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PHARMACEUTICAL ECOLOGY

Manual for Pharmacy students,specialty «Pharmacy»,
English medium
Part 1

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The present manual in Pharmaceutical Ecology includes chapters on General ecology, Human ecology. The manual is designed for Pharmacy students, specialty «Pharmacy», English medium.

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ БЮДЖЕТНОЕ
ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ
«ВОЛГОГРАДСКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ»
МИНИСТЕРСТВА ЗДРАВООХРАНЕНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ

ФАРМАЦЕВТИЧЕСКАЯ ЭКОЛОГИЯ

Учебно-методическое пособие
для студентов фармацевтического факультета,
обучающихся по специальности «Фармация»,
на английском языке
Часть 1

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Предлагаемое учебно-методическое пособие содержит модули «Общая экология», «Экология человека». Учебно-методическое пособие предназначено для самостоятельной работы студентов 4-го курса фармацевтического факультета специальности «Фармация» по дисциплине «Фармацевтическая экология», обучающихся на английском языке.

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CONTENTS

Introduction

Pharmaceutical ecology is an academic discipline aimed at developing systematic ecological thinking of future pharmacists studying in specialty programs in the specialty 05/33/01 Pharmacy.

The educational and methodological manual (part 1) is an integral part of the educational and methodological complex in the discipline "Pharmaceutical Ecology" and is intended to prepare students studying in the specialty 33.05.01 Pharmacy for seminar-type classes. The textbook contains brief theoretical material, instructions for completing the practical part of the lesson (independent work), educational tables, test tasks for ongoing monitoring of the level of knowledge.

1.1. Purpose of the discipline:

Acquisition by students of systemic knowledge on issues of general ecology and special pharmaceutical ecology, nature conservation.

1.2. Objectives of the discipline:

- to develop knowledge about the general laws of ecology;
- to generate knowledge about the achievements of environmental science and practice, the concept of development of environmental protection and environmental legislation;
- to develop knowledge about the main anthropogenic pollutants of the hydrosphere, atmosphere, lithosphere, and their hazard classes;
- to develop knowledge about the maximum permissible concentrations of pollutants in the atmosphere, hydrosphere, and soil;
- to generate knowledge about the consequences for the animal and plant world, public health of denaturation of the biosphere and the main directions of their prevention;
- teach methods of sampling atmospheric air and determining pollutants in industrial emissions of chemical and pharmaceutical enterprises according to scientific and technical documentation;

- teach methods for sampling wastewater from chemical and pharmaceutical enterprises and determining organoleptic, chemical and physicochemical indicators of wastewater according to scientific and technical documentation;

- to develop knowledge about environmental principles of ensuring the safety of products and raw materials used for the production of medicines;

- to generate knowledge about the modern concept of development, production of biologically active food additives (BAA), classification, evaluation of the effectiveness and use of dietary supplements in various fields of medicine;

- to develop knowledge about the general principles of assessing the effectiveness, safety and good quality of food additives about the main regulatory documents relating to the production, quality control and use of food additives (Federal laws of the Russian Federation, orders of the Ministry of Health of the Russian Federation, SanPin, guidelines and instructions approved by the Ministry of Health of the Russian Federation) and development methods for monitoring the content of chemical contaminants in food additives and biologically active food additives;

- develop the ability to give an environmental assessment of the main environmental factors and identify violations of the ecological well-being of the territory;

- introduce the main regulatory documents in the field of ecology and environmental protection;

- develop the ability to use basic regulatory documents in the field of environmental control and environmental protection to make management decisions;

- develop the competencies of informational, educational and sanitary educational work with the population on environmental safety issues.

Chapter 1
GENERAL ECOLOGY (MODULE 1)

THEME 1
HISTORY OF ECOLOGY

Motivation statement

Ecology as a science is aimed at understanding the functioning of ecosystems, the relationship of species of living beings with their environment, the conditions for the development and balance of such systems. Its object is natural ecosystems, as well as ecosystems transformed in the process of production and economic activity, studied by biological methods. It studies the relationship of living organisms, their natural and artificial groups with their environment and among themselves.

There is a figurative expression that we live in the era of three "E": economy, energy, ecology. At the same time, ecology as a science and a way of thinking attracts more and more close attention of mankind.

The term "ecology" was introduced by the German naturalist E. Haeckel in 1866. Literally translated from Greek, it means the science of the house (*oikos* – house, dwelling; logos – teaching).

For this reason, ecology is sometimes associated only with the study of the environment (house) or environment. The latter is fundamentally correct with the significant amendment that the environment cannot be considered in isolation from organisms, just like organisms outside their habitat. These are components of a single whole. It was organisms that shaped the modern environment. They also play a primary role in neutralizing those impacts on the environment that have occurred and are occurring for various reasons.

Each science has its own starting point and milestones of development. The study of the history of ecological studies makes it possible to understand how researchers managed to identify certain very important patterns in the structure of populations, communities, ecosystems, as well as to analyze the causes of failures and circumstances hindering the development of ecological thought.

The objective: is to introduce the main stages and prerequisites for the formation of environmental science.

Questions for discussion

1. Ecology as a science. Purpose, objects and tasks of ecological research.
2. Methods of ecological research. Relationship with other sciences.
3. The main stages in the development of ecology. Principles of construction of periodization of development of ecology.

Independent work of students

1. Speech with abstract messages on the topic of the lesson (individual task).
2. Participation in a regulated discussion (the topic is indicated in the task for the practical lesson)

Topics for discussion

2.1. Variety of the term "ecology". Differences between scientific and everyday approaches to the concept of "ecology". What is the difference between the original and modern definitions of ecology as a science?

2.2. Comment on E. Haeckel's statement: "Ecology is the knowledge of the economy of nature...".

2.3. What are the functional differences and tasks of theoretical and applied ecology?

2. 4. What is the "greening of knowledge" and what causes it? Ecologization of pharmaceutical knowledge.

3. Work with training test tasks (test tasks No. 1 and No. 2):

Task 1

Select the correct answer from the options provided (choice of one answer).

1) The term "ecology" was introduced into scientific use in 1866:

a) J. Liebig;

b) V. V. Dokuchaev;

c) E. Haeckel;

d) N. A. Severtsev.

