diseases, and the decrease in immunity. The fact being of a particular concern is that many contaminants, for example, salts of heavy metals, pesticides, detergents and others have mutafacient and carcinogenic activity causing congenital defects and cancerous diseases.

1.8.2 Global Ecological Problems

Intensified contamination of the environment results in arising of global ecological problems which include the following:

The greenhouse effect is an effect of heating the surface air caused by the atmosphere's absorbing long-wavelength (heat) emission of the earth surface, to which a major part of light energy of the Sun reaching the Earth transforms. The concentration of greenhouse gases (carbon dioxide, methane, nitrogen oxides and water vapour) in the atmosphere increases that results in climate warming.

Desertification is arising of landscapes close to desert with a rare vegetative cover as a result of human business activities, degradation and decrease in biological efficiency of the ecosystems.

Acid rains are precipitation which contain sulphuric and nitric acids.

The decrease of a biological diversity, the diversity of forms and processes in the organic world is manifested on molecular and genetic, population and biocenosis levels of organizing alive. The biological diversity provides continuity of life in time, and maintains the biosphere's functional structure and ecosystems being its components.

Destruction of the ozone layer is destruction of layers of the atmosphere (stratosphere) with the increased level of ozone (O_3) located at the height 18-23 km that protects living organisms from hard ultraviolet rays.

Self Assessment Questions

1. Enumerate and characterize main phases of interactions of society and nature
2. What is contamination of the environment, main types of contamination?
3. What are reasons of arising of global ecological problems?
4. What the role of the ozone screen and reasons of its destruction
5. Causes and consequences of the greenhouse effect
6. How does acid precipitation influence on the environment?
7. What is the reason of the decrease in biological diversity?

1.9 Social and Ecological Problems of Modernity and Sustainable Development

In the course of evolution the ecosystems undergo various changes which finally lead to the condition of a relative (dynamic) balance. The nature systems try to maintain a stable equilibrium under the influence of a large variety of internal compensating mechanisms of self-regulation. Self-regulation or homeostasis characterizes the capacity of the ecosystems to resists changes of its abiotic and biotic components and to preserve its equilibrium of production and decomposition of an organic matter within a significant period. As a whole the biosphere is an ideal well-functioning system of self-purification and self-restoring of the environment. To reduce

pollution of the environment by industrial waste it is necessary to model and borrow these mechanisms from the nature. The notion close by the content and functioning of the biosphere and self-purification of the environment gives an idea of a closed manufacturing cycle – repeated use of material resources in production (for example, recycling water supply). In the process of the closed manufacturing cycle, environmentally friendly and sound state of the environment is provided.

Ecological problems began to arise from the first days of the mankind's existence. However, only within the last two centuries, especially beginning from fifties of the 20th century the ecological problems became a threat to the existence of the biosphere. The ecological problems are caused, first of all, by the pollution of the environment, air and the World Ocean, depletion of natural resources. The ecological problem, including the issues of the environment protection and rational nature management, is a global problem affecting the interests of all six-billion population of our planet, interests of all states, interests of each person without exception. This is why any economic and political decisions violating scientifically justified medical, ecological or other requirements to the environment are in principle unacceptable.

1.9. 1 Main Components of the Ecological Problems

Three main components of the ecological problems could be identified: biological, technical and social and economic. The basis of the biological component is destruction of the ecosystems, the extinction of living organisms, the decline in the capacity of the nature, worsening living conditions of people. The technical component is imperfect technology of modern production, a high rate of intensification of business complexes. The basis of the social and economic component is uncontrolled management, superprofit seeking, consumer attitude to the environment and nature, available forceful, administrative and business management, breach of scientific principles of rational nature management.

There are already available features of global ecological crisis that is confirmed by an extremely unfavourable ecological situation not only on regional scale but also on planetary scale. These issues could be solved only involving all states of the world community, uniting their efforts and force.

1.9.2 The Population Upsurge and Resource Crisis

Social and ecological problems are also qualified as global problems of present days. The reason of them is a gap between technical capacities of a human being and extremely primitive strategy of survival, where the growth prevails over sustainability, and the number of population prevails over its quality. The social and ecological problems are caused by the population upsurge, resource crisis and change of gene pool.

The population upsurge. The number of people living in the Earth has been steadily increasing for the last 2000 years, but the most intensively it has been increasing within the last 200 years. It is explained mainly by a drastic reduction of mortality in the majority of countries. Though a major part of people considers that the mortality is caused by achievements in medicine (antibiotics), however, less notable improvement of nutrition and sanitary and hygienic conditions played much larger role. For example, in the USA, during the Civil War 92000 people died of wounds and 190000 people died from typhus fever (clothes and head lice are causative agents of typhus and trench fever).

At present the population of the Earth is increasing with the pace of about 250 000 people on a daily basis, 1750 000 people on a weekly basis, 7 500 000 people on a monthly basis, and 90 000 000 people on an annual basis. It increased from 500 000 000 in 1650 up to 5 000 000 000 in 1981, in 2000, the population was over 6 000 000 000, and at present it makes up 6 500 000 000 people. It took 100 years to increase the population twice (from one billion up to two billion), I took less than seventy years for double increase the population from two billion up to four billion, and it will take less than 50 years for the next double increase. Such a rapid population upsurge of the Earth is called "demographic explosion". According to the data of the UN, a main growth of population takes place in the developing countries. A rapid growth of population in the developing countries aggravates drastically ecological and social problems.

The number of inhabitants in these countries makes three quarters of the planet's population and they consume only one third of the global production, and besides, the consumption per capita gap continues to increase. One popular American edition depicted our planet with the population of six billion as a village with the population of 100 people, where the existing ratios of modern mankind would remain the same. As a result the following picture was obtained: there would be 57 Asians, 21 Europeans, 14 representatives of North, Central and South America and 8 Africans;

- 50 % of all wealth would belong to 6 persons, and all of them would be citizens of the USA;
- 70 persons would be unable to read;
- 50 would suffer from undernourishment;
- 80 persons would live in houses unfit for living in;
- only 1 person would have higher education.

The growth of population must stop, when there will be too many people in the Earth that each person could obtain sufficient quantity of any required but limited resource. One of such vital and essential resources is food, insufficient quantity of which has already started to slow the population

development in some countries. All over the world, every day about twelve thousand people starve to death, and ten million children are malnourished to such extent that their life is under threat. Only in India one million children die of undernourishment (Diagrams 14-16) every year.

It is recognized that if to harvest 1 tonne of grain from 1 hectare per person, then there will be no problems with hunger. Then six billion tones will be required for six billion population, and only one and half billion tones of grain are harvested. The reason is that there are only 0.28 hectares of arable land per person in the world. In addition there is an intensive process of desertification is ongoing that means soil exhaustion of arable land. Within historic period the mankind lost almost two billion hectares of productive land. The area of anthropogenic (man-made) deserts is equal to ten million square meters or 6.7 % of the whole surface of the land. The process of desertification is taking place at a speed of 6.9 million hectares per year.

According to the law of the pyramid of numbers, taking upper levels of a trophic chain the mankind may form a biomass to a significant extent less than the biomass of a living matter of the biosphere as a whole. M.E. Vinogradov (1994) thought that the biosphere will preserve the stability if there are 250 t/y of the living matter per head. The total production of the biosphere (land and ocean) makes up 5 x 1023 t/y. Therefore, only 3-4 billion people may exist in the biosphere not violating its stability. Maybe global ecological problems started to arise namely after the population's size exceeded the stated limit.

The population upsurge is followed by a number of processes: the consumption expansion, the urban growth (urbanization), contamination of the environment, life style changed, the drop in the living standards, the change in the population composition, and congestion.

The resource crisis. In the nearest future one would expect the decrease in growth of world gross product in association with arising ecological and economic problems. This concept affects land and energy resources. The crisis of land resources is caused by the depletion of soil, the loss of fertility. The energy crisis is caused by transition to use non-renewable energy resources (oil, mineral coal, natural gas) yielding up to 75% of all energy consumed by the mankind (even reserves in Middle East may cover the deficit of oil in these countries only up to 2030). If even new fields and deposits are discovered, then the population growth will be about 2.5 billion in the nearest few years, and the general energy consumption will increase by 20-25 %, this is why even the growth of reserves in two and half times cannot compensate the consumption expansion. Though nuclear power engineering is a viable alternative to fossil fuels, however, due to accidents having taken place at the nuclear power stations, in particular, Chernobyl

disaster (1986) the nuclear power stations are not considered a reasonable alternative due to high risk and hazard to life and health of people. In association with this the prospects of using non-traditional sources of energy have become very urgent and pressing. The non-traditional sources of energy are the heat of earth interior, solar batteries, energy of wind, tidal energy, use of biological processes and systems to produce ecologically pure fuel (hydrogen, hydrocarbons, ethyl alcohol etc).

The change of gene pool is the change of habitats taking place as a result of business activities of people that have an impact on the human population which turns out to be very often unfavourable even adverse. Finally all these negative changes in the environment lead to the changed gene pool which acquired a global scale. Mutations (alteration of genes) caused by the influence of both physical (all types of ionizing radiation) and chemical compounds are very often of a negative nature. Out of hundreds of thousand various chemical compounds discharged in the environment in the form of domestic and industrial pollutants 20% have mutagenic activity. As a consequence of this the genetic load increases (accumulation of negative mutations) leading to a significant increase of the number of hereditary diseases.

Self Assessment Questions

1. Why is enhanced interest to the problems of the environment protection observed in all countries at present?
2. What are reasons of social and ecological problems arising?
3. How do social and ecological problems influence on sustainable development?
4. Why is the resource crisis one of main ecological problems of nowadays?
5. Why does the increased genetic load arouse concern of scientists?
6. What is the population upsurge related to and what are the consequences of this process?

1.10 Conservation of Nature and Sustainable Development

1.10.1 Ecological Monitoring

When assessing the environmental condition, ecological monitoring plays a very important role. The concept of monitoring was introduced into the scientific literature in early seventies of the last century, and it means observation and exercising control over changes in the state of biosphere (background ecological monitoring) and ecosystems, populations, organisms (local ecological monitoring) influenced by human activities, and also the atmosphere, the water, the oil and human health. The environmental control

system incorporates three major types of activities: 1) tracking and control is a systematic environmental monitoring; 2) forecast is to determine probable changes of weather under the influence of natural and anthropogenic factors; 3) management is measures and actions to regulate the state of environment.

Ecological monitoring is exercised by means of ground facilities and route methods. When exercising biological ecological monitoring, the state of species of plants, animals and whole ecosystems is assessed, and the judgment on the impact of human activities on these objects is provided based on the results. Recently aerospace ecological monitoring is widely used. Spatial scales of objects of space monitoring are as follows: topological, regional, and global. Time scales of monitoring are as follows: daily, seasonal, yearly, and multi-year. In assessing the state of environment such surface techniques as geophysical, geochemical and indication play a critical part alongside with remote control methods. Indicators of the natural undisturbed state of nature complexes or background parameters of the environment act as criteria of the state of environment. In practice of monitoring observation two main groups of standard indicators: sanitary and hygienic and ecological are applied. The sanitary and hygienic indicators are determined based on the requirement of environmental safety of population. These indicators include: maximum permissible concentration (MPC) of contaminants in the air, water, soil, food products and maximum permissible emissions (MPE) of contaminants in the air, water bodies. The ecological criteria are regarded as a measure of anthropogenic impact on ecosystems, in which major functional and structural characteristics (the productivity, the intensity of biological cycle, the species diversity, and stability) do not go beyond the limits of natural changes.

1.10.2 Protected Areas One of Forms of Environment Protection

An important indicator of the state of environment is *the health of population*, the criteria of which are the infant mortality dynamics, congenital anomalies of newborn infants, diseases of children and adults. Protected areas one of forms of environment protection being of exclusive value is protected areas. The forms of protected areas are very diverse in the world, they are as follows: reserves, wildlife sanctuaries, natural monuments, national and natural parks, botanical gardens, and biosphere reserves. At present the protected areas make up approximately 1.6-2.0% of the land of the planet. The largest national park of the world in Greenland occupies the area of about seven million hectares. The Central Kalahari Game Reserve in Botswana is one of the biggest protected areas in Africa; it occupies 5.3 million hectares; Wood Buffalo National Park (Canada) with the area of 4.5 million hectares; Great Gobi an international Biosphere Reserve (Mongolia) with the area of about 4 million hectares. Reserves are the most perfect form

of full protection, because they cover the entire area, natural complex, and there are no business activities using natural resources there. Protection of unique objects of nature may be arranged by a system of areas with protective mode of business activities – wildlife sanctuaries. Nature (national) parks may be considered to be one of categories of protected areas. Their main task is to provide population with recreation services.

There are 10 reserves operating on the territory of Kazakhstan at present: the Aksu Zhabagly Nature Reserve (Southern Kazakhstan region), the Barsa-Kelmes - Nature Reserve (Kyzylorda region, Figure 4); the Naurzumsky State Reserve (Kostanai region), the Almaty Reserve (Almaty region), the Kurgaldzhinsky Reserve (Akmola region), the Markakolsky state natural reserve (Eastern Kazakhstan region), the Ustyurt National Biosphere Reserve (Mangistau region), the Alakol State Nature Reserve (Almaty region), the West Altai State Nature Reserve (Eastern Kazakhstan region), the Karatau Nature Reserve (Zhambyl and Southern Kazakhstan regions).There are 8 National Nature Parks operating on the territory of Kazakhstan: the Bayan-Aul State National Park (Pavlodar region); the Ile-Alatau State National Park (Almaty region) located on the northern hillside of a central part of the ridge Ile-Alatau in Northern Tien Shan between the Chemolgan River and the Turgen River, the Altyn-Emel National Park (Almaty region), it is located among the southern spurs of the Zhungar Alatau Range on the territory of Kerbulak, Panfilov and Talgar Districts), the Kokshetau Burabay National Nature Park (Kokshetau region), The Karakaralinskiy National Park, the Katon-Karagay National Park, the Charyn National Park. In the nearest future on the territory of Kazakhstan it is planned to organize 18 new reserves, 12 national parks, wildlife sanctuaries and natural monuments. In June 1992, at the World Forum in Rio de Janeiro the Convention on Biological Diversity was signed and ratified by more than 100 states of the world. The main aim of the Convention shall be to sustain the rich diversity of life on Earth and sustainable use of its elements. The International Conference on Biosphere Reserves (Seville, 1995) developed the Seville Strategy for Biosphere Reserves and the Role of Biosphere Reserves in the 21st century. Proposals on establishing biosphere reserves are put forward by the national governments. The biosphere reserves shall fulfill three complementary functions as follows:

- protection to sustain genetic resources, biological species, ecosystems and landscapes;
- he function of development to promote sustainable economic and human development;
- the function of material and technical support to promote and encourage activities in the field of research, education, training

staff and monitoring actions of local, national and global character carried out with the aim of protecting nature and sustainable development.