2) General ecology is a science that studies:

a) general scientific methods of cognition of reality;

b) specific groups of living organisms and their relationship with the environment;

c) the totality of organisms together with the environment;

d) reactions of environmental components to anthropogenic impacts.

3) Synecology studies:

a) the relationships of individual organisms with the environment;

b) relationships of individual species with the environment;

c) structure and functioning of populations;

d) structure and functioning of natural communities and ecosystems.

4) The science of interaction with the environment of the biosphere is called:

a) social ecology;

b) global ecology;

c) urban ecology;

d) general ecology.

5) Ecology as a science solves the following problems:

a) conservation of reference areas of the biosphere; b) creation of a scientific basis for rational nature management;

c) ecological indication of the properties and components of the environment;

d) justification of the transition from farming to fishing;

e) regulation of the human population on Earth.

6) Mathematical models that take into account random parameters available in real systems are:

a) deterministic models;

b) stochastic models;

c) optimization models;

d) game models.

7) The mathematical model of Volterra-Lotka is dedicated to the simplest ecological system:

a) the landlord;

b) symbiont host;

c) predator-prey;

d) predator-predator.

8) The Law of Limiting Factors was formulated in 1909:

a) J. Liebig;

b) W. Shelford;

c) G. Odum;

d) F. Blechman.

Multiple choice questions

9) The areas of engineering ecology include:

a) agroecology;

b) bioresource ecology;

c) ecological ergonomics;

d) transport ecology;

e) industrial ecology.

10) The methods of environmental research include:

a) laying out and description of trial plots and accounting sites;

b) marking of animals;

c) experiments in natural conditions;

d) mathematical modeling;

e) modified methods of physiology.

Multiple Choice

11) Choose the correct judgments (from 0 to 4).

a) The mathematical model of the Gaia biosphere was developed under the leadership of D. Meadows (1972);

b) The first model for predicting the consumption of resources was the model of T. Malthus (1798);

c) The model of M. Mesarovic and E. Pestel describes the world system as a set of regional systems;

d) Mathematical models help confirm the data obtained during the experiment.

12) Choose the correct judgments (from 0 to 4).

a) According to the one percent rule, a change in the energy of a natural system within 1% does not bring it out of equilibrium;

b) The best chance for self-preservation has a system that least contributes to the flow of energy and information from outside;

c) Some factors can enhance or soften the force of other environmental factors;

d) The endurance of an organism is determined by the strongest link in the chain of its ecological needs.

Sequencing

13) Restore the correct sequence of steps for building mathematical models:

a) development of a mathematical theory describing the processes under study;

b) the study of real phenomena that need to be modeled;

c) calculation based on the model and comparison of results with reality.

14) Restore the correct sequence of stages of system analysis for solving practical environmental problems:

a) modeling;

b) evaluation of possible strategies;

c) implementation of the results;

d) choice of problem;

e) choice of ways to solve problems;

f) setting the problem and limiting the degree of its complexity;

g) establishing a hierarchy of goals and objectives.

Task 2

Ecology is an integral science. After reading Rosenberg's "Calendar of Environmental Events," highlight turning points in the development of environmental knowledge. Fill out the table, noting the accompanying breakthroughs for ecology in related sciences.

Table 1

Stage / The science	I	II	III	IV	V
Botany					
Zoology					
Genetics / Evolutionary doctrine					
Chemistry/Physics					

Reference material

Ecology is a science that studies the organization and functioning of supraorganismal systems at various levels: populations, biocenoses (communities), ecosystems and the biosphere. Ecology is also defined as the science of the relationship of organisms with each other and with the environment.

Main sections of modern ecology:

- general (theoretical) ecology,
- bioecology,
- geoecology,
- human ecology and social ecology,
- applied ecology.

Environmental objectives:

1. study of bilateral relations between biological objects of different levels of organization and the environment;
2. study of mechanisms of adaptation to the environment;
3. study of the mechanisms of ecosystem stability;
4. study of mechanisms for maintaining biodiversity;
5. research of production processes;
6. modeling of environmental systems and processes;
7. studying the laws of interaction between human society and nature, forecasting and optimizing this interaction, etc.

Classification of methods used in environmental studies

Among the methods used in ecology, according to the peculiarities of their application, one can single out both *general scientific* and *private*, only ecological methods. According to another classification, ecology methods can be divided into: laboratory and field methods. The latter, in turn, are divided into the following methods: route, stationary, descriptive and experimental. Field research in ecology is the most significant, since it is they that make it possible to study environmental

phenomena directly in the natural environment. They allow you to establish the relationship of organisms with the environment, identify environmental environmental factors and determine the adaptation of living things to the environment.

General scientific research methods. Among the general scientific methods there are: observation and description; comparative method; historical method; experimental method; modeling method; statistical method, etc.

Private Methods of Ecological Research. Among ecological methods in science, the following are more often used: monitoring, microscopic, isoenzyme analysis, X-ray diffraction analysis, biomorphological analysis, group analysis, morphophysiological indicators, introduction, indication of environmental pollution, remote study of ecosystems, atomic absorption spectrophotometry.

Periodization of the development of ecology

Ecology as a biological discipline arose in the middle of the 19th century, and became an independent science only in the first half of the 20th century. However, the emergence of ecology was preceded by a long prehistory. The accumulation of environmental information began with the appearance of man on Earth and is closely related to the initial knowledge of plants, animals and environmental conditions.

The entire history of the development of ecology can be conditionally divided into *five* stages:

1. The stage of accumulation of ecological information about the interaction of plants and animals with the environment within the framework of botany and zoology. This stage lasted from ancient times until the end of the 18th century.

2. The stage of formation of ecological directions within the framework of biological and zoological geography. It lasted from the end of the 18th century. until the middle of the 19th century.

3. The stage of formation of plant ecology and animal ecology as sciences about the adaptation of organisms to the environment. This stage lasted from the middle of the 19th century. until the 20s of the XX century.

4. The stage of formation of ecology as a general biological science, which is the theoretical basis for nature conservation, lasted from the 20s to the 60s of the XX century.

5. The stage of development of global ecology with the allocation of human ecology within its framework. Started in the 60s of the XX century. and continues at the present time (Maglysh S.S., 2001).

Of great interest is the periodization of the history of ecology by G.S. Rosenberg (2005). It is “tied” to dates significant for ecology and reflects the change of paradigms in it:

The first period – from ancient times to 1866 (the concept of "ecology" is defined and justified as an independent scientific discipline). This is the preparatory period, the period of "naive ecology", when its elements appear in the works of botanists, zoologists and other natural scientists. A characteristic feature of this period is the absence of a conceptual apparatus of its own for ecology.

The second period is from 1866 to 1935 (the definition of the concept of "ecosystem" is given). This is the period of the formation of factorial ecology, the discovery of the patterns of the relationship of animals or plants to various abiotic factors.

The third period is from 1935 to the beginning of the 70s. This is the period of synecological research, when the study of the relationship of populations in ecosystems came to the fore. The basis of the research of this period was seven provisions:

- establishment of ecology as a fundamental theoretical discipline;
- the idea that nature is predominantly in balance;
- synecological approach;
- primacy of competitive relations;

- low "weight" of evolutionary factors in the development of ecosystems;
- idea of discreteness of ecosystems.

The fourth period is from the early 1970s to the mid-1980s. At this time, the seven "theses" of the third period were opposed by the corresponding "antitheses":

- difficulties in identifying any general laws of community development;
- constant disturbances of equilibrium states;
- renewed interest in population (demecological) research;
- rejection of competition as the main factor in community formation;
- study of ecosystems in their development (including evolutionary factors);
- the prevalence of the concept of continuum over the concept of discrete ecosystems;
- the increased role of random factors in explaining the structure and dynamics of ecosystems. *The fifth period* is the last 20 years, when there has been a tendency to combine the ideas of the deterministic-population second period, the deterministic-synecological third and stochastic-population fourth periods, which made it possible to speak about the beginning of the formation of a truly systematic approach to the study of ecological objects. G.S. Rozenberg in 2005 proposed the "Calendar of Ecological Events", which briefly highlights the most important events for the formation of ecology, and notes the contribution of domestic and foreign scientists to the development of science (Table 2).

Table 2

Calendar of events in the field of ecology (according to G. O. Rozenberg, with changes and additions)

Time: centuries, years	Author	A country	Summary of the environmental study
6th-4th centuries BC e.		ancient india	The epic poems «Ma habharata and «Ramayana »describe the lifestyle and habitats of about 50 species of animals».
490–430 AD BC e. (years life)	Empedocles of Acragas	Ancient Greece	Considered the relationship of plants with the environment
384–322 BC e. (years life)	Aristotle	Ancient Greece	In the treatise «History of Animals», he proposed a classification of animals, which had an ecological coloring.
370–285 AD BC e. (years life)	Theophrastus (Theophrastus) of Eresia	Ancient Greece	In the book «Studies on Plants », he described about 500 plant species and their groupings; laid the foundations of geobotany
23–79 (years life)	Pliny the Elder	Ancient Rome	In 37 books, «Natural History »summarized data on zoology, botany, forestry, described the practice of using animals in various sectors of the economy
1202	Leonardo of Pisa (Fibonacci)	Italy	Formulated the first problem of the mathematical theory of populations (taking into account the age structure)
1670	Boyle R.	England	Carried out the first ecological experiment: the effect of low atmospheric pressure on various animals
1686	Ray J.	England	He formulated the problem of determining the biological criteria for identifying a species (later «the concept of a species »was developed by the works of C. Linnaeus, J. B. Lamarck, C. Darwin, etc.)

Continuation of the table 2

Time: centuries, years	**Author**	**A country**	**Summary of the environmental study**
1700	Tourne-fort J. P. de	France	He was one of the first to describe the vertical zonality of vegetation in the mountains and compare it with the horizontal zonality of vegetation in the plains (based on the data of the expedition to Mount Ararat)
1715	Leeuwen-hoek A. van	Holland	For the first time he studied «food chains »and some mechanisms of population regulation
1749	Linnaeus K.	Sweden	«Saving nature »- proposed a typology of plant habitats. «The social structure of nature »(1760) – laid the foundations of taxonomy
1749–1788	Buffon J. L. L. de	France	«Natural history »in 36 vols. – developed the idea of species variability under the influence of the environment and the unity of flora and fauna.
1763	Lomo-nosov M.V.	Russia	He made a number of assumptions about the influence of the environment on the body
1775	Kaver-znev A. A.	Russia	«On the rebirth of animals »- made a conclusion about the variability of organisms under the influence of environmental factors
1786	Zuev V.F.	Russia	«Inscriptions of natural history »- the first school textbook of an ecological profile
1794	Darwin E.	England	He published the work «Zoonomy, or the Laws of Organic Life », in which he developed peculiar ideas about the evolution of organisms. In the poems «The Botanical Garden »(1789) and «the Temple of Nature »(1803), he popularized his natural science views in poetic form.
1798	Malthus T. R.	England	In the work «Experiment on the law of population, »he proposed an equation for geometric (exponential) growth; first mathematical model of population growth

Continuation of the table 2

Time: centuries, years	**Author**	**A country**	**Summary of the environmental study**
1809	Lamarck J. B. P.	France	In the two-volume «Philosophy of Zoology, »he gave an idea of the essence of interaction in the «organism-environment system.»
1824	Edwards W.	France	«The influence of physical agents on life» the first summary of environmental physiology
1831–1836	Darwin C.R.	England	Circumnavigation on the «Beagle »; all observations are summarized in «the Research Diary »(1839), one of the first comprehensive environmental studies
1840	Morran Sh.	Belgium	Fixed the term «phenology »for the doctrine of seasonal phenomena in nature
1840	Liebig Yu.	Germany	Formulated the law of the minimum (limiting factors)
1854	Geoffroy Saint-Hilaire I.	France	In the book «Natural History of the Organic World, »he laid the foundations of ethology, which studies the «relationships of organisms within families and groups, in an accumulation, in a community». A number of researchers consider I. Geoffroy Saint-Hilaire, and not Haeckel, «the» godfather of »modern ecology, considering the proposed term «ethology as a synonym «for ecology»
1854	Baer K. M. von	Russia	Laid the foundations of the modern theory of fish population dynamics
1855	Severtsov N. A.	Russia	«Periodic phenomena in the life of animals, birds and reptiles of the Voronezh province »- a comprehensive ecological study
1855	Decandol A.	France– Switzerland	«Botanical geography », in 2 volumes – studied the patterns of plant settlement depending on the environment and geological history, created the foundations of the doctrine of the origin of cultivated plants
1858	Roulier C.F.	Russia	Substantiated the method of ecological study of animals, substantiated the impact of the environ-ment on the development of the organic world