Each biosphere reserve shall consist of its own area of outstanding natural beauty, a buffer zone and a flexible transition zone, where some agricultural activities may be carried out, populated areas may be located or which may be used for other purposes and within the borders of which local administrative and scientific institutions, nongovernmental organizations, cultural societies, business circles and other partners work jointly for the purposes of sustainable development and rational use of resources available in this area. In May 1996, at Kazakh National University named after Al-Farabi, the International Conference on Biosphere Reserves was held. The result of the conference was the Appeal of a number of international and nongovernmental organizations and also scientific public of Kazakhstan to the Government of the Republic of Kazakhstan regarding establishing a number of biosphere reserves on the territory of Kazakhstan. It is planned that the first Kazakhstani biosphere reserve would be established on the basis of the Kurgaldzhinsky Reserve in Akmola region. So, the biosphere reserves may play a new important environment-oriented role. They will become not only the means to provide the population living in these areas with the opportunity to develop the areas and keep in balance with the environment and maintain biospheric balance but will contribute to satisfy the needs of society as a whole showing the way to more sustainable future development.

With the intent to build harmonious relations between the nature and society it is necessary to solve three the most important tasks:

1. to form a new type of social and ecological thinking eliminating an exclusive consumer approach to the nature;
2. wide publicity, enlightenment and elucidation of social and ecological problems accompanying development of human civilization;
3. developing a business mechanism of nature management providing full coordination of individual, collective and national interests in the area of environment protection and rational use of natural resources.

Main principles of rational nature management are research, protection, development, and reformation. Protection of resources means to maintain their qualities favourable for carrying out business activities, and reformation means to improve them (melioration, reclamation of land). The concept of rational development of natural resources and conditions includes the most complete use of advantages of the environment and economical energy generation and production of raw. As a whole the modern mankind

still rests on an extensive type of nature management, at which the increase in production is achieved by means of increasing loads on nature complexes. The total anthropogenic load on the nature systems began to exceed their capacities to self-restoring (self-purification) that affected nature systems on a planetary scale: the World Ocean, atmosphere, river systems, flora and fauna. This is why it is necessary to transit to environmentally friendly and balanced nature management, when the society exercises control over all parts of its development that the aggregate anthropogenic load does not exceed the nature systems' capacities of to self-restoring. The ecological education and enlightenment are of paramount significance in ensuring sustainable development of the mankind. One of the most important tasks is to educate all layers of society in an active civil position to nature conservation, preservation of its wealth, in particular, the biological diversity as a guarantor of the biosphere's integrity and stability. It is necessary to foster in a careful protective attitude to the nature from the moment of forming a future citizen of society as a personality.

Self Assessment Questions

1. Enumerate main principles of environmental protection.
2. What are protected areas?
3. Enumerate reserves of Kazakhstan
4. Why is protection of genetic diversity necessary?
5. What is the essence of rational nature management?
6. What is ecological monitoring, its objectives and aims?
7. What is the role of ecological education in providing sustainable development of nature and society?

1.11 Actual Ecological Problems of Sustainable Development of the Republic of Kazakhstan

1.11.1 The Reasons and Causes of Unstability of Natural Environment in the RK

The ecological situation in Kazakhstan is far from being satisfactory . Let's review main factors of anthropogenesis and industries of economy that determine the current ecological state of the natural environment in the country. Numerous electric power plants and heating plants with various capacities operating on oil products, natural gas, and nuclear fuel occupy large areas. They pollute the atmosphere, soil with gases and dust to a greater extent, exert harmful impact on flora and fauna. In Kazakhstan a breakthrough type of impact of energy on the environment is a seawater desalinator in Aktau city operating on a nuclear reactor. Deposits and fields are often developed violating the scientific and technical rules that result in

lost raw when producing, dressing and transporting (the Sokolovsko-Sarbaiskoie mining administration, the Zhezkazganski ore mining and processing enterprise, the Karaganda coal field, the Balkhash copper-smelting integrated works and others). As a result of these violations quarries, mines, pits, holes come into being; the atmospheric air is contaminated by deflation of mined and waste ore in waste piles and quarries, natural flora and fauna vanish, the increased disease incidence among workers and local population. When producing oil the level of underground and ground water decreases; the integrity of vegetative ground cover is destroyed. In peninsula Mangistau uncontrolled construction of earth roads to drilling units leads to rapid soil erosion at the roadside. Storing excess oil in open pits is often a reason of a complete loss of the vegetative ground cover. Surface and underground water is contaminated with oil, and then the contaminated water flows to water bodies consumed by the population. At some fields in West Kazakhstan natural gases are burnt in flares in oil-wells polluting the atmosphere by products of incomplete hydrocarbon combustion. Enterprises of ferrous and non-ferrous metallurgy consume large quantities of water (Ust-Kamenogorsk titanium and magnesium works, Ziryanovsky, Ulbinsky, Balkhash smelting integrated works and others). Waste water containing large quantities of various oils, alcohols and phenols flow into rivers and water reservoirs, large quantities of sulphur dioxide gases and dust are discharged in the atmosphere. In non-ferrous metallurgy it is necessary to process 50-100 tonnes of ore at dressing works in order to produce 1 tonne of metal, and however, large quantities of waste ore are delivered to waste tips that are spread over huge areas. Large quantities of sulphuric acid are used to produce mineral fertilizers which are discharged in the environment with industrial waste. However, the largest ecological damage is caused by emissions of gaseous matters contaminating the atmosphere (Atyrau city, Zhambyl city, Pavlodar city, Shymkent city and others). Uncontrolled business activities of enterprises do great harm to the top soil; such consequences of human activities as wind and water erosion, contamination of soil by domestic and industrial waste contribute to contamination of the environment. The change in the top soil takes place due to felling forests, thinning out thickets of haloxylon (saxaul, sacsaoul) and bottom-land forests (tugais), mechanical destruction of plants when carrying out engineering, construction, irrigation and melioration and road works. In Kazakhstan degradation of grazing land reached 60%, overgrazing of cattle caused heightened soil erosion and processes of desertification (Diagram 19). Destroying plants in urban landscapes (urban greening) leads to increase of temperature and pollution of the atmospheric air in cities. Expanding urban greening in cities and populated areas is of large sanitary and hygienic value.

Phytomelioration of soils is a universal way to restore the disturbed ecological balance of natural and anthropogenic systems (according to A.V. Chigarkin, 1995). At present an explicitly expressed tendency of aggravating a critical ecological situation is observed in the areas of the Aral Sea and the Balkhash Lake, Rudny Altai, the Irtysh River, the Caspian Sea, Almaty city, Zhambyl city, Ust-Kamenogosk city, Shymkent city and others. The areas with disastrous destabilization of ecosystems and geosystems include the existing and former water space of the Aral Sea, territories of the Semipalatinsk nuclear site, the north east coast of the Caspian Sea, urban and industrial natural areas of Rudny Altai: Ust-Kamenogosk city, Leninogorsk city, Zyryanovsk city. The following industrial areas: Balkhash, Zhambyl, Zhezkazgan, Kzyl-Orda, Temirtau, Shymkent, Almaty and Karaganda, the rivers: the Irtysh, Syrdarya, Nura, Arys may be qualified as regions with a critical ecological destabilization. The cities Aktau, Aktobe, Atyrau, Semipalatinsk, the Kapshagai and Shardara water reservoirs, the Balkhash Lake, the Ili River, the Shu River may be considered to be regions with a Regions with a satisfactory level of ecological destruction are urban and industrial natural areas: Akmola city, Kokshetau city, Taldy-Korgan city, Petrapavlovsk city, Uralsk city, the Ishim River, Talas River, Tobol River, Sarysu River, the Ural River. Regions with favourable level of ecological destruction include significant under-populated areas of Kazakhstan: semideserts, deserts, mountain areas (according to A.V. Chigarkin, 1995). The problem of radiation pollution is still pressing and urgent. Radiation pollution control may be only of preventive nature, because there are no methods of biological decomposition and other mechanisms that give an opportunity to neutralize this pollution of the environment. Radioactive matters spreading by a food chain (from plants to animals) with food products come to the human body and may accumulate in such quantities that may do harm to the human being. Nuclear weapon tests may be qualified as a very serious crime against the nature and mankind. Since 1949 up to 1962, at the Semipalatinsk nuclear site approximately 200 explosions in the atmosphere were performed; and since 1963 up to 1989, about 400 underground explosions were performed, a part of which were followed by discharge of radioactive nuclides. The population of East Kazakhstan received the largest dose of ionizing radiation after Hiroshima, Nagasaki and Chernobyl. The data on the disease incidence caused by ionizing radiation were prohibited for publication up to 1989. According to unofficial sources, the number of people died from leucaemia makes up tens thousand of people. There are a number of factors that form a radioecological situation in the country:

- the activities of the former Semipalatinsk nuclear site;

- nuclear explosions for the purposes of solving business tasks;
- enterprises of nuclear and industrial complexes;
- mining and processing complex ores, oil and gas with high radioactivity.

The condition of water resources is unfavourable in Kazakhstan. In our country water arteries are represented by 85 000 rivers. The largest waterways are the Irtysh River, the Ishim River, the Syrdarya River, the Ural River, the Shu River, the Talas River, and the Assa River. Within the last years drying up of a number of lake systems has been observed that is related to damming the flow of rivers and natural fluctuations of their levels. In respect to the ecological condition the basin of a main water artery of Kazakhstan, the Irtysh River is the most adverse. Its water is polluted by heavy metals (copper, zinc, cadmium, arsenic etc) that flow into the river with waste water. The situation with environment in the Caspian Sea region is determined by an increase of the Caspian Sea level and anthropogenic (man caused) impact on the coastal ecosystems. According to the forecast of experts, the increase in the sea level will lead to elongation of the coastal line up to 2400 – 2700 km, and additional 1.2 – 2.2 million ha of flooded areas. In terms of flooding oil fields located in the north and north-east coast of the Caspian Sea are exposed to higher hazard (out of 43 oil fields under the threat of flooding 32 fields are located in Atyrau region and 11 fields are located in Mangistau region). The Caspian Sea is the largest habitat of sturgeons in the world. For this reason the problem of the Caspian Sea is not only national but also a global problem. To preserve the biological diversity of the Caspian Sea is the concern of the world community. In 1995, in Tehran (Iran) the meeting of representatives of the Caspian Sea countries was held. The objective of the meeting was to develop the concept of ecologically sustainable Caspian Sea region and control over use of its resources. However, implementation of any ecological program is aggravated by its increasing value as the largest oil and gas field.

One of the most urgent problems not only for Kazakhstan but also for the whole world community is still the problem of the Aral Sea (Diagram 20). Beginning from sixties of the last century the area of the Aral Sea began to decrease to a greater extent. The use of water for irrigation of agricultural crops resulted in the decrease by over 90 % of the natural water flow from the Tien Shan Mountains. The area of the sea decreased by 2.6 million ha, the sea lost 6% of its volume, the water level decreased by 12 – 24 meters, the content of salts increased in two times. Every day 200 tonnes of salt and sand are spread by the wind for a distance up to 300 km. At present the processes of desertification, salting of soil, depletion of flora and fauna, change of climate are still ongoing, the disease incidence of the population has

increased drastically. The ecological situation of the Aral Sea led to failure to implement traditional directions of economy development and caused a number of social problems.

1.11.2 The Mechanisms Providing Continuous Development of the RK

Destroying the environment any modern society destroys its own future. For future prosperity of next generations it is mandatory to preserve ecological stability. To preserve future ecological stability it is mandatory to exercise thorough and strict control over the condition of the environment, to introduce norms and prevent the discharge of industrial waste, develop and introduce non-waste and resource-saving technologies.

With the purpose of providing sustainable development of the Republic of Kazakhstan the following mechanisms were developed:

- financing activities for Environmental Protection from the state budget, local budgets, funds of subsoil users, international loans and grants and other sources;
- organizing tenders for the Environmental Protection and rational nature management with possible funding from the state budget, local budgets;
- implementing the principle "a person contaminating the environment will pay" meaning that a subsoil user shall bear responsibility for funding activities of environment protection and compensation of possible ecological damage or shall refuse from carried out activities;
- to apply the principle of rental payments in taxation of subsoil users;
- to refuse gradually from the fiscal value of payment for emissions in the environment within the norms reducing the list of matters for emission of which the payment is charged and simultaneously increasing an incentive value of damage compensation for exceeding the established norms, increasing administrative fines for breaching the environmental protection legislation;
- ecological insurance of the environment damage, and also establishing foundations to finance activities for restoration of the environment at liquidation of enterprises;
- introduction of ecological taxes on manufacturing of ecologically hazardous products and/or services with possible allocation of funds directly to implement large environment-oriented programs;

- including the full cost of natural objects in economic indicators with due account for their environment-forming function and also the cost of environmental protection (ecological) work (services);
- forming and applying taxation and tariff policy that stimulates reorientation from export of raw materials to finished products (to import-substituting direction of activities);
- establishing and applying the systems of taxes and fees stimulating use of environmentally friendly technologies, goods and services irrespective of the country-manufacturer;
- introducing systems of emissions trading (commitments) among subsoil users;
- introducing market mechanisms of the environment protection, including stimulating reuse and reprocessing of industrial goods;
- using international financial and economic mechanisms in the area of the environmental protection provided for by international conventions and agreements;
- establishing conditions for stimulating charity in the area of the environmental protection.