Continuation of the table 2

Time: centuries, years	**Author**	**A country**	**Summary of the environmental study**
1859	Darwin C.R.	England	In the work «The Origin of Species by Natural Selection, or the Preservation of Favored Breeds in the Struggle for Life» – in addition to widely known evolutionary ideas, the work presents a large amount of material on the ecological patterns of the life of plant and animal communities. The work became fundamental for E. Haeckel in creating the science «of ecology»
1860	Middendorf A.F.	Russia	«Journey to the north and east of Siberia », in 2 vols., based on travels to the Kola Peninsula (1840), Taimyr and Yakutia (1842–1845) – biogeographic patterns of Siberia are described
1860	Pasteur L.	France	Laid the foundations of the ecological direction in microbiology (in 1922, S. N. Vinogradsky formalized this new scientific direction)
1861	Sechenov I. M.	Russia	In public lectures, «The so-called plant acts in animal life », where he expressed the principle of unity: «An organism without an external environment that supports its existence is impossible; therefore, the scientific definition of an organism should also include the environment that affects it»
1866	Haeckel E.	Germany	«General morphology of organisms », in 2 vols. – proposed the concept «of ecology »: «... biology is mixed with ecology, with the science of economy, of lifestyle, of the external life relationships of organisms with each other, etc. »(vol. I, p. 8)
1868	Reclus E.	France	Proposed the concept «of biosphere»
1868	Wallace A.R.	England	«The Malay Archipelago – the homeland of the orangutan and the bird of paradise» – proposed the concept of «a biological niche », substantiated the methods of biogeographic analysis

Continuation of the table 2

Time: centuries, years	Author	A country	Summary of the environmental study
1870	Spencer g.	England	«The Study of Sociology». Together with the works of T. G. Huckley (1863) and J. P. Marsh (1864), he laid the foundations of human ecology
1875	Suss E.	Austria	«The Face of the Earth»- established the concept «of the biosphere in science» (independent of E. Reclus)
1877	Mobius K. A.	Germany	«Oysters and oyster farming»- proposed the concept «of biocenosis ». In domestic science, biocenotic studies were started by S. A. Zernov in 1913, complex studies by V. N. Beklemishev in 1923.
1883	Doku-chaev V.V.	Russia	«Russian black soil» – laid the foundations for the doctrine of soils (pedology) and land-scapes («Our steppes before and now », 1892)
1887	Forbes S.	USA	He proposed the concept «of» microcosm. For the first time he considered the lake as a microcosm, gave the beginnings of the doctrine of the ecosystem
1895	Warming J.E.	Denmark	«Ecological geography of plants» (Russian translation, 1901) – first used the term «ecology» in relation to plants, following F. Unger developed the foundations of ecological botany. Introduced the concept «of life forms»
1896	Beketov A.N.	Russia	«Plant geography »- the first original textbook
1896	Hudson W.	England	He proposed the concept of «a wave of life »to describe the dynamics of the number of animals (rediscovered in 1905 by S.S. Chetverikov).
1896	Schroeter K., Kihner O.	Germany, Swiss-ria	They proposed to distinguish between aut- and synecology (fixed in 1910 by the decision of the III International Botanical Congress)
1899	Dokuchaev V.V.	Russia	«To the doctrine of natural zones. Horizontal and vertical soil zones»

Continuation of the table 2

Time: centuries, years	Author	A country	Summary of the environmental study
1901	Coles T.	USA	Created the doctrine of successional series, and simultaneously with G. Whitford (USA) proposed the concept of «menopause»
1902	Jacquard P.	France	Developed a quantitative method for comparing floras, laying the foundations for the quantitative and statistical direction in the study of ecosystems
1903	Johansen V.L.	Denmark	Borrowed from demography and introduced the concept «of population into ecology»
1903	Raunkier K.	Denmark	He created the doctrine of the life forms of plants (based on the concept introduced by E. Warming).
1909	Kolkwitz R., marson m.	Germany	Developed the basics of bioindication of pollution of water bodies.
December 29, 1909 - January 6, 1910		Russia	XII Congress of Naturalists and Physicians of Russia (Moscow) – keynote speeches by G. F. Morozov, V. N. Sukachev, L. G. Ramensky, B. A. Keller and others.
1910	Gleeson G.	USA	He formulated an individualistic hypothesis, which consists in recognizing the uniqueness of the ecology of each species
1910	Ramensky L. G.	Russia	Formulated the principle of continuity. At present, the principle of L. G. Ramensky and the hypothesis of G. Gleason are united by the concept of continuum. Later, these same principles were independently described by G. Negri (Italy, 1914) and F. Lenoble (France, 1926)
1910		Belgium	III International Botanical Congress (Brussels). Report by Sh. Flao and K. Schroeter on fixing the basic geobotanical terminology, defining the concept «of association». The concepts of»autecology and «synecology are» separated«

Continuation of the table 2

Time: centuries, years	**Author**	**A country**	**Summary of the environmental study**
1910		Russia	The Permanent Biogeographical Commission was founded at the Russian Geographical Society (P. P. Semenov-Tyan-Shansky)
1911	Petersen K., Ekman S.	Denmark, Sweden	For the first time, quantitative studies of benthos were carried out using bottom grabs (K. Petersen also proposed the very concept of «benthos »)
1911	Shelford W.	USA	Formulated the law of maximum (tolerance)
1912	Keller B. A.	Russia	He proposed the concepts «of ecological group of species », «ecological series»
1912	Morozov G. F.	Russia	«The doctrine of the forest »is a classic work in forest geobotany. According to V. N. Sukachev, «Morozov, like no one else, filled the concepts of "plant community" and "phytosociology" with rich content and showed the practical significance of the latter.»
1913	Brown-Blanquet J.	Switzerland-ria, France	He laid the foundation for the development of a method for classifying vegetation (we can also talk about the classification of ecosystems marked by plant communities) based on ecological and floristic criteria. This method is currently the most widely used in the world.
1915	Alekhin V.V.	Russia	Formulated the rule of anticipation (independently rediscovered by G. Walther in 1951 and known in modern ecology as the Walther–Alekhine rule). A similar principle of stations for insects was proposed by G. Ya. Bei-Bienko in 1959.
1915	Vysotsky G. N.	Russia	Introduced the concept of «ecotope»
1917	Grinell J.	USA	Proposed the concept «of spatial ecological niche»