The permit system for pollution of the environment gives an opportunity to regulate contamination of the environment by industrial enterprises.

Self Assessment Questions:

1. What has caused the necessity to protect the environment of the RoK from hazardous man-induced impact?
2. What is the ecological situation in the Aral Sea area and Caspian Sea area?
3. What are the zones of ecological disaster in the RK?
4. What are the ways to improve the ecological situation in the country with the intent to achieve sustainable development?

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5. *Ecology*. Under the editorship of V.V. Denissov Rostov-on-Don: MarT, 2002.

Additional:

1. T.A. Akimova, V.V. Khaskin. *Ecology* —M.: Printing house YUNITI, 1998.
2. G.M. Andersen. Ecology and environment sciences. The Biosphere, the Ecosystem, the Human Being. L., 1985.
3. E.A. Arustamov, I.V. Levakova, N.V. Barkalova. *Ecological Basis of Nature Management*. M.: 2001.
4. A.S. Beissenova, Z.B. Shildebaev, G.Z. Sautbaev. *Ecology*. Almaty: Gilim, 2001.
5. V.D. Valova. *The Basis of Ecology*. M.: Dashkov and Co., 2001.
6. A.M. Vladimirova, Y.I. Lyakhin, L.T. Matveev, V.G. Orlov. *Enviroment Protection. L. Gidrometeoizdat*, 1991.
7. E.V. Girussov. *Ecology and Economy of Nature Management*. M.: Statute and Law, YUNITI, 1998.
8. A.A. Gorelov. *Ecology*. Course of lectures —Moscow. Centre, 1997.
9. P. Camp, K.Arms *Introduction to Biology*. M., Mir, 1988.
10. V.A. Krassilov. *Nature Protection: Principles, Problems, Priorities*. M., 1992.
11. *The Environment and Sustainable Development in Kazakhstan*. Publications of UNDP Kazakhstan. Almaty, No UNDPKAZ 06, 2004

2.THE PRACTICAL PART

2.1 Methodical Instructions on Practical Sessions (seminars)

The methodological instructions contain themes of workshops *Ecology and Sustainable Development,* including questions, logical problems, and the list of recommended literature and forms of conducting lessons.

The objective of workshops (seminars) is to form students' competence and knowledge in issues of ecology and sustainable development, extend theoretical knowledge and develop the ability to apply the knowledge in a flexible, creative manner in practice.

Major tasks of the seminars are as follows:

• students learn new concepts and technologies in the area of ecology and sustainable development;
• developing skills to analyze ecological processes, setting exact tasks and priorities of sustainable development of nature and society with the intent to use acquired knowledge in solving ecological objectives;
• mastering and acquiring skills to study the proposed literature and documents in the area of ecology and sustainable development independently;
• mastering main methodological approaches to discussion of problems of sustainable development;
• developing the ability to apply the acquired theoretical knowledge on laws of relationships of living organisms and environment in practical activities with the aim of maintaining sustainable development.

During the semester it is provided for to conduct 15 seminars, the subjects of which will reflect main sections of the program for the present course.

Seminar 1.

Ecology as a theoretical basis of conservation of nature and rational use of natural resources

Questions:

1. Subject *Ecology and Sustainable Development*, its aims and tasks.
2. Short review of ecology history.

3. What explains enhanced interest to ecology within the last decades?
4. Relationship of ecology with other sciences and your selected profession?
5. Ecology is a scientific and theoretical basis of nature conservation and rational use of natural resources.
6. The concept of *Sustainable Development*. Why is ecology a component of the concept of *Sustainable Development*.

When preparing the subject of the present seminar students should pay attention to the definition of ecology as a science, nature conservation and rational use of natural resources, reasons of arisen interest to sustainable development. All this may help to understand the subject and answer questions to the present subject.

Seminar form: Test and verbal questioning.

Recommended literature:

1. Y.V. Novikov. *Ecology, the Environment and a Human Being*. M., FAIR-PRESS, 2003.
2. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006.
3. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007.

Seminar 2.
Impact of Motor Transport on the Environment

Questions:

1. What is the impact of motor transport on the environment?
2. What harmful substances are discharged in the atmospheric air by motor vehicles?
3. What measures are aimed at protection from the impact of motor transport on the environment?

Recommended literature:

1. Course: Ecology. Unit 1. Study book for students of higher schools/ written by T.A. Kuzovnikova. M: 2001, p. 13-24.
2. Ecology negizderi. Okulyk/ A. Baeshov, Z.Y. Daribaev, B.S. Shakirov et al – Turkistan, KHKTU, 2000, - p. 196.
3. T.A. Akimova, V.V. Khaskin. Ecology —M.: Printing house YUNITI, 1998
4. A.A. Gorelov. Ecology (Course of lectures) —M. Znanie, 1998.

Seminar 3.
Main types of habitats and their characteristics

Questions:

1. The concept of Ecological factor, habitat.
2. Classification of Ecological factors by origin and time. Examples.
3. The concept of limiting factors (the law of minimum, the law of tolerance). Examples.
4. Give examples of eurybiontic and stenobiont organisms.
5. Water as a habitat.
6. Soil as a habitat.
7. Ground and air habitat and its main characteristics.

When preparing the subject of the present seminar students should pay attention to the fact that all organisms live in such conditions to which they are adapted (adaptation). Namely this condition enables them to survive extreme conditions within the tolerance limits. If main factors are favourable, but one of them goes beyond the tolerance limits, then this organism cannot survive these conditions. This determines the habitat of living organisms.

Seminar form: Test and verbal questioning.

Recommended literature:

1. Y.V. Novikov. *Ecology, the Environment and a Human being*. M., FAIR-PRESS, 2003.

2. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006.
3. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology.* Almaty, Kazakh universiteti, 2007.

Seminar 4.

Population as the form of the species existence and its main criteria

Questions:

1. Population is an elementary unit of species. Main criteria of the population.
2. What new properties does the population acquire as a group association?
3. Statistic characteristics of the population (the number, the density, the sex and age structure).
4. Dynamic characteristics of the population (the birth rate, the mortality, survival, growth of population level).
5. Regulation of the population level in nature.

Logical problems:

1. How many ooblastemae of one female do have to survive on average in order to have the constant population level
2. The sex ratio in the population of some species of animals may deviate from 1:1 significantly. What is the reason of such deviations?
3. If the population responds to its own high density by the decline in the birth rate, then why is excessive propagation of parasites possible in fields and orchards?

When preparing the subject of the present seminar students should pay attention to the fact that the population as a group association has a larger tolerance than the tolerance of a separate organism. This property enables the species to survive in various conditions and adapt to them that is very important for solving practical questions related to restoration of the number of organisms.

Seminar form: Test and verbal questioning, solving logical problems.

Recommended literature:

1. V.I. Yliyn. Ecology, M., Perspectiva, 2007.
2. Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006
3. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007.

Seminar 6.

Ecosystem, its structure and functional organization

Questions:

1. Abiotic and biotic complexes of ecosystem.
2. The concept of ecosystem and biogeocenose.
3. Classification of ecosystems. Main types of bioms of the Earth. Give examples.
4. Relations of organisms in the community. Examples of main types of relations.
5. The trophic structure of community.
6. Energy flow and cycle of substances in ecosystems (law of 1% and 10% energy)
7. Food chains and its types (detritus and pasture).
8. Ecosystem productivity, types of productivity.
9. Ecological pyramids and its types.
10. Dynamics of ecosystems: ecological successions and its types. Examples.

To understand the subject students should pay attention to the fact that in order to maintain the ecosystem in a stable equilibrium it must include all representatives of trophic levels. It will enable trophic levels to exchange the substance and its energy as per laws of 1 and 10% energy. In this respect biological diversity of organisms in each trophic level will play a large role. The energy flow is linear; it always decreases with each trophic level. The residues of energy transform into heat energy and are not used repeatedly. The cycle of substances is always closed. It is caused by a different character of nutrition of living organisms. The stability of ecosystem will also depend on external ecological factors. It is of large practical significance to

understand these issues for developing environmental actions with the aim of maintaining the ecosystems' stability.

Seminar form: Test and verbal questioning.

Recommended literature:

1. Y.V. Novikov. *Ecology, the Environment and a Human being*. M., FAIR-PRESS, 2003.
2. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006
3. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007.
4. T.A. Akimova, V.V. Khaskin. Ecology. A Human being – Economy – Biota – Habitat., M.: YUNITI, 1998

Seminar 7.
The structure of biosphere and its boundaries

Questions:

1. The concept of biosphere, its boundaries, its specific properties.
2. The essence of the Doctrine of V.I. Vernadskiy about biosphere.
3. The role and functions of a living substance in the biosphere.
4. Main cycles of substances in the biosphere.
5. Main differences of a large cycle (geological) from a small one (biological).
6. The concept of noosphere. Main features of the noosphere.

Logical problem:

To analyze the extent of meeting the conditions necessary for formation and existence of the noosphere in contemporary world and give your conclusion whether the transformation of biosphere into noosphere may be considered complete or incomplete. Justify your answer.

When studying this subject students should compare the biosphere of the Earth with spheres of other planets. It will help to understand the role of the living substance and the role of the human being in the biosphere.

Seminar form: Test and verbal questioning, solving the logical problem.

Recommended literature:

1. V.I. Vernadskiy. *Philosophic Thoughts of a Natural Scientist*, M., Nauka, 1988.
2. V.I. Vernadskiy. *Living Matter*, M., Nauka, 1969.
3. A.M. Nikanorov, T.A. Khorunzhaya. *Global Ecology*. M., CJSC, Kniga service, 2003.
4. Y.V. Novikov. *Ecology, the Environment and a Human being*. M., FAIR-PRESS, 2003.
5. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006.8
6. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007

Seminar 8.

A pivotal role of the Doctrine of V.I. Vernadskiy about noosphere in developing the concept of sustainable development

Questions:

1. Key provisions of V.I. Vernadskiy's concept of noosphere.
2. Main strategies and principles of sustainable development.
3. What is the essence of the triune concept of sustainable development?
4. Main models of sustainable development.

When studying this subject students should analyze the Report of the Conference in Rio de Janeiro, 1992. *An Agenda for the 21st Century*, which states main concepts, trends and principles of sustainable development. It will help to understand the triune concept of sustainable development.

Seminar form: verbal questioning.

Recommended literature:

1. V.I. Vernadskiy. *Philosophic Thoughts of a Natural Scientist*, M., Nauka, 1988.
2. V.I. Vernadskiy. *Living Matter*, M., Nauka, 1969.
3. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006.
4. N.N. Marfenin. *The Concept of Sustainable Development* / Russia in the Environment: 2002 (Analytical annual) // under the general editorship of V.I. Danilova-Daniyan, S.A. Stepanov. - M.:Publishing House MNEPU, 2002.
5. Charter *Sustainable Cities & Towns (Cities of Europe on the Path towards Sustainable Development)* (Aalborg Charter, Denmark, 1994)
6. The report of the UN conference on the environment and sustainable development, Rio de Janeiro, 1992. Volume 1, New York, 1993.

Seminar 9.

The Problem of Providing the Human Society with Natural Resources

Questions:

1. The concept of natural resources, their classification and characteristics
2. Modern ecological state of land, water, biological and energy resources
3. Use of alternative ecologically pure sources of energy as a component of sustainable development of ecosystems and society
4. What is your opinion regarding the possibility to use alternative sources of energy efficiently in Kazakhstan?
5. When studying the present subject students should pay attention to a contemporary state of all natural resources. It will help to understand the reason of taking urgent measures

and actions for rational management of natural resources and using non-waste and low-waste technologies and also alternative sources of energy.

Seminar form: verbal questioning and in writing .

Recommended literature:

1. T.A. Akimova, V.V. Khaskin. Ecology. A Human being – Economy – Biota – Habitat., M.: YUNITI, 2007.
2. Y.V. Novikov. *Ecology, the Environment and a Human being*. M., FAIR-PRESS, 2003.
3. A.M. Nikanorov, T.A. Khorunzhaya. *Global Ecology*. M., CJSC, Kniga service, 2003.
4. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007.
5. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006.

Seminar 10.

The Quality of Natural Environment and Health of Population

Questions

1. The concept of quality of the natural environment and its sanitary and hygienic indicators.
2. Health and factors of risk
3. Relationships of unfavourable factors of the environment and diseases of people.
4. Degradation of mankind's gene pool.
5. Pernicious habits and habitat.
6. Healthy lifestyle as the basis for sustainable development of society.

Logical problems:

1. AIDS and drug addiction are spreading in the world at a larger pace that the growth of population. Is there any

relation between them? Are they a threat to the mankind's gene pool and development of future civilization?

2. If you are a heavy smoker you are requested to analyze the handout very carefully. Assess a relative risk of carcinoma of lung, cancer of laryngeal and ischemia of heart. May it is better to give up smoking?

To study this subject a student should pay attention to the criteria of the environment's quality and indicators of health. It will help him to understand the damage and hazard caused to health by his behavior, pernicious habits, and later wasting lot of force, energy and money to mitigate and eliminate the obtained harm. A healthy lifestyle provides a person with physical, mental and social well-being in a real environment. The health of society is formed of the health of its citizens. This is why at present it is of great significance to adhere to a healthy lifestyle and strive for improving the quality of the natural environment.

Seminar form: Test and verbal questioning, solution of logical problems.

Recommended literature:

1. V.V. Denissov. I.N. Lozanovskaya, I.A. Luganskaya et el *Ecology*. Rostov-on-Don: MarT, 2002.
2. T.A. Akimova, V.V. Khaskin. Ecology. A Human being – Economy – Biota – Habitat., M.: YUNITI, 2007.
3. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006

Seminar 11.