Continuation of the table 2

Time: centuries, years	Author	A country	Summary of the environmental study
1918	Gams H.	Switzerland –Austria	He divided biology into idiobiology (the study of organisms) and biocenology (the study of communities of organisms), introduced the concept of «phytocenology », «synusia »(the term was used in his lectures in 1917 by the Swiss geobotanist E. Rübel; Lippmaa T. M. made a great contribution to the study of synusia), independently proposed the concept of «phytocenosis »(proposed in 1915 by I.K. Pachosky)
1921	Park R., Burgess E.	USA	They proposed the concept of «human ecology»
1925	Lotka A.	USA	«Fundamentals of biophysics »- together with V. Volterra (1926) laid the foundations of mathematical ecology
1926	Vernadsky V.I.	USSR	«Biosphere », in 2 vols. – developed ideas about the planetary geochemical role of living matter
1926	Volterra W.	Italy	Together with A. Lotka (1925) he laid the foundations of mathematical ecology. Developed mathematical models for the growth of individual populations and populations related by relations of competition and predation (Lotka-Volterra models)
1927	Leroy E.	France	Suggested to understand under «the noosphere» «the spiritual layer of life» (Teilhard de Char den, 1930 adhered to a similar path of ki)
1927	Friedrich K.	Germany	He put forward a hypothesis according to which the regulation of population size is a consequence of the totality of the influence of all factors (abiotic and biotic) at the level of biocenosis
1927	Elton Ch.	England	«Animal ecology »- designed a new scientific direction – «population ecology », proposed the law «of the pyramid of numbers », the concept of «a trophic ecological niche»

Continuation of the table 2

Time: centuries, years	**Author**	**A country**	**Summary of the environmental study**
1928	Beklemi-shev V. N.	USSR	In the works «Organism and community (on the formulation of the problem of individuality in biocenology) »and «Basic concepts of biocenology as applied to the animal components of terrestrial communities» (1931), he proposed the concept of Geomerida – consideration of all living matter of the biosphere as some kind of systemic unity
1933	Kashkarov D.N.	USSR	«Environment and community (basics of synecology) »; «Fundamentals of Animal Ecology »(1938) – the first Russian textbooks on ecology
1933	Leopold O.	USA	Proposed the concept of «edge effect»
1933	Nicholson A.	Austria	He put forward a hypothesis of density-dependent regulation of the population size (self-regulating process)
1934	Gause G.F.	USSR	«Struggle for coexistence »- outlined the principles of competitive exclusion; described the first experimental study of species relationships
1935	Tansley A.	England	Introduced the concept of «an ecosystem»
1938	Williams W.R.	USSR	«Soil science »- proposed a hypothesis of independence of fundamental environmental factors : «... plants for their life require both the joint presence or the same influx of all the conditions or factors of their life without exception»
1938 February		USSR	I All-Union Environmental Meeting (Leningrad)
1939	Troll K.	Germany	He defined a new scientific direction – «landscape ecology »(based on the works of K. D. Glinka and L. S. Berg; USSR, 1927–1929)

Continuation of the table 2

Time: centuries, years	**Author**	**A country**	**Summary of the environmental study**
1940		USSR	I All-Union Environmental Conference (Kyiv); II–IV were held there in 1950, 1954 and 1962; All-Union Environmental Conference (Moscow, 1973)
1940	Vernadsky V.I.	USSR	Proposed a fundamental principle (in fact, an axiom) about the biogenetic migration of elements
1941	Severtsev S. A.	USSR	Connected ecology with evolutionary ideas and defined «ecology »as the science of the mechanisms of the struggle for existence
1942	Lindeman R.	USA	Article «Trophy-dynamic direction in environmental research »- described the law «of the energy pyramid »(10% rule) and methods for calculating the energy balance of an ecosystem
1942	Sukachev V. N.	USSR	Proposed the concept «of »biogeocenosis
1944	Vernadsky V.I.	USSR	Article «A few words about the noosphere »: «The biosphere of the 20th century is turning into a noosphere, created primarily by the growth of science, scientific understanding and the social labor of man based on it»
1951	Beklemi-shev V. N.	USSR	He proposed the concept «of consortium » (in 1952, this concept was independently proposed by L. G. Ramensky). V. V. Masing made a great contribution to the development of ideas about consortia
1951	Margalef R.	Spain	For the first time, he proposed to use informational entropy measures to assess the ecological diversity and stability of ecosystems; further developed ideas about communities as self-organizing (cybernetic) systems
1952	Burkhol-der P.	USA	He proposed a classification of biotic interactions according to quantitative effects («+ »- positive, «0 »- neutral, «- »- negative)

Continuation of the table 2

Time: centuries, years	Author	A country	Summary of the environmental study
1954	Grigoriev A. A.	USSR	Developed (together with M. I. Budyko) the concept of periodic geographic zoning
1957	Hutchinson J.	USA	Generalized the concept of «a niche »by J. Grinell and C. Elton and proposed the concept of a «multidimensional or hyperspatial ecological niche »; also proposed the concept of «a realization ecological niche ». Simultaneously with R. McArthur, he developed a formal system of mathematical relations for describing ecological diversity
1961	Hutchinson J.	USA	He described «the paradox of plankton »and was one of the first opponents of the idea of competition as the main force that forms the community
1963	Sochava V. B.	USSR	He proposed the concept «of geosystem»
1965	Rodin L. E.	USSR	«The dynamics of organic matter and the biological cycle of ash elements and nitrogen in the main types of vegetation on the globe »- one of the first monographs on the cycle of substances in ecosystems
1966	MacArthur R.	USA	«Population Biology »(together with J. Connell) and «The Theory of Island Biogeography» (together with E. Wilson, 1967) – in these books and earlier works, he approved a deterministic point of view on ecological processes, the primacy of stability and competition in the formation of communities, which contributed to the formation mathematical (analytical) ecology; proposed the concept of «a minimum viable population »(1967)
1968		France	MAB («Man and the Biosphere ») is a scientific program adopted in Paris at the UNESCO Intergovernmental Conference on the rational use and protection of biosphere resources