International Conventions and Treaties on Global Ecological Problems of Nowadays

Questions:

1. Main principles of international cooperation in the area of ecology.
2. The strategy of the UN in solving global ecological problems.

3. International cooperation and national interests of the Republic of Kazakhstan in the sphere of ecology.
4. Change of the world outlook and strategy is one of conditions for sustainable development.

Assimilation of the present subject is to be started from analyzing international conventions (the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer, the United Nations Framework Convention on Climate Change and Kyoto Protocol to the Convention, Convention on Biological Diversity, Convention to Combat Desertification and others). It will help to understand the reason of Kazakhstan strengthening international cooperation in the sphere of ecology and taking urgent actions and measures to ensure environmental safety.

Seminar form: Test and verbal questioning.

Recommended literature:

1. A.M. Nikanorov, T.A. Khorunzhaya. *Global Ecology*. M., CJSC, Kniga service, 2003.
2. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007.
3. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006.
4. United Nations Framework Convention on Climate Change, 1992.
5. Kyoto Protocol, 1993, 1997.
6. Convention on Biological Diversity. 1992.

Seminar 12.
Reserves on the territory of the Republic of Kazakhstan

Questions:

1. Strategy of establishing protected areas, their purposes and objectives.

2. The concepts of reserve, wildlife sanctuaries, national park, biosphere reservations, biosphere reserves, natural monuments and their peculiar features
3. Give examples of protected areas on the territory of the Republic of Kazakhstan.
4. Give a brief characteristic and history of establishing the Almaty Reserve and the Aksu Zhabagly Nature Reserve.
5. Which reserve has obtained the international status of UNESCO and why?

When preparing the subject it is necessary to review such concepts as the endemic species, relict, rare species, and endangered species. It will help students to understand issues of preservation of biodiversity and the role of protected areas. The reserves are to be characterized in the following succession:

1. The aim and year of establishing the reserve
2. The location of the reserve
3. What endemic species, relict, rare species, and endangered species of plants and animals are there on the territory of the reserve?

Seminar form: verbal questioning.

Recommended literature:

1. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007.
2. S.Z. Kolumbaeva, R.M. Bildebaeva. General Ecology. Almaty. Kazakh universiteti, 2006.
3. Environmental Code of the Republic of Kazakhstan. Astana 2007.

Seminar 13.

Human Development and Millennium Development Goals

Questions:

1. The concept of human development, its main aspects
2. Human development and millennium development goals

3. National goals of millennium development of Kazakhstan
4. Economic growth and its relationship with human development
5. The problem of employment of able-bodied population in the context of human development.
6. Influence of globalization on human development.

It is necessary to review this subject starting from analysis of the United Nations Millennium Declaration (New York, 2000) which developed a set of general tasks known as the Millennium Development Goals at the dawn of a new millennium and also provided main concepts and definitions of human development. National goals of millennium development were developed on the basis of this Declaration. The Declaration will help students to look into issues of the seminar and understand the role of human development in sustainable development.

Seminar form: verbal questioning.

Recommended literature:

1. Y. Shokamanov, A. Makazhanova et al. *Human Development in Kazakhstan*. UNDP Kazakhstan. Chrestomathy. Almaty: S-Print. 2006
2. Y. Shokamanov, A. Makazhanova et al. *Human Development in Kazakhstan*. UNDP Kazakhstan. Workshop. Almaty: S-Print. 2006
3. The United Nations Millennium Declaration New York, 2000.

2.2 Methodological Recommendations for Independent Work under the Supervision of Teacher

The objective of the independent work under the supervision of teacher is to obtain a consultative aid for the course *Ecology and Sustainable Development*. The teacher provides consultative aid to the students who have been unable to understand and master some or other aspects of the discipline. Students are also provided with the consultative aid when they prepare for workshops, select the subject, and write independently their works. The students must attend the sessions of independent work under the supervision

of teacher as per the schedule of the Dean's office. During the semester 8 sessions of independent work under the supervision of teacher are to be held.

Assignment 1. **Adaptability of organisms to environmental factors**

Assignment form: Discussion.

Questions:

1. Light as an ecological factor. The concept of photoperiodism.
2. Temperature as an ecological factor.
3. Water as an ecological factor.

Methodological recommendations for performance: to analyze the role of the stated above ecological factors by providing concrete examples.

Literature:

1. A.O. Tarassov. *Ecology and Nature Conservation*. Saratov, 1990.
2. V.A. Radkevich. Ecology. Minsk: Visheisha shkola, 1997.
3. Ecology. Under the editorship of V.V. Denissov Rostov-on-Don: MarT, 2002.
4. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006.
5. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007.

Assignment 2. **Population Level Regulating Mechanisms**

Assignment form: Discussion.

Questions:

1. Physiological mechanisms of regulation
2. Migration as a factor of regulation
3. Competition and predation as factors of regulation

Methodological recommendations: to analyze periodic and nonperiodic irruption of the population level by providing concrete examples.

Literature:

1. A.O. Tarassov. *Ecology and Nature Conservation*. Saratov, 1990.
2. V.A. Radkevich. Ecology. Minsk: Visheisha shkola, 1997.
3. Ecology. Under the editorship of V.V. Denissov Rostov-on-Don: MarT, 2002.
4. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006.
5. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007.

Assignment 3. **Energy Flow and Cycle of Substances in Ecosystem**

Assignment form: Discussion.

Questions:

1. Autotrophic and heterotrophic components of the ecosystem
2. Operation of laws of thermodynamics in ecosystems
3. The role of living organisms to maintain a continuous cycle of substances in the ecosystem

Methodological recommendations for performance: to develop the diagram of linear energy flow and cycle of substances in various land and water ecosystems.

1. A.O. Tarassov. *Ecology and Nature Conservation*. Saratov, 1990.
2. V.A. Radkevich. Ecology. Minsk: Visheisha shkola, 1997.
3. Ecology. Under the editorship of V.V. Denissov Rostov-on-Don: MarT, 2002.
4. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006.
5. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007.

Assignment 4. **Evolution of Biosphere**

Assignment form: Discussion.

Questions:

1. The role of living organisms in changing physical and chemical parameters of atmosphere, lithosphere and hydrosphere
2. Contemporary theories of the origin of life
3. Mechanisms for stability of the biosphere

Methodological recommendations: To compare a scheme of original and contemporary biosphere

Literature:

1. A.O. Tarassov. *Ecology and Nature Conservation*. Saratov, 1990.
2. V.A. Radkevich. Ecology. Minsk: Visheisha shkola, 1997.
3. Ecology. Under the editorship of V.V. Denissov Rostov-on-Don: MarT, 2002.
4. S.Z. Kolumbaeva, R.M. Bildebaeva. *General Ecology*. Almaty. Kazakh universiteti, 2006.
5. A.B. Bigaliev, M.F. Khalilov, M.A. Sharipova. *The Basis of General Ecology* Almaty, Kazakh universiteti, 2007.

Assignment 5. **International organizations in the area of environment protection and sustainable development**

Assignment form: Discussion.

Questions:

1. International summits and initiatives of international organizations to ensure sustainable development of nature and society
2. The role of nongovernmental organizations in solving ecological

problems.
3. Examples of successful civil initiatives in issues of conservation of nature

Methodological recommendations: to analyze international documents in the area of environment protection (Kyoto Protocol, the work of the Club of Rome etc.)

Literature:

1. N.N. Marfenin. *The Concept of Sustainable Development* / Russia in the Environment: 2002 (Analytical annual) // under the general editorship of V.I. Danilova-Daniyan, S.A. Stepanov. - M.:Publishing House MNEPU, 2002.
2. Charter *Sustainable Cities & Towns (Cities of Europe on the Path towards Sustainable Development)* (Aalborg Charter, Denmark, 1994)
3. The report of the UN conference on the environment and sustainable development, Rio de Janeiro, 1992. Volume 1, New York, 1993.
4. Y. Shokamanov, A. Makazhanova et al. *Human Development in Kazakhstan*. UNDP Kazakhstan. Chrestomathy. Almaty: S-Print. 2006
5. Y. Shokamanov, A. Makazhanova et al. *Human Development in Kazakhstan*. UNDP Kazakhstan. Workshop. Almaty: S-Print. 2006
6. The United Nations Millennium Declaration New York, 2000

Assignment 6. **Ecological aspects of sustainable human development in the RoK**

Objective: to analyze *Strategy Ecology and Natural - 2030*

Assignment form: Discussion.

Questions:

1. Human development and the Millennium Development Goals
2. The National environment action plan for sustainable development of the Republic of Kazakhstan
3. Ecological policy of the Republic of Kazakhstan

Methodological recommendations: to compare a contemporary level of development of developing and developed countries, analyze objectives, aims, indicators of the Millennium Declaration

Literature:

1. N.N. Marfenin. *The Concept of Sustainable Development* / Russia in the Environment: 2002 (Analytical annual) // under the general editorship of V.I. Danilova-Daniyan, S.A. Stepanov. - M.:Publishing House MNEPU, 2002.
2. Charter *Sustainable Cities & Towns (Cities of Europe on the Path towards Sustainable Development)* (Aalborg Charter, Denmark, 1994)
3. The report of the UN conference on the environment and sustainable development, Rio de Janeiro, 1992. Volume 1, New York, 1993.
4. Y. Shokamanov, A. Makazhanova et al. *Human Development in Kazakhstan*. UNDP Kazakhstan. Chrestomathy. Almaty: S-Print. 2006
5. Y. Shokamanov, A. Makazhanova et al. *Human Development in Kazakhstan*. UNDP Kazakhstan. Workshop. Almaty: S-Print. 2006
6. The United Nations Millennium Declaration New York, 2000

2.3 Methodological instructions for doing individual work

To do the task you should read the recommended literature. In addition you should select books and publications related to the selected subject. You should build a scheme given in the task, and while reading you should make notes, stating the most interesting ideas, ways of their performance, positive and negative issues etc. Please note that your report should include all main blocks being parts of the task.

Introduction

The methodological recommendations include the list of

recommended literature, tasks for independent work, and recommendations for performance. The methodological recommendations are developed to be used by students and teachers.

The objective of studying the present course is to increase professional competence of students in the theory of ecological education and develop the ability to apply the knowledge in a flexible, creative manner in practice.

Main tasks are as follows: students review new technologies, concepts of educating ecological culture, broadening knowledge of nature, developing students' skills to analyze various approaches, views of ecological knowledge and conditions of sustainable development, forming the students' ability and capacity to establish conditions for succession in a continuous ecological education system.

The developed topics of independent work provide for to study both theoretical and practical issues of ecological education system. Studying each subject a student must think of the plan of answers to each question connecting theoretical principles with skills acquired at practical sessions.

The objective of independent work is to develop the ability to analyze, compare and generalize the material on ecology and sustainable development.

Assignment 1. **The relation of ecology with other sciences**

Prepare a basic scheme including the stated sciences (chemistry, mathematics, physics, geography, biology, any humanitarian science) and examples of laws, calculations, methods from the stated above sciences used in ecology. You may compare an alternative variant, i.e. to provide examples of using ecological laws, rules, knowledge in natural and humanitarian sciences.

The objective of the task is to justify the situation of ecology being a synthetical science at the current stage, and that its scientific data are used in other areas of knowledge.

The independent work is made in the work-book as a scheme or table, the number of pages is not to be more than 1 page.

You may find materials to prepare this task in any text book on ecology in the first chapters on history of development and social value of ecology.

Assignment 2. **Influence of ecological factors on the life of organisms**

It is better to start the task with exploring the concept of the ecological factor: to write down the definition, give examples.

To understand the tolerance limits, ecological optimum, minimum and maximum it is desirable to draw a diagram of influence of the selected ecological factor on certain species. For example, let's review the influence of watering on the growth of a houseplant – a spiderwort. We shall show watering in ml on the horizontal axis, and the growth of stem on the axis of ordinates for each 3 days. In our example the watering is an ecological factor, and we shall determine the optimum, minimum and maximum of this factor by the reaction of a living organism, in our case it is a spiderwort. It is necessary to indicate the optimum, zones of inhibition, minimum and maximum.

The objective of task is to understand the meaning of the term tolerance of the organism, species and learn to calculate the range of tolerance.

Assignment 3. **Group characteristics of the population. The types of relations between organisms**

First of all, write down the definition of the population which may be found either in the glossary Syllabus or in the text book. Give examples of the population. Then describe group characteristics of the population which are used in ecology: statistic and dynamic characteristics with examples. Knowledge of populations may be used in practice in regulating their number. You may give alternative examples on the decrease and increase of the number of populations by species performed by the people.

Populations of various species come across, live on one territory, and have relations. In the course of evolution a diversity of biotic relationships

have arisen: symbiotic, a predator-prey, host-parasite relationships, competitive, neutral, amensalism, and commensalism etc. To reveal differences among them it is proposed to fill out the table:

No	Biotic relationships	Definition, meaning	Example from nature	Denotation with (0,-, +. 0 means neutral relation
1	Prey-predator	Specimens of one species kill specimens of other species for survival	Leopard hunts for gazelle	+ - , as leopard gets benefit, and gazelle does not

The objective of task is to understand the concept of the population, the meaning of its quantitative indicators and review diversity of biotic relations.

Assignment 4. **The flow of energy and the cycle of substances**

Explain the concept of energy and substance, give examples. Draw one of cycles: carbon, water, nitrogen, sulphur, oxygen or energy. Write the names of levels of the given cycle: large (geological), or you choose a small cycle (biotic) or mixed (biochemical).

Give the meaning of the food chain, draw an example, and depict an ecological pyramid stating trophic levels and their representatives directly on the pyramid. Write down the ecosystem productivity and maybe the diagram of types of productivity: primary (gross and net) and secondary.

The objective of task is to understand the expediency of cycles for maintaining energy and substance for inconvertible long time.

Assignment 5. **The integrity and stability of ecosystems**

It is necessary to write the definition of the ecosystem, provide examples of various ecosystems, justify their openness and interrelation, and give the concept of the integrity.

To give the definition of homeostatis and ecological succession and time of their passing and give examples.

The objective of task is to show a dynamic interrelation of ecosystems.

Assignment 6. **Functions of a living substance of the biosphere**

To write the definition of a living substance according to N.I. Vernadskiy. To draw a table listing functions of a living substance with examples.

Function	Definition and example
Energy	Accumulation and transformation of energy, for example, solar energy is transformed into chemical and etc. energy by means of photosynthesis

To emphasize a planetary role of the living substance.

The objective of task is to understand the significance of the living substance for the Earth and Universe.

Assignment 7. **The problem of natural resources supply**

The subject is intended for discussion. While preparing it is necessary to brush up the concept of natural resources and their types, find statistical data of extraction and production of some of these resources; think over prospects and propose the way out of this situation. We propose one way out of the situation which is to develop and introduce low-waste and non-waste technologies. You may try to develop such technology on your own.

The objective of task is to attract attention of the audience and society to the problem of depletion and loss of a number of natural resources, the need to take urgent actions in these activities.

Assignment 8. **Ecological problems of Kazakhstan**

Choose for yourself one or two ecological problems of Kazakhstan, find statistical proof and develop your own plan of solving one or other problems and present for discussion at the lesson. The information is to be exact and short for 5-7 minutes. Explain the reason of choosing this problem, what is your personal attitude to the present fact? Think over and tell your position, may you help to solve ecological problems in person? If yes, then how may you help?

The objective of task is to identify reasons and consequences of destabilization of the natural environment in Kazakhstan.

Assignment 9. **The human being and the environment**

Prepare a short report on any demographic situation and problem of depopulation in human society on a level of the planet, your region, province, city etc).

Try to determine the present and future of the population described by you. Answer the question: will the increase in population lead to crisis? Describe crisis of land and energy resources.

The objective of task is to develop a critical, positive approach to the analysis of relationships between the society and nature.

Assignment 10. **Ecological basis of nature management**

Preparing to discussion it is necessary to brush up the concept of ecological contaminants, their classification, and the concept of regulating contaminants in the environment, environmental monitoring, and expert

examination. It is desirable to find an example of economic encouragement of environmental protection, for example, by granting licenses for volume of released pollutants to enterprises.

The objective of task is to develop active social position of students in nature protection.

Assignment 11. **The stages of biological evolution of the Earth**

It is proposed to students to draw a table as follows:

Age	List of periods	Duration, billion years	Main events in fauna	Main events in flora
Archaean				

It is desirable to fill out the table starting with the most ancient age and completing with a modern one. If events cannot be classified as fauna or flora, then they may be described in two last columns of the table, for example, the emergence of unicellular eukaryotes, and provide an example of the unicellular animal and plant. It is necessary to name the table and explain the concept of biological evolution.

One may find materials in all text books on biology and many text books on ecology.

The objective of task is to compare rates of evolution in different ages and its productivity.

Subjects of written works

Subjects of papers

1. The role of nature in formation and development of human society
2. History of ecological knowledge development
3. Natural resources and rational nature management

4. Global contamination of the environment (social, economic and ecological consequences)
5. Nature protection in different countries and the role of international cooperation
6. Increase in production and load on environment
7. Natural resources of the Earth (the lithosphere, hydrosphere, and atmosphere) and their use of the human being
8. Economic resources of forest
9. Water resources of Kazakhstan (the current state – scarcity of fresh water resources, pollution of water bodies, damage from contamination etc.)
10. Atmosphere and its pollution
11. Subsoil of the Earth and reserves of mineral products in different countries
12. Planning and management in the area of nature management
13. Economic incentives for nature protection and rational nature management
14. Urbanization and its influence on the environment
15. Environmental safety
16. The Doctrine of V.I. Vernadskiy about biosphere and noosphere
17. Modeling in ecology. Works of the Club of Rome.
18. Ecological organizations, parties and ecological movement
19. The UN international conference on the environment in Stockholm (Sweden), Rio de Janeiro, Johannesburg and their decisions
20. Ecological problems of the Republic of Kazakhstan
21. The ecological state of territories in East Kazakhstan
22. The ecological state of territories in West Kazakhstan
23. Ecological problems of Yly-Balkhash basis
24. Crisis of the Aral Sea: causes and consequences
25. Genetic consequences of the environment pollution
26. Scientific and technical progress and pollution of the environment
27. Ecological monitoring and organizing and exercising control over the state of the environment
28. Ecological consequences of the operation of Semipalatinsk nuclear site
29. Ecological problems of the Caspian Sea
30. Ecological present and future state of Kazakhstan
31. The concept of sustainable development of society and the environment
32. Protected areas as one of forms of environment protection
33. Red Book

34. Demographic aspects of the ecological problem
35. Environmental risk and methods of ensuring environmental safety
36. Prospects of social development and ecological revolution
37. Ecology and economy: contradictions and unity
38. Ecology and health
39. Ecological disasters and their causes
40. Military and industrial complex and environmental safety
41. Sustainable development of the world community. The model of sustainable society, its features and principles of operation.

You should advise your teacher of your selection in advance. You may do one task that is to contain the following sections:

1. Ecological problems of the selected area or simply the problem
2. Factors establishing the current ecological situation in the region being of interest to you.
3. The opportunities to solve the ecological problems stated in p.1.
4. Conclusion (your opinion regarding the established situation and prospects to improve the ecological situation in the region, forecast and consequences).
5. References to literature.

The number of pages of the paper must be not more than 10 pages of a typed or handwritten text.

The project may vary with respect to the structure of tasks and its headings. The presentation in Power Point in addition to the paper would be appreciated. The material only from the Internet will not be accepted. The presentation in Power Point may contain not more than 12 slides. The task is developed using not less than 5 sources of data (periodicals, books, and newspapers). Provide the list of used sources. If using the Internet, you are requested to give URL to the source and the date of getting information from the Internet.

The Literature for doing independent work

Main:

1. A.O. Tarassov. *Ecology and Nature Conservation*. Saratov, 1990.
2. I.A Shilov. *Ecology*. M.: Higher School, 2001.
3. V.A. Radkevich. *Ecology*. Minsk: Visshaya shkola, 1997.
4. G.V. Stadnitskiy, A.I. Rodionov. *Ecology*. St. Petersburg: Khemia, 1996.
5. *Ecology*. Under the editorship of V.V. Denissov Rostov-on-Don: MarT, 2002.

Additional:

1. T.A. Akimova, V.V. Khaskin. *Ecology* —M.: Printing house YUNITI, 1998.
2. G.M. Andersen. Ecology and environment sciences. The Biosphere, the Ecosystem, the Human Being. L., 1985.
3. E.A. Arustamov, I.V. Levakova, N.V. Barkalova. *Ecological Basis of Nature Management*. M.: 2001.
4. A.S. Beissenova, Z.B. Shildebaev, G.Z. Sautbaev. *Ecology*. Almaty: Gilim, 2001.
5. V.D. Valova. *The Basis of Ecology*. M.: Dashkov and Co., 2001.
6. A.M. Vladimirova, Y.I. Lyakhin, L.T. Matveev, V.G. Orlov. *Enviroment Protection. L. Gidrometeoizdat*, 1991.
7. E.V. Girussov. *Ecology and Economy of Nature Management*. M.: Statute and Law, YUNITI, 1998.
8. A.A. Gorelov. *Ecology*. Course of lectures —Moscow. Centre, 1997.
9. P. Camp, K.Arms *Introduction to Biology*. M., Mir, 1988.
10. V.A. Krassilov. *Nature Protection: Principles, Problems, Priorities*. M., 1992.
11. B.M. Mirkin, L.G. Naumova. *Popular ecological dictionary* / Under the editorship of A.M. Gilyarov. M.: Ustoichivy mir, 1999.
12. A.M. Nikanorov, T.A. Khorunzhaya. *Global Ecology*. M., CJSC, Kniga service, 2003.
13. N.F. Reimers. *Nature Management*. M.: Mysl, 1990.
14. S. Rozanov. *General Ecology*. S-P-M-Krasnodar: Lan, 2003.
15. L.N. Semenova. *Sustainable Development*. School book. Almaty: Fund 21st century, 1997.

16. A.V. Chigarkin. *Geoecology of Kazakhstan*. Almaty: Sanat, 1995.
17. *The Environment and Sustainable Development in Kazakhstan*. Publications of UNDP Kazakhstan. Almaty, No UNDPKAZ 06, 2004

TESTS

1. The term ecology (from Greek "study of") is the science studying:

A) The structure of living organisms;
B) Inheritance and variation of organisms;

C) Economy of nature;
D) The origin of living organisms;
E) House, habitation.

2. This interrelation between populations, such as "parasitism" is defined by the following combination of signs.

A) «- -»;
B) «+ +»;
C) «+ -»;
D) «+ 0»;
E) «- 0».

3. The observation and data collection about ecological situations on the planet is called:

A) global monitoring
B) chemical monitoring
C) physical monitoring
D) biological monitoring
E) sociological monitoring

4. One of the objectives of ecology is the study of:

A) diversity of fauna;
B) molecular organization of living organisms;
C) peculiarities of biochemical processes in the cells of various tissues;
D) display of physical laws in living organisms;
E) organization of constant observation (monitoring) of conditions of natural environment.

5. The reasons of origins of ecological problems:

A) violation of dynamic balance in the nature;
B) condition of the use of natural resources;
C) inability of a man to conduct a purposeful economical activity, which is defined by the prior up-brining and education;
D) critical state of interaction of society and nature;
E) direct or indirect destruction of various kinds of biosphere.

6. The concept "ecosystem" is:

A) sequential change of biocoenosis, which successively appear on

the same territory in the result of influence of natural and anthropogenic factors;

B) sphere of "constantly working biological rotation in biosphere, the whole set of substances, the whole set of forms of energy, continuously circulating in this big cycle" (A.V. Timofeyev-Resovskiy);

C) group of species of one type, which are in the state of interaction; living in one common territory and producing generations;

D) system of jointly inhabiting species of various types and conditions of their existence, which are in regular interrelation with each other;

E) combination of natural and social systems of the planet Earth.

7. The concept "noosphere" is:

A) unification of people based on the features, related to the life in community (industrial, cultural, religious)

B) field of circumplanetary space, physical properties of which are defined by the magnetic pole of Earth and its interaction with stream of charged particles of cosmic origin;

C) historically structured steady unification of people on the definite territory, possessing common features in culture, language, mentality;

D) the highest stage of development of biosphere, related with the appearance and formation of civilized society in it, when the rational function becomes main defining factor.

8. Section of ecology "autoecology" studies:

A) patterns of self-regulation of biological systems;

B) patterns of adaptation of individual organisms at the environ

C) dynamics of natural populations;

D) the role of predators in regulation of population size of the victim;

E) productivity of ecosystems.

9. Synecology studies:

A) respiration intensity of the plant organism;

B) adaptive properties of the organism in different climatic conditions;

C) lifespan of the organism;

D) the rate of growth of the organism;

E) changes in species composition of the community over time.

10. Demecology studies:

A) chemical composition of emissions from heavy industry;
B) oil and gas processing plant emissions influence on population size of sparrows that live in the area;
C) impact of wastewater on the species composition of aquatic hydrocole rivers;
D) influence of the chemical components of wastewater on the metabolism of zooplankton;
E) the effect of various components of wastewater on the heredity of water of organisms.

11. The greatest amount of emissions in enterprises of iron and steel are carried out in the manufacturing process of:

A) pellets;
B) domain;
C) steelmaking;
D) chemical-recovery;
E) Rolled.

12. What is the "sanitary security zone"?

A) zone within which the organized protection of air cleanliness;
B) territory within which the company arranges the disposal of radioactive waste;
C) the area between the residential buildings and boundaries of the industrial site, warehouse. Indoor and outdoor storage of materials and reagents, rural enterprises economy from the perspective of their
D) Zone creating architectural and aesthetic barrier between the industrial and housing areas;
E)Additional landscaping around the area of industrial or agricultural enterprise in order to enhance assimilation and filtering air pollutants.

13. The resource of chemical pollution of the environment:

A) thermokarst;
B) underground utilities;
C) heating;
D) communication teams and collectors;
E) aerosols

14. To the biological pollution of the environment belongs: crows, mice,pigeons);

A) excessive expansion of commensal animals in urban areas (rats,
B) pesticides;
C) detergents;
D) solifluction;
E) aerosols.

15. Physical pollution is associated with:

A) penetration into the environment of heavy metal compounds;
B) phenomenon of genetic engineering;
C) electromagnetic radiation;
D) production of plastics;
E) production of antibiotics.

16. Oil pollution - is:

A) accident tanker fleet;
B) oil film;
C) supply of petroleum products in sea water;
D) concentration of oil in sea water;
E)Oil production on the shelf.

17. The main sources of radioactive contamination of the oceans are as follows:

A) untreated industrial water;
B) rainwater from urban areas;
C) atmospheric transport from the continents;
D) contamination of radioactive waste, accidents, ships with nuclear reactors, disposal of radioactive waste;
E) radioactive fallout.

18. The country with the highest number of operating nuclear power plants and the maximum of their shares in total world electricity generation:

A) Canada;
B) Germany;
C) South Korea;
D) United States;
E).France.

19. The predominant types of pollution of aquatic ecosystems mining and coal industry are:

A) flotation reagents, mineral suspended solids, phenols;
B) petroleum products, organic dyes;
C) organic matter, ammonia nitrogen;
D) sulfates, aromatic hydrocarbons;
E) benzo (a) pyrene.

20.Contaminants supplied to the environment by enterprises of the agricultural cycle:

A) heavy metals;
B) organophosphate pesticides;
C) sulfur compounds;
D) domestic waste water;
E) petroleum products.