Continuation of the table 2

Time: centuries, years	**Author**	**A country**	**Summary of the environmental study**
1968		Italy	The Club of Rome »was founded «- an international scientific (non- governmental) organization created to develop strategies for solving many global (including environmental) problems. Gave impetus to the construction of simulation models global processes in the biosphere
1971	Com-moner B.	USA	The work Closing Circle was published «, in »which four laws of ecology are formulated
1971	Odum Yu.	USA	«Fundamentals of Ecology »(Russian translation, 1975), «Ecology »in 2 vols. (1983; Russian translation, 1986)
1972	Meadows D. et al.	USA	Report to the Club of Rome «Limits to Growth»
1973	Lovelock, J. Margulis L.	USA	They put forward «the hypothesis of Gaia »- considering the Earth as a single cybernetic system with biological mechanisms of regulation
1974		Holland	I International Congress of Ecologists (The Hague). The International Society of Ecologists (INT- EKOL) was founded
1977	Budyko M.I.	USSR	«Global ecology »- the foundations of a new scientific direction have been laid
1988			«The Center for Our Common Future »is a philanthropic organization to promote the involvement of the public and organizations around the world in efforts towards sustainable development
1992		Russia	The Law on Environmental Protection was adopted
1992		Brazil, Rio de Janeiro	UN Conference on Environment and Development; The document «Agenda for the 21st Century was adopted », etc.
1992	Meadows D. et al.	USA	Report to the Club of Rome “Beyond Growth”

End of the table 2

Time: centuries, years	**Author**	**A country**	**Summary of the environmental study**
1996		Russia	Presidential Decree on Russia's transition to the concept of sustainable development
1997		USA, New York	UN Conference on Environment and Development "Rio+5"
1997		Greece, Thes-saloniki	International Conference “Education for Sustainable Development”
1999		Denmark, Aarhus	International Convention on Environmental Information and Citizen Involvement in Environmental Decision-Making
2000			The 52nd session of the UN General Assembly proclaimed 2000 the International Year for the Culture of Peace
2001		Italy, Genoa	G8 summit
2002		South Africa, Johan Nesburg	UN Conference on Environment and Development «Rio+10»
2003		Russia Moscow	International Conference on Climate Change

THEME 2
THE BODY AS A LIVING HOLISTIC SYSTEM. LEVELS OF BIOLOGICAL ORGANIZATION AS OBJECTS OF STUDY IN ECOLOGY. TROPHIC LEVELS: CONCEPT AND ECOLOGICAL FUNCTIONS

Motivation statement

Any living being is an organism. It differs from inanimate nature by a certain set of properties inherent only in living matter: cellular organization, metabolism with the leading role of proteins and nucleic acids, which ensures homeostasis organism – self-renewal and maintenance of the constancy of its internal environment. Living organisms are characterized by movement, irritability, growth, development, reproduction and heredity, as well as adaptability to the conditions of existence – adaptation.

Gene, cell, organ, organism, population, community (biocenosis) – are the main levels of life organization. Ecology studies the levels of biological organization from organism to ecosystems. It is based, like all biology, on the theory of the evolutionary development of the organic world by Charles Darwin, based on the ideas of natural selection. In a simplified form, it can be represented as follows: as a result of the struggle for existence, the most adapted organisms survive, which transmit beneficial traits that ensure survival to their offspring, which can develop them further, ensuring the stable existence of this type of organisms in given specific environmental conditions. If these conditions change, then organisms with traits that are more favorable for the new conditions, transmitted to them by inheritance, survive, etc.

The objective: to study the basic properties and levels of organization of living matter. To form an idea of trophic relationships in the biosphere and the logic of energy transitions along trophic levels.

Question for discussion

1. Connections in Nature
2. General ecological maxims
3. The boundaries between living and non-living matter. Phenomena of anabiosis.
4. Levels of organization of the living, features of the ecological approach to their study.
5. Trophic chain in an ecosystem.

Independent work of students

1. Solving a situational professionally oriented problem, documenting the solution in a protocol.
2. Watch an educational video on the topic of the lesson.
3. Completing assignments on the topic «The body as a living integral system." Levels of biological organization as objects of study in ecology. Trophic levels: concept and ecological functions».

Tasks

1. After becoming familiar with the basic theoretical axioms of biology, take part in the discussion «Can viruses be considered living organisms? »
2. Solve test questions.

1. The organisms that make up the food chain and receive food through an equal number of links in this chain belong to the same...

a) trophic level

b) trophic structure

2. As a result of the successive transfer of matter and energy through trophic levels, each ecosystem establishes its own...

a) food chain

b) trophic structure

3. Ecologists depict the trophic structure:

a) around

b) a pyramid

c) a square

4. In the process of the circulation of substances in the biosphere, decomposers...

a) participate in the formation of organic substances from inorganic

b) use sunlight to synthesize nutrients

c) decompose organic residues and use the energy contained in them

4) absorb carbon dioxide and oxygen

5. Which food chain correctly reflects the transfer of energy in it?

a) fox → earthworm → shrew → leaf litter

b) leaf litter → earthworm → shrew → fox

c) shrew → earthworm → leaf litter → fox

d) shrew → fox → earthworm → leaf litter

6. In detrital food chains, the following occurs:

a) mineralization of organic residues

b) reduction of carbon dioxide

c) consumption of live plants

d) the formation of organic substances

7. The first link in the grazing chains of terrestrial communities is represented by...

a) bacteria

b) mushrooms

c) animals

d) plants

8. The level at which the processes of biogenic migration of atoms are studied is called:

a) biogeocenotic

b) biospheric

c) population-species

d) molecular genetic

9. At the population-species level, they study

a) gene mutations

b) organ systems

c) the relationship of organisms of the same species

d) metabolic processes in the body

10. The water cycle in nature is observed at the level of life organization:

a) population-species

b) biospheric

c) organism

11. The living matter of the land reflects the level of organization of the living:

a) ecosystem

b) organism

c) biosphere

12. The similarity of the elementary composition of a cell and bodies of inanimate nature indicates:

a) the material unity of living and inanimate nature

b) dependence of living nature on inanimate

c) the complex chemical composition of living and inanimate bodies

13. Establish a correspondence between the levels of organization of living things and their characteristics and phenomena occurring at these levels: biocenotic:

a) transfer of energy from producers to consumers

b) processes cover the entire planet

c) interspecies struggle for existence

14. Establish a correspondence between the levels of organization of living things and their characteristics and phenomena occurring at these levels: biospheric:

a) symbiosis

b) processes cover the entire planet

c) interspecies struggle for existence

15. Living from non-living is different:

a) the ability to change the properties of an object under the influence of the environment

b) the ability to participate in the cycle of substances

c) the ability to reproduce their own kind

16. Living from non-living is different:

a) openness to substances, energy and information

b) the ability to change the properties of an object under the influence of the environment

c) change the size of an object under the influence of the environment

17. All living organisms are characterized by:

a) the formation of organic substances from inorganic substances

b) active movement in space

c) irritability

18. The cellular level of organization coincides with the organismic level in:

a) the polio virus

b) amoeba dysentery

c) bacteriophages

Reference material

Classification of interspecies relationships

In biocenoses, certain connections (biotic relationships) arise between different types of organisms. The main form of these connections are food relations (trophic connections). *Trophic* relationships occur between species when one species feeds on others: living individuals, dead remains, waste products. Of course, in each system there are also topical connections (manifested in a change in the living conditions of another species by one species), and *phoric* connections (they arise when one species participates in the spread of another), and *factory* connections (consist in the fact that one species uses for of their structures, excreta, dead remains, or even living individuals of another species).

1. According to trophic indicators, i.e., the nutritional relationships of organisms that regulate the entire energy of biotic communities and the entire ecosystem as a whole. Autotrophic organisms use inorganic sources for their existence, thereby creating organic matter from inorganic matter. Such organisms include photosynthetic green plants of land and aquatic environments, blue-green algae, some bacteria due to chemosynthesis, etc. Heterotrophic organisms consume only ready-made organic substances. These include all animals and humans, fungi, etc. Heterotrophs that consume dead organic matter are called saprotrophs (for example, fungi), and those that can live and develop in living organisms at the expense of living tissues are called –parasites (for example, ticks).

2. Since organisms are quite diverse in types and forms of nutrition, they enter into complex trophic interactions with each other, thereby performing the most important ecological functions in biotic communities. Some of them produce products, others consume, others convert it into an inorganic form. They are called respectively: *producers*, *consumers* and *decomposer*.

Producers – producers of products that all other organisms then feed on – are terrestrial green plants, microscopic sea and freshwater algae, producing organic substances from inorganic compounds.

Consumers – These are consumers of organic substances. Among them there are animals that eat only plant foods – herbivores (cows) or carnivores (carnivores) that eat only the meat of other animals, as well as –"omnivores" (humans, bears) who consume both

Reducers (destructors) – reducers. They return substances from dead organisms back to inanimate nature, decomposing organic matter into simple inorganic compounds and elements (for example, into CO_2, NO_2 and H_2O). By returning nutrients to the soil or aquatic environment, they complete the biochemical cycle. This is done mainly by bacteria, most other microorganisms and fungi.

1. By type of respiration (participation of $O_{2)}$. Microorganisms, bacteria and other more complex forms, depending on the habitat, are divided into aerobic, that is, living in the presence of oxygen, and anaerobic –living in an oxygen-free environment.

Food chains are divided into two main types – *grazing* (consumption chains) and *detrital* (decomposition chains). Grazing chains start with a green plant and lead to the organisms that eat those plants–grazing herbivores–and then to herbivorous predators or parasites. An example would be meadow communities with herbivores grazing on them, which are hunted by predators. Detrital chains start from the organic matter of dead organisms or their parts and then lead to organisms that feed on this decaying ("dead") organic matter (*detritivores*) and their consumers (*predators*).

The detritus food chain is characteristic of aquatic ecosystems. In forests, there are grazing and detrital food chains, which are interconnected by predators that eat both herbivores and animals that feed on fallen organic matter. Food chains are not isolated from each other, but are closely intertwined. Their plexuses are often called the food web. In a complex natural community, organisms that obtain their food from plants through the same number of stages are considered to belong to the same trophic level.

The trophic level is also defined as a set of organisms united by one type of nutrition, occupying a certain position in the general food chain. Green plants occupy the first trophic level – the level *of producers*, herbivores – the second, or the level *of consumers of the 1st order* (these include various animals – many insects, rodents, ungulates, etc.), predators that eat herbivorous animals – the third (*level 2nd order consumers*, secondary consumers), secondary predators – fourth (level of 3rd order consumers, *tertiary consumers*), etc. For example, a predatory beetle eating a herbivorous caterpillar belongs to the first order predators; an insectivorous bird eating a predatory beetle is a predator of the second order, and a falcon

attacking it is a predator of the third order. So, the first consumers of energy in ecosystems are plants, the second – herbivorous animals or phytophages. Subsequent consumers of energy are animals that feed on other animals (zoophages, including parasites, predators). After the death of organisms, dead organic matter, semi-decomposed remains are used by bacteria, fungi, and some animals – *decomposers* (dead beetles, dung beetles, vultures, hyenas, etc.).

At each stage of energy transfer, a significant part of it (on average 90%) is lost, since in any part of the food chain food is used for growth, is spent on meeting energy costs for respiration, movement, reproduction, and maintaining body temperature. Let us assume that at the first trophic level, in the process of photosynthesis, green plants store 1,000,000 units of conventional energy, then only 100 will remain at the fifth level.

The efficiency of product transfer between neighboring trophic levels is, therefore, on average 10%. The action in nature of this pattern limits the possible number of links in the food chain, usually to 4–5. The shorter the food chain, the greater the amount of final, available energy, the greater the production can be removed at the next link.

If the species included in the trophic network are ordered by groups (producers, consumers) and by trophic levels (consumers of the first order, second, etc.), then we can talk about the trophic structure of a given biocenosis, ecosystem (biogeocenosis).

There are different levels of existence of living matter – from large molecules to plants and animals of various organizations.

1. *Molecular (genetic)* – the lowest level at which a biological system manifests itself in the form of the functioning of biologically active large molecules – proteins, nucleic acids, carbohydrates. From this level, properties that are characteristic exclusively of living matter are observed: the metabolism that occurs during the transformation of radiant and chemical energy, the transmission of heredity with the help

of DNA and RNA. This level is characterized by the stability of structures in generations.