21. The living matter of the biosphere is associated with:

A) orogenesis processes;
B) continuous cycling of matter in the ecosystem;
C) volcanic activity of Earth;
D) sunami;
E) solar activity.

22. Features of the current level of interaction between nature and society?

A) the struggle for existence;
B) systematic relationship with the environment;
C) the impact of the social nature of man, in the process, above all, work on the biosphere;
D) a complex impact on the biosphere, human, cosmic, geophysical, etc. impacts;
E) a qualitatively new state in the evolution of the planet, where the processes and phenomena of the biosphere are sent to the human intellect.

23. The concept of ecology:

A) science that studies the set of co-inhabiting species of organisms and their conditions of existence, are in a regular relationship with one another;
B) science that studies the conditions of existence, a species in

interaction with the environment;
C) science that studies the conditions for the existence of living organisms and the relationship between organisms and the environment;
D) science that studies the conditions for the existence of individuals and organisms;
E) science that studies the biogenic and abiogenous components epgeosphere of the Earth.

24. Under the community know:

A) collection of individuals who have a direct similarity of morphological, physiological and biochemical characteristics;
B) the set of freely interbreeding individuals of one species, long-existing within the same range;
C) the totality of living organisms from different species that live in the existing within the same range; existing within the same range;
D) relationships of one kind to the environment;
E) interaction of organisms with the animate and inanimate nature.

25. Object of study in ecology:

A) living organisms;
B) objects animate and inanimate nature;
C) Biosphere;
D) results of human activity;
E) integrated and comprehensive state of the interaction between society and the environment and the possible effects of anthropogenic impacts on the biosphere

26. Such a relationship between populations, as "mutualism," is marked by signs:

A). "- -";
B). "+ +";
C) «+ -»;
D). "+ 0";
E). '- 0 ".

27. Functional classification of ecosystems based on:

A). type of vegetation;
B). zoogeographic zoning;
C). differentiation of the Earth's surface in natural areas;

D). diversity of climate;
E). Depending on the source, quantity and quality of the incoming energy.

28. Structural classification of ecosystems includes:

A). the scale of ecosystems;
B). structural features of the biosphere;
C). structure of the atmosphere;
D). natural vegetation and landscape features (land), geological and physical features (the ocean);
E) a variety of energy functions.

29. What are resources?

A). key components of the environment used to create the material and cultural needs of society;
B) a combination of natural factors positively affecting the spiritual wealth of the people;
C). real components of the biosphere that are used in agriculture as mineral or energy resources;
D). relatively stable state of flora and fauna in an ecosystem that occurs during the course of plant communities;
E). group of ecologically similar species belonging to the same trophic level.

30. The most common classification of human impact:

A) the degree of exposure;
B). the depth of exposure;
C). by type of economic activity;
D). at the time of exposure;
E). reversible and irreversible.

31. The Kyoto Protocol (1997) in respect of the acceding countries includes a commitment ...

A) reduce the production of private cars by 5% until 2025;
B) eliminate the use of chlorinated solvents in industry till 2010;
C) to reduce or stabilize emissions of hotbed gases relative to 1991 levels;
D) reduce emissions ozon demolition substances into the atmosphere by 50% by 2002

E) to reduce emissions of sulfur gases

32. The classic definition of "sustainable development" as "development that ensures the needs of present generations without compromising the ability of future generations to meet their needs," was first formulated in ...

A) report "Limits to Growth" (1975);
B) the report "Our Common Future" (1987);
C) Declaration of Rio de Janeiro Conference on Environment and Development (1992);
D) Declaration on Sustainable Development in Johannesburg (2002).

33. "Greenhouse Effect" and the destruction of the ozone layer affect ...

A) the economically developed countries;
B) Russia and the CIS;
C) The Europe and America;
D) All of the countries.
E) Countries of Central Asia

34. The warming of the earth is connected ...

A) with the ozone shield;
B) with the "greenhouse effect»;
C) with the appearance of smog;
D) with La Niña
E) with sulfur dioxide.

35. Convention for the Protection of the Ozone Layer was adopted ...

A), Vienna (1985);
B) New York (1997);
C) in Montreal (1987);
D) in Rio de Janeiro (1992)
E) in Prague

36. Where a protocol was signed, aimed at controlling the production and the use of chlorofluorocarbon?

A) in Montreal (1987);
B) in Rome (1996);
C), London (1972);
D) in Paris (1992).
E) in Prague

37. What is the year of signing the Kyoto Protocol to stabilize greenhouse gas emissions?

A) 1987;
B) 1997;
C) 1992;
D) 1985
E) 1983

38. Public environmental group Greenpeace organized ... Twentieth century.

A) in the 50s;
B) in the 60s;
C) in 70 years;
D) in 80 years
E) 90 years

39. That does not apply to three types of pollution?

A) chemical;
B) physical;
C) biological;
D) information.
E) methane

40. Acid rain - it's rain or snow, having a pH ...

A) less than 5,6;
B) of about 7;
C) is about 9;
D) greater than 11.
E) of about 8.

41. Interspecific competition in a community of living organisms is studied by:

A). global ecology;
B). autoecology;
C). demecology;
D). synecology;
E). Geoecology.

42. The relationship of the "predator-prey" in the community of living organisms is studied by:

A). global ecology;

B). autoecology;
C). demekologiya;
D). synecology;
E) 5. Geoecology.

43. Relationships "host - parasite" in the community of living organisms is studied by:

A). global ecology;
B). sinecology;
C). autoecology;
D). demecology;
E). Geoecology.

44. Competitive relationship between different types of community living organisms is studied by:

A). global ecology;
B). auotecology;
C). demecology;
D). synecology
E). Geoecology.

45 . Ecological niche – is:

A). habitat for certain species;
B). part of the habitat, which is used for a limited time for animals certain purposes (reproduction)
C). place the species in an ecosystem, defined by its biological potential and combination of environmental factors;
D). space used for feeding;
E). part of the ecosystem that is used especially for food and reproduction.

46. Producers - organisms that are at trophic level:

A). I;
B) II;
C). III;
D). IV;
E). V.

47. Xerophytes - plants that are adapted to environmental conditions in:

A). the aquatic environment;
B). ground-water environment;
C). in conditions of high humidity;
D). habitats with sufficient moisture;
E). drylands.

48. Autotrophic organisms are the ones, which are:

A). independently synthesize organic matter from inorganic compounds;
B). use ready-made organic substances in the process of life;
C). decompose dead organic matter;
D). feed on vegetable food;
E). eat food of animal origin.

49. The organisms that belong to heterotrophic organisms are:

A). chemosynthetic bacteria;
B). crustaceans;
C). multicellular algae;
D). coniferous trees;
E). Tigers.

50. Heterotrophic organisms in the process of life:

A). independently synthesize organic matter from inorganic using light energy (photosynthesis);
B). ready consume organic matter;
C). feed exclusively on inorganic compounds (CO2, H2O);
D). use only the thermal energy;
E). use only the electric energy

51. Toxic components of exhaust gas on a vehicle:

A). O_2;
B). N;
C). $C_{20}H_{12}$;
D)CO_2;
E). water vapor.

52. To global environmental problems include:

A). increase in park city vehicles;
B). roads in rural areas;

C). low fertility in human society;
D). desertification processes;
E). construction of nuclear power plants.

53. To global environmental problems include:

A). increase the oxygen content in the atmosphere;
B). volcanic eruptions;
C). increase the layer of humus in the soil;
D). reduction of pathogenic microorganisms;
E). the greenhouse effect.

54. What ocean polluter is more dangerous for the living organisms at this stage?

A). polyethylene;
B). nitrates;
C). oil;
D). debris;
E). waste production.

55. The bulk of carbon dioxide (CO?) Enters the atmosphere at the present stage as a result of:

A). volcanic eruptions;
B). forest fires;
C). oxidation of methane coming from the surface of the marsh;
D). combustion of all fuels fossils;
E). respiration of living organisms.

56. The global warming predicted by scientists is associated primarily with emissions to the environment:

A). carbon dioxide;
B). Freon;
C). dust;
D). sulfur compounds;
E). oxides of nitrogen.

57. The Kyoto protocol is an international protocol dedicated to reducing emissions;

A). Freon;
B). greenhouse gases;

C). heavy metals;
D). dust;
E). sulfur dioxide.

58. What type of energy is the most environmentally friendly?

A). thermal power plants;
B). hydropower;
C). nuclear power plants;
D). use of wind energy;
E). all of these sources of energy are equivalent.

59. The difference between cleaner production of ecological production is:

A). neutralization of the negative impacts of human activities;
B). creating Recreation Area;
C). formation of ecosystems;
D). adaptation of technologies to the existing biosphere conditions;
E) the planned production and reproduction of natural ingredients and conditions the environment.

60. Biotechnology - is:

A). drawing program to create the technical design;
B). way to obtain the necessary materials on the basis of purposeful change the genetic code of an organism;
C). introduction of information technologies in various spheres of human activity;
D). monitoring, evaluation and forecast of the biota;
E). achievement of technical goals in biological research.

61. In biocenosis plants serve as:

A). Consumers of the 1st order;
B). Decomposers;
C). Producers;
D). Consumers of order 2;
E). Feeders.

62. The role of producers in an aquatic ecosystem perform:

A). Phytoplankton;
B). Zooplankton;

C). Predatory fish;
D). Clams;
E). Waterfowl.

63. The role of consumers in an aquatic ecosystem perform:

A). Algae;
B). Predatory fish;
C). Filamentous algae;
D). Bacteria;
E). Flowering plants.

64. The role of decomposers in an aquatic ecosystem perform:

A). Algae;
B). Predatory fish;
C). Producers;
D). Micro-organisms;
E). Autotrophs.

65. Relationship between populations as a "symbiosis" is marked by s signs:

A). "- -";
B). "+ +";
C). "+ -";
D). "+ 0";
E). '- 0 ".

66. Destructive function of living matter of the biosphere is to:

A). Concentrations in the bodies of organisms of different chemical elements;
B). Synthesis of organic compounds from inorganic;
C). Decomposition of dead organic matter and mineral species;
D). Converting light into chemical energy;
E). increase in species diversity of flora.

67. Energy function of living matter of the biosphere is to:

A). Creation of the fertile soil of the earth;
B). Decomposition of dead organic matter;
C). Accumulation of solar energy in photosynthesis;
D). Increase in species diversity of wildlife;
E). Accumulation in the bodies of organisms of the atoms of substances which are scattered in nature.

68. Environment-forming function of living matter of the biosphere is to:

A). Ozone depletion;
B). Formation and acid precipitation;
C). Transformation of physico-chemical parameters of the environment;
D). Ensuring the processes of desertification;
E). Destruction

69. Functional classification of ecosystems based on:

A). Type of vegetation;
B). Zoogeographic zoning;
C). Differentiation of the Earth's surface in natural areas;
D). Diversity of climate;
E). Depending on the source, quantity and quality of the incoming energy

70. As a result of environment-forming functions of the living matter of the biosphere in the Earth's geographical sphere was an important event:

A). Changed the chemical composition of the primary water of the ocean and atmosphere;
B). Increased flow of solar energy;
C). Increase in the number of volcanoes;
D). Decreased the equatorial radius of the Earth;
E). Increased area of the oceans.

71. Chemical compounds that can cause malignant and benign tumors in the body, called the ...

A) Toxigenic;
B) Mutagens;
C) Blastomogenic
D) teratogens.
E) kontserogenami

72. World population in 2005 was ...

A) 3 mlrd.chel. ;
B) 4 billion people. ;
C) 6,5 billion. ;
D) 5,5 billion people
E) 6.mlrd. people ..

73. At the heart of environmental management and environmental protection are issues such as economic, health, aesthetic, educational and ...

A) Research;
B) Apocalyptic;
C) Scholastic;
D) Ambitious.
E) Classic

74. Use and protection of natural resources should be based on anticipation and prevention as possible negative effects of nature - this is called the rule ...

A) Conservation priority over its use;
B) Enhance the use;
C) Regionality;
D) Prediction.
E) Localization

75. Increase or decrease the use of a resource increases or reduce the use of another resource - it's a combination interests of economic entities.

A) neutral;
B) alternative;
C) competition;
D) mutually beneficial.
E) unfavorable

76. The elements of nature, necessary for a man of his livelihood and becoming involved in material production, they are called ...

A) Natural resources;
B) natural conditions;
C) The natural environment;
D) Consumer goods.
E) Environments

77. What natural resources are coal, oil and most of the other minerals?

A) exhaustible nonrenewable;
B) exhaustible renewable;
C) inexhaustible.
D) Renewable
E) non-renewable

78. Human activities are aimed at restoring the natural environment disturbed by human activities or natural processes, is ... action.

A) design;
B) stabilizing;
C) destructive.
D) concentration
E) energy

79. Geochemical processes caused by mining, technology, engineering and construction and agricultural activities of man, said ...

A) noogenesis;
B) urbanization;
C) ecocentrism;
D) technogenesis.
E) demographics

80. Ecological trouble, which is characterized by deep irreversible environmental changes and a significant deterioration in health, is called ...

A) environmental risk;
B) the environmental crisis;
C) an ecological catastrophe.
D) a social crisis
E) population explosion

81. Who coined the term "ecology"?

A). MV Lomonosov;
B). E. Haeckel;
D). Charles Darwin;
E). V.I.Vernadsky.

82. Who is the author of teaching about the biosphere?

A). MV Lomonosov,

B). Haeckel;
C). Charles Elton;
D). Charles Darwin;
E). VI Vernadsky

83. For the first time the term "ecosystem" was introduced by:
A). Tensli A.;
B). J. von Liebig;
C). Charles Darwin;
D). E. Haeckel;
E). V. Sukachev.

84. By the abiotic environment include:
A). community of living organisms desert ecosystems;
B). temperature and humidity of air;
C). composition of plant communities of tundra ecosystems;
D). phytoplankton aquatic ecosystems;
E). population of rabbits ecosystem forest. .

85. To the biotic factors of the environment belong:
A). water chemistry and temperature regime of the aquatic ecosystem;
B). population of birds of the steppe ecosystems;
C). climatic factors;
D). depth of the aquatic ecosystem;
E). humidity of air.

86. To such a relationship between populations, as "competition", denoted combination of characters is defined as:
A). "- -";
B). "+ +";
C). "+ -";
D). "+ 0";
E). '- 0 ".

87. Tolerance - is:
A) Optimal conditions for the flourishing of the organism;
B) reaction to the excess of any environmental factor;
C) minimum factors necessary for the existence of an organism;
D). the stability limits of organisms to fluctuations in environmental factors
E) reaction to the lack of any environmental factor.

88. According to the law, "tolerance" of V. Shelford organisms:

A). withstand any changes in environmental factors;
B). thrive in any changes to environmental factors;
C). die at any changes of environmental factors;
D). withstand changes in environmental factors within certain limits;
E). withstand only minimal changes of environmental factors.

89. The limiting factor is:

A). element of the environment, the presence of which causes the death of the body
B). Any environmental factor whose value is close to the upper or lower limit of endurance of the body;
C). environmental factor, whose value is close to the optimum for the species organisms;
D). element of the environment in which the presence of the organism flourishes;
E). environmental factor in the presence of the organism which has the greatest life expectancy.

90. Ecological succession – is:

A). sequence of communities which succeed each other;
B). simple substitution of more complex community rich in bio-d iversity;
C). stage of development;
D). replacement of climax ecosystems young (recheck cuz in Russian nothing is clear)
E). sequence of changes in species.

91. What is the role biologization production in solving environmental problems?

A). contributes to the harmonization of relations machinery with the environment;
B). determines the level of environmental pollution;
C). using specific methods and approaches;
D) has some impact on technology upgrades;
E) opens the possibility of controlling the cycles of the cycle of matter in nature protection biota of the Earth from xenobiotics.

92. Human ecology - the science that studies:

A). man's role in scientific and technological progress;
B). part of social ecology, which studies human interaction with the environment;
C). cooperation between society and nature;
D). physiological capabilities of man in different ecological situations;
E). human health under extreme conditions.

93. Ethnological and precipitating factors of human diseases:

A). change in mean daily air temperatures;
B). natural disasters;
C). environmental pollution;
D). emotional stress;
E). socio-economic situation.

94. The population explosion - is:

A). increase the population growth of the Earth;
B). increase in the population of the elderly;
C). reproduction of the population;
D). periodic sharp increase in population associated with improvement socio- economic conditions;
E). loss of economic need for children.

95. The first metropolis of the world is:

A). Most of Calcutta;
B). Mexico City;
C). Tokyo;
D). Moscow;
E). BosVash.

96. Wastewater treatment methods used are:

A). mechanical and biological;
B). biological;
C). chemical and mechanical;
D). biological and mechanical;
E). mechanical, chemical and biological.

97. Under the Reclamation is understood the complex of works:

A).rehabilitation of disturbed soil fertility and the return of the land in agricultural use;

B). engineering;
C). mining;
D). control of soil erosion;
E). land reclamation.

98. The total environmental damage - is:
A). loss of productivity of the forest;
B). the cost of maintaining green spaces;
C). transportation costs for delivery of the crop;
D). insurance of human life;
E). additional costs associated with the restoration of health and health of the population, crop losses, productivity of water bodies and forests, the aftermath of fires and other disasters.

99. According to the Law on Environmental Protection of RK who is responsible for production monitoring?
A). specially authorized state bodies;
B). entities - of natural resources;
C). Inspector for Environmental Protection;
D). regional environmental prosecutor;
E). maslichat

100. The basic principle of international cooperation in the sphere of Conduct Environmental Protection in RK:
A). noninterference in internal affairs of neighboring states;
B). mutual interests;
C). compliance with the priority of general environmental safety;
D). mutual cooperation;
E). exchange of environmental information.

101. Ecology - the science that studies:
A). basic laws governing the functioning of genes;
B). The effect of nutrition on the health;
C). Geographical shell of the Earth;
D). Formation of different types of climate;
E). Patterns of relationships of organisms with their environment

102. Relationship between populations as the "predation" is marked by signs:
A). "+ +";

B). "+ -";
C). "+ 0";
D). '- 0 ".

103. The essence of the "rules of the minimum" of Libikh is that if:

A). All the necessary environmental factors for the development of the body, are within the minimum, then the body feels optimal;
B). All the environmental factors necessary for the development of the body, are within the minimum, the organism thrives;
C). All the environmental factors for a long time are in the zone of optimum, then the body dies;
D). At least one of the environmental factors beyond the minimum (less than the minimum), the body dies;
E). Organisms need to flourish at least the major environmental factors.

104. A relationship between populations as "commensalism," is marked by signs:

A) «- -»
B). "+ +";
C). "+ -";
D). "+ 0";
E). '- 0 ".

105. The concentration function of living matter of the biosphere is to:

A). Mineral rock decay;
B). Accumulation in the bodies of organisms of the atoms, substances dispersed in nature;
C) Converting light energy into chemical energy;
D). Transfer of nutrients through a series of organisms;
E). Transfer of energy through a series of organisms.

106. Who presented works brought below for the first time as ecology the science of the general relations of organisms to the environment?

A). Aristotle;
B). JB Lamarck;
C). KF Roulier;
D). Ernst Haeckel;
E). Alexander von Humboldt.

107. Biological process in which light energy is converted to and

accumulated in the cell, called:

A). Breathing;
B). Reproduction;
C). Photosynthesis;
D). Division;
E). Migration.

108. Biological process in which nutrients are oxidized, is called:

A). Breathing;
B). Reproduction;
C). Photosynthesis;
D). Division;
E). Migration.

109. Which functional group contains bacteria and fungi in the biocenosis?

A). Consumers;
B). Decomposers;
C). Producer;
D). Predators;
E). Phototrophs.

110. Which functional group includes animals in the biocenosis?

A). Consumers;
B). Decomposers;
C). Producer;
D). Autotrophs;
E). Phototrophs.

111. International program devoted to the most acute problems of the ecological crisis (desertification of the planet, land degradation, disforest, pollution of fresh water, etc.):

A). MAB - "Man and the Biosphere" by UNESCO, 1970;
B). IUCN - The "International Union for Conservation of Nature and Natural Resources", UNESCO, 1948;
C). FAO - the organization of protection of forests and wildlife;
D). UNEP - International Program - 2 United Nations Environment Programme, 1972;
E). WHO - World Health Organization.

112. Sustainable development is:

A). Stable economic development
B). Stable ecological development
C). Stable and social development
D). Economic development without detriment to the nature
E). Stable and cultural development

113. Stage monitoring - the basic level of collection of primary data:
A). Local (sanitary);
B). Regional;
C). Global;
D). Nature-economic;
E). Biosphere.

114. Man-made anthropogenic impacts on the biota - is:
A). The impact of road transport;
B). The impact of built-up floor type;
C). Nuclear test site;
D). Livestock farm;
E). Mining and industrial complex.

115. The most common classification of human to the anthropogenic impact is:
A). The degree of exposure;
B). The depth of exposure;
C). Ty type of economic activity;
D) At the time of exposure;
E). Reversible and irreversible.

116. The level of traffic noise produced by heavy truck (dB):
A). 100;
B) 170;
C). 70;
D). 40;
E). 20.

117. Environmental noise - is:
A). Improvement of hearing on the motion of automobiles;
B) A form of pollution, which consists in increasing the noise level in excess of natural background;
C). Phenomenon, acting negatively on living organisms and humans;
D). Phenomenon caused by the action of the railways;

E). Pain in the noise associated with the action of compressor stations.

118. Environmental noise occurs during the functioning of household:

A). Gas turbine power plants;
B). Passenger cars;
C). Vacuum cleaner;
D). Bulldozer;
E). Excavator.

119. Allowable traffic noise in the walls of houses in the afternoon (dB):

A). 70;
B) 100;
C). 20;
D). 50;
E). 30.

120. The basic unit of activity decay of the radioactive material is:

A). REM;
B). X-ray (R) - rad;
C). Pendant;
D). J / kg;
E). Ku (Ci).

GLOSSARY

The autotrophs are organisms synthesizing organic substances from inorganic compounds (as a rule, from CO_2 and H_2O) involving light energy.

Adaptation is adaptation of an organism to certain conditions of environment by means of characteristics: morphological, physiological, and behavioral characters.

Acclimatization is adaptation of organisms to new or changing conditions of existence in which they undergo all development stages and reproduce a viable offspring.

Organisms' accumulation of substances is accumulation of mineral elements and some compounds in organisms which are available in low concentrations in the environment. On each next **trophic level** the accumulation of substances increases several times.

The alternative sources of energy mean a combined concept uniting any sources of energy, when using them the environment is not polluted significantly.

Amensalism is a relationship of organisms in which one of them is inhibited or destroyed and the other is unaffected. For example, the tree overshadowing a plant growing under it.

Anabiosis is a state of an organism in which life processes slow down to such extent that there are no visible signs of life. It is the organism's adaptation to unfavourable external conditions. For example, the winter dormancy of plants, latent life of seeds, winder dormancy of mammalians.

Anthropogenic factors are factors caused by business activities of human beings.

Upwelling is an oceanographic phenomenon that involves wind-driven motion of dense, cooler, and usually nutrient-rich water towards the ocean surface (fishing grounds).

The area is the areal of organisms of one species.

The atmosphere is a layer of gases which surrounds the entire Earth. It is a mixture of various gases.

Nuclear power plants are power stations generating energy by burning nuclear fuel (controlled thermonuclear reactions).

Autecology is a section of ecology studying the impact of factors of the environment on separate organisms.

The non-waste technology is the most ecological variant of production in which the waste of one enterprises or shop is the raw material for operation of the other one.

The benthos is an aggregate of organisms living on the bottom of water bodies.

Biological production is the ability of organism to produce an organic matter in its vital activity.

Biological indicators are organisms reacting to changes in the environment by their presence or absence, changing their external appearance, chemical composition and behavior.

Biological resources are sources of material benefits required to the human being.

Biological pollution is introduction of microorganisms into the environment which cause diseases of people or farm animals and their reproduction.

Biological diversity (Biodiversity) is the degree of variation of life forms within the given ecosystem, biome, or an entire planet.

The biomass is a reserve of a living organic substance (microorganisms, plants and animals). The average biomass per surface is 0.5 kg/ha.

The biome is a higher unit of ecosystem classification, a region where plants with one life-form prevail. With respect to the volume the biome is the same as the concept of a natural zone.

Biorhythms are regular periodic changes of physiology or behavior of organisms when the time of day, seasons, tides and lunar phases change.

The biosphere is an areal of living organisms of the planet, the largest ecosystem of the Earth in which the ecological balance is sustained. The biosphere's life is supported by a constant flow of ecologically pure and inexhaustible solar energy and cycles of chemical biogenic elements.

The biota is a community of living organisms populating the present ecosystem.

Biotic factors are factors of wildlife generated by organisms' activities. They include various relationships of organisms (for example, competition, predation, parasitism etc.) and also the influence of their vital activities.

The biotope is a homogeneous habitat by abiotic factors populated by one and the same community.

The biocenose is a community of living organisms within the boundaries of the biotope related in their vital activities.

The organisms' relations are direct or indirect influence of organisms on each other. They may be intraspecific and interspecific, between organisms of one trophic level (horizontal) and various trophic levels (vertical).

The species is a group of bions (species) with common morphological and physiological, biochemical and behavioral characters being able to reciprocal crossing.

Age structure of population is a correlation of various age species within the population. Depending on the relation of various age species the populations may be growing, stable or decreasing.

The survival ability is the ability of organisms to survive under the conditions of adverse factors (physical, chemical contamination, drought, flood, earthquake etc). The environmental load of the impact of anthropogenic load on the ecosystems is regulated by survivability control.

Hetereotrophs are organisms using an organic matter of vegetable matters or animal organisms. Consumers and decomposers are classified as hetereotrophs.

Gaia (Greek personification of the Earth as a goddess) the concept put forth by the ecologist James Lovelock in seventies last century, and with regard to the meaning mainly coinciding with a more popular term *biosphere*. According to Lovelock, (Gaia) the biosphere is a self-regulating entity; the biota responds to unfavourable external impact in such a way as to alleviate its consequences.

The hydrosphere is a discontinuous water and ice envelope of the Earth located between the atmosphere and lithosphere, the aggregate of oceans, seas, rivers, lakes, underground water, and glaciers. The hydrosphere by 98% is represented by salty water of oceans and seas.

The State Environmenal Impact Assessment (Expert Examination) is a competent analysis of possible consequences of the impact of business human activities on the environment (construction of enterprises, developing oil and gas fields etc) that may do harm to the nature.

The humus is organic matter of soil, the detritus of the ecosystem, and the basis of soil fertility.

DDT (dichloro-diphenyl-trichloroethane) is one of the most ecologically destructive insecticides, it differs by high stability and it is absorbed by living organisms from the environment and accumulated in various tissues of mammalians. At present there are about two hundred and eighty thousand of the xenobiotics circulating in the biosphere, though their production was prohibited since seventies of the last century.

Demographic explosion is a drastically increased growth rate of population that is related to improved social and economic conditions and also the fact that there is no family planning in the developing countries. The demographic explosion takes place in countries of Africa, Asia and South America.

Depopulation is the decline in population of any organism.

The detritus food chain is a food chain, in which a dead organic matter called 'detritus' is eaten by detritophags (detritus consumers) that may be consumed by predators.

The detritophags are various organisms eating a dead organic matter called the detritus. They are subdivided into decomposers (bacterias and fungi) and animals consuming excrements or corpses (necrophages ,scavengers).

Predominants are organisms dominating in the ecosystem.

The life form is an appearance of the organism, the set of morphological, anatomic, physiological, and behavioral characters which reflect its adaptability to conditions of the environment. For example, with respect to flowering plants there are different variants of life cycles in terms of duration (there are annual, biennial and perennial plants) and in terms of fruiting.