2. *Cellular* – the level at which biologically active molecules are combined into a single system. With regard to cellular organization, all organisms are divided into unicellular and multicellular.

3. *Tissue* – the level at which the combination of homogeneous cells forms tissue. It covers a collection of cells united by a common origin and functions.

4. *Organ* – the level at which several types of tissues functionally interact and form a specific organ.

5. *Organismic* – the level at which the interaction of a number of organs is reduced into a single system of the individual organism. Represented by certain types of organisms.

6. *Population-species*, where there is a set of certain homogeneous organisms related by unity of origin, way of life and habitat. At this level, elementary evolutionary changes in general occur.

7. *Biocenosis and biogeocenosis (ecosystem)* – a higher level of organization of living matter, uniting organisms of different species composition. In biogeocenosis, they interact with each other on a certain area of the earth's surface with homogeneous abiotic factors.

8. *Biospheric* – the level at which a natural system of the highest rank was formed, covering all manifestations of life within our planet. At this level, all cycles of matter occur on a global scale, associated with the vital activity of organisms.

Features of the living *B. M. Mednikov (1982)* formulated in the form of **axioms of theoretical biology:**

1. All living organisms turn out to be a unity of a phenotype and a program for its construction (genotype), which is inherited from generation to generation *(A. Weisman's axiom).*

2. The genetic program is formed in a matrix way. The gene of the previous generation is used as a matrix on which the gene of the future generation is built *(N.K. Koltsov's axiom).*

Non-directionally as a result of various reasons, and only by chance can such changes be successful in a given environment *(Ch. Darwin's 1st axiom).*

4. Random changes in genetic programs during the formation of the phenotype increase many times over *(axiom of N. V. Timofeev-Resovsky).*

5. Repeatedly enhanced changes in genetic programs are subject to selection by environmental conditions *(2nd axiom of Charles Darwin).*

From these axioms one can derive all the basic properties of living nature, and primarily such as discreteness and integrity – two fundamental properties of the organization of life on Earth. Among living systems there are no two identical individuals, populations and species. This unique manifestation of discreteness and integrity is based on the phenomenon of convariant reduplication.

Convariant reduplication (self-reproduction with changes) is carried out on the basis of the matrix principle (the sum of the first three axioms). This is probably the only property specific to life, in the form of its existence on Earth known to us. It is based on the unique ability for self-reproduction of the main control systems (DNA, chromosomes, genes).

THEME 3
PHYSICAL AND CHEMICAL ENVIRONMENTAL FACTORS IN THE LIFE OF ORGANISMS, ROLE AND SIGNIFICANCE

Motivation statement

The vast majority of all living organisms that make up complex ecological systems are exposed to physical and chemical factors in their life activities. Moreover, these factors often play the role of limiting factors, i.e. factors that limit the development and vital activity of the body due to their deficiency or excess compared to the need (optimal content). For the first time, the importance of limiting factors that were at a minimum was pointed out by the German agrochemist J. Liebig in the middle of the 19th century. He described the importance of even individual chemical deficiencies for plant productivity (for example, insufficient phosphorus in the soil can reduce yields).

This phenomenon was called the law of the minimum by Yu. Liebig. R. Mitscherlich showed that the combined effect of all plant life factors, including physical ones: temperature, humidity, light, etc., is important for productivity. Subsequently, in the development of theoretical aspects of the influence of physical and chemical environmental factors on the vital functions of organisms, the law of independence of factors by V. R. Williams and the law of tolerance by V. Shelford played a huge role. It has now been repeatedly confirmed that in natural conditions, organisms depend on critical levels of exposure to physical factors, the content of necessary chemicals, as well as on the range of tolerance of the organisms themselves to various environmental factors. These patterns relate to the fundamental ecological principles and laws, knowledge of which is of great practical professional importance for pharmacists and can

be used in developing methods for growing medicinal plants or creating test systems for the selection of plants resistant to oxygen deficiency and other physical and chemical factors, contributing to the formation of environmental thinking.

The objective: to form an idea of the meaning and role of physical and chemical factors in the life of organisms, as a theoretical basis for the implementation of professional labor actions, taking into account the need to ensure environmental safety.

Questions for discussion

1. The concept of limiting environmental environmental factors and the range of tolerance of organisms to their effects (stenobionts and eurybionts).

2. Physical environmental factors and their significance in the life of organisms (temperature, humidity, air movement, light, radiation).

3. Poikilothermic and homeothermic animals: concepts, examples. The combined effect of temperature and humidity on the life of organisms.

4. Light and its role in the life of organisms: The concept of photoperiodism, examples of the influence on the life of representatives of the animal and plant world.

6. The importance of oxygen in the life of organisms. Gas exchange in the aquatic environment (adaptation of organisms to living in an environment with low oxygen content, adaptation to fluctuations in oxygen content in the environment).

7. Hypoxia – concept, adaptation mechanisms. Comparative analysis of the quantitative oxygen content in different media (water, air), factors that change the amount of oxygen.

8. The importance of green spaces in changing the chemical composition of the air.

9. Water as the most important environmental factor. Classification of terrestrial organisms depending on their water needs.

10. Nutrients (macro- and microelements): concept, examples, significance in the life of plants and animals. Large cycle of substances in nature.

Independent work of students

1. Carrying out practical work to determine physical environmental factors:

1.1. Measuring and recording ambient air temperature

1.2. Determination of relative air humidity using an aspiration psychrometer.

1.3. Determination of air speed with an anemometer.

4. Solving a situational professionally oriented problem, documenting the solution in a protocol.

5. Listening and discussing the essay prepared by the student on the individual instructions of the teacher.

6. Working with control tests.

6.1. Input test to control the level of knowledge on the topic of the lesson.

Exercise. Input control of the level of knowledge in the second lesson on topic No. 3 – give written answers to control test questions and submit the work to the teacher for checking.

Reference material

Limiting environmental factors, or limiting factors, are environmental factors (usually of a physical or chemical nature) that limit the development of organisms due to a deficiency or excess compared to the need (optimal content).

The range of tolerance (or tolerance) of environmental factors in various plant or animal organisms is very diverse. However, in accordance with W. Shelford's law, both a deficiency and an excess of any factor (in a qualitative or quantitative sense) may be close to the limits of what can be tolerated for each specific organism. Such limits are called limits of tolerance.

Organisms