The life cycle is an aggregate of all phases that the organism undergoes from the birth till the death.

Pollution is introduction of chemical, physical and biological agents into the environment being alien to the environment.

The wildlife reserve is a temporary protected natural area established with the intent to restore the population of one or several species of plants or animals.

The reserve is a special protected area, where it is prohibited to carry out any business activities in full (including tourism) for the purpose of preserving natural complexes, protecting animals and plants and also tracing processes taking place in the nature.

Soil salination is accumulation of phytotoxic salts in the soil solution.

The drought is the period, when the precipitation is to greater extent less than the mean annual precipitation that has influence on the hydrological regime of landscapes and the state of plants (first of all of crops) and animals.

The ecological disaster zone is an area, where as a result of human business or other activities such drastic changes of the environment occurred that it became dangerous for the life of people.

Indicators of the environmental quality are qualitative indicators assessing the environmental suitability for life of people or other organisms.

Insecticides are agricultural chemicals used to control the population concentration of destructive insects in agriculture and forestry.

Cadastres are systematized consolidated data on the state of various components of the ecosystem (soil, species of plants, animals, fungi) or whole ecosystems.

Carcinogenic materials are chemical compounds causing cancer.

The quota is a legislative environmental standard of the impact on resources and environment (the ratio of commercial animal populations that may be entrapped and caught. The ratio of using renewable resources, for

example, water, the planned quantity of pollutants that the enterprise is allowed to discharge in the environment without risk of its destruction etc.).

Acid rains are precipitation containing sulphuric and nitric acids.

The climax is a stable state of communities or ecosystem, at which their composition, structure and cycles of nutrients are stable and are in equilibrium with the environmental conditions, in particular with climate of the given region.

Commensalism is a form of symbiosis of organisms in which one of them gets benefits and as to another one these relations are indifferent (denoted with combination of signs "+0").

Composting is one of old methods to transform organic waste into a fertilizer – the compost.

Competitive exclusion is a drastic decrease of the number or full extinction of one species in any concrete habitat as a result of competition with other species for resources limiting them.

Competition is a competition of organisms of one trophic level for consuming resources available in limited quantities.

The continental shelf is coastal shallow waters with the depth not more than 150 m, the most important part of seas for practical use.

Consumers are organisms eating a living or dead organic (plants, animals, fungi, bacteria, detritus) represented by animal species.

The continuum is a community composition of ecosystems gradually changing in space.

The Red Book is a publication including the list and characteristics of endangered species of plants, animals and fungi in a certain area.

The cycle of substances in the ecosystem and biosphere is a multiple involvement of matters in processes of synthesis and decomposition of an inorganic matter.

The landscape is a natural geographical complex in which all main components (the relief, climate, water, soil, vegetation, and animals) are interrelated.

The limiting factor is an ecological factor that limits the organisms' vital activities influencing on the composition and biological product of the ecosystem

The lithosphere is the hard and rigid outer shell of the Earth, the thickness of which is 50-200 km.

The megalopolis is giant agglomerations of cities with the population over ten million people.

International cooperation (in the area of nature protection) is implemented in accordance with intergovernmental treaties or under

nongovernmental programs which are developed by social movements or scientists.

Migration is a regular cyclic migration of animals between habitats.

Mutualism is a form of organisms' relationships, when each interacting organism gets benefit (is denoted with combination of signs "++").

The National park is one of forms specially protected natural and special use areas.

Nekton is the aggregate of actively swimming aquatic organisms in a body of water (usually oceans or lakes) able to move independently of water currents.

Nitrates are salts of nitric acid used as fertilizers and food supplements. In getting in the organism nitrates transform into nitrites that react with amines. When the nitrites level is excessive, carcinogenic materials – nitrosamines are formed in the organism. Therefore it is necessary to exercise strict control over adding mineral nitrogenous fertilizers to soil.

Noosphere is the "sphere of mind". Pierre Teilhard de Chardin put forth the present term for the first time, however, V.I. Vernadsky created the doctrine of noos as a definite stage of the biosphere development, according to which, the human being becomes a powerful geological force able to transform the biosphere by his work and thought.

The ozone layer is a layer in Earth's atmosphere (stratosphere) which contains relatively high concentrations of ozone (O_3). It is located at the height 18-23 km. and protects the surface of the planet from ultraviolet light, which is damaging the life forms on Earth.

Species Optimum is a set of ecological conditions under which species of the type of organisms feel good, grow and reproduce fast.

Desertification is arising of landscapes similar to deserts with thin vegetation caused by business activities of people.

Protection of nature is conservation of the biosphere's resources, its biological diversity, and water, soil, subsoil, the atmosphere.

The natural monument is a small protected area, including separate trees, populations of rare species of plants, rare communities, whole landscapes etc.

Parasites are animals, plants and microorganisms that benefits at the expense of the other, the host, it is one of functional groups being consumers of the ecosystem.

The greenhouse effect is an effect of surface layer warming caused by the atmosphere absorbing long-wave (thermal) radiation of the earth surface, into which a larger part of solar light energy is transformed when

reaching the Earth. It is increased by the heightened concentration of the greenhouse gases in the atmosphere that results in climate warming.

The maximum permissible emissions (MPE) is an ecological norm usually used for assessing the environment contamination by exhaust gases of vehicle engines and industrial exhaust gases.

The limited permissible dose (LPD) is an ecological norm of the limited quantity of a matter, the ingress of which into the orgsanism does not produce a harmful effect.

The maximum permissible concentration (MPC) is an ecological norm of the limited concentration of a matter in water, soil, atmoisphere or food products which could do harm to the human health.

The maximum permissible discharges (MPD) is maximal permissible quantity of a matter discharged with sewage water per unit of time provided that admissible quantity of water is preserved.

Pesticides are various chemical compounds used to protect plants. Insecticides, herbicides fall under the category of pesticides. A major part of pesticides have a harmful influence on the human health (cause diseases of kidneys, upper air passages, cancer and other).

A food chain is a linear sequence of links in a food web starting from a trophic species that eats no other species in the web and ends at a trophic species that is eaten by no other species in the web.

Plankton (singular plankter) are an aggregate of organisms drifting (floating) within the water column and carried over by the flow – seaweeds (phytoplankton), animals (animalculines, crustaceans, worms, medusas - zooplankton), and microorganisms (bacterial plankton).

The population is an aggregate of one type species populating a certain area (space) within a lengthy period (a large number of generations) with relatively homogeneous conditions and being able to interbreed (**panmixia**).

Producers are primary producers of the primary biological product in the ecosystem (see autotrophs).

Radioactive contamination also called **radiological contamination,** is introducing radioactive substances in the environment which are unavailable in nature or increased concentration of natural radioactive substances; the most hazardous physical contamination of environment (accidents at nuclear plants, violations of rules for storage and nuclear waste disposal).

Radioactive waste is all radioactive and contaminated materials generated in using radioactive processes by people and not used in future.

Rational nature management is using natural ecosystems or their elements (forest stand, population of game animals, grass pasture, soil etc.)

when resources are not destroyed and the habitat and also human health are not worsened.

Regulation of population growth is a set of actions to exert impact on the population size being the most important condition of building society for sustainable development purposes.

Decomposers (or saprotrophs) are organisms that break down dead or decaying organisms and in doing so transform organic residues into inorganic matters providing that elements containing in the residues are returned to the cycle of substances (fungi and microorganisms).

Recreation capacity of ecosystem is the limit of vacationers who may stay at the rest area not destroying the ecosystem for a definite period.

Recreation is organizing rest for people accompanied with the impact of people on the ecosystem. It is an important factor of destroying ecosystems of suburban forests, amenity forests, national parks and all other areas where a large number of holiday makers is concentrated.

Reclamation means actions to liquidate and restore landscapes destroyed by industrial activities.

Resources are any sources and preconditions of getting material and spiritual benefits required for people which could be used with existing technologies.

The Club of Rome is one of the most authoritative nongovernmental organizations founded in April 1968 by Aurelio Peccei, an Italian industrialist (1908-1984). The aim of the club was to conduct researches of mankind development in the epoch of technological revolution.

Symbiosis is a stable coexistence of two or several species of organisms, in which both partners (symbiotes) get benefits in relations with the environment.

Smog is a misty cloud over industrial enterprises, cities and towns formed by gaseous waste, first of all by sulfur dioxides.

Social ecology is a science discipline studying relations of society and nature.

Stress is a general protective reaction of a living organism to any strong impact exerted on it.

The technocratic approach means views of followers of a technocratic global model with the population growing up to 30 billion people and creating the world without nature.

Toxicity is poisonousness, the substance's capacity to do harm to the human health.

Tolerance is the organism's (cell, organ) resistance to effect of adverse factors.

Heavy metals are metals with the specific gravity over 4.5 g/cm^3. There are metals vital for organisms such as zinc, iron, and manganese, copper and there are toxic ones, such as cadmium, mercury, lead, arsenic, nickel and chrome.

Ultraviolet radiation is a type of electromagnetic radiation with the length of wave 180-400 nm. Small doses of ultraviolet with the length of wave 290-315 nm contribute to synthesis of vitamins, activate breathing and blood circulation, and improve a general state of people (the moderate tan effect. The short-wave ultraviolet (180-290 nm) is dangerous for living organisms as it destroys the organic matter, causes carcinoma cutaneum and cataract. A large part of the short-wave ultraviolet is absorbed by the ozone layer of the Earth.

Urbanization is a process of increase in the urban population and influence of cities on the biosphere. In 1830, 3% of planet's population lived in cities and towns, in 1960, the urban population was 34 %, and in 2000, the population in cities was equal to 48-50 %.

Living standards are well-being of the population in the country or social group within the population assessed by quantitative and qualitative indicators. The overall indicator is the gross national product (GNP) per capita. The countries with the GNP per capita less than $ 400 per year are classified as the countries with low living standards, and the countries with the GNP per capita more than $ 10000 per year are classified as countries with high living standards (USA, Sweden, Canada, Great Britain, and Switzerland).

Sustainable development is the English term meaning sustained development. With respect to the population ecology it means such development of the population when the stability of ecological niche is preserved. In human society the sustainable development implies such development of society when needs of people are satisfied and the future generations' interests are not put at threat. This definition implies that each generation bears responsibility to hand over unspent natural and economic resources to the next generation.

Freons are saturated gaseous or liquid fluorohydrocarbons or polyfluorohydrocarbons often containing atoms of chlorine. They are used in cooling plants, propellants for aerosols, components of fire extinguishing compositions. They are involved in destruction of the ozone layer of the Earth.

Predators are organisms eating other living organisms. As a rule, they are animals, however, there are carnivores.

Blooming of water is algal nuisance resulting in eutrophication of water bodies.

Eutrophication is a process when the state of water ecosystem is changed as a result of increased concentrations of mineral nutrients (phosphates and nitrates) and increased growth of plants and algae. It results in the decreased water transparency, increased oxygen consumption; many species of fish, water plants perish. The main reason of eutrophication is pollution from such sources as leachate from fertilized fields, effluent from animal farms and sewage effluent, especially containing phosphor.

Ecological niche is an aggregate of ecological conditions (resources, space) necessary for existence of population in the ecosystem. According to Eugene Pleasants Odum, the ecological niche is the functioning of species in the ecosystem.

Ecological succession is a process of a gradual change of the composition, structure and functions of ecosystems under the influence of external (allogenic succession) or internal factors (autogenic succession). One may identify primary and secondary successions. The primary succession arises on the territory where there were no living organisms (for example, overgrowing of rocks, lakes, waste dumps). The secondary succession takes place on areas, where vegetation was destroyed, but there was an organic matter in the soil.

Ecological pyramids are graphs showing the ratios of the number, biomass and energy on various trophic levels.

Ecological factors are components of the environment which directly or indirectly have influence on living organisms. The ecological factors are components of the ecosystem to a large extent determining its character (composition, structure). The ecological factors are divided into abiotic (meaning not alive) and biotic (factors resulting from the activities of a living thing or any living component in an environment). The aggregate of abiotic factors within the ecosystem is called an ecotope, and the aggregate of abiotic and biotic factors is called a biotope.

Ecological monitoring is a tracking system of processes taking place in ecosystems, populations and organisms (including a human being) influenced by changes of the habitat. Objects of ecological monitoring are the atmosphere, water, soil, the state of populations of plants and animals, human health.

Ecological regulation is to determine threshold limit values of the human impact on ecosystems or human health, after exceeding which the impact may be negative and adverse to a large extent. Ecological regulation is the most important condition of rational nature management.

Ecological education is a system of education aimed at mastering the theory and practice of rational nature management and environmental

protection, shaping environmentally friendly world outlook and thinking based on the principle of individual environmental responsibility.

Ecological law is a legislative base formed by the government regulating relationships between human beings and nature.

Ecological forecast is to determine a future development of the process taking place at present on the basis of calculations and being the object of ecological monitoring. It is possible to prepare an ecological forecast of erosion processes development, depauperation of fauna in rivers at heightened contamination of water, decrease in the wildlife population if poaching capture and shooting is continued.

Ecology is a set of sciences studying various aspects of relations of living organisms and conditions of the environment.

The ecosystem is an aggregate of organisms and conditions of the environment, in which the organisms live being one of basic notions of ecology.

Erosion is a destruction process of soil influenced by the impact of water or wind.

Nuclear winter is a forecast scenario of nuclear war consequences, when large masses of smoke and dust is discharged in the atmosphere and in doing so it will reduce drastically penetration of the sunlight on the surface of the plant and cause decrease in the temperature.

Nuclear energy is the way to generate electric energy using nuclear reactors which recover thermal energy in radioactive decay of nuclear fuel – enriched uranium and some other radioactive materials.

The layer is an element in a vertical structure of surface ecosystem. The layering is the most evident in the above ground part of forests in the middle latitudes, and however, the layering is the basis of differentiating ecological niches of animals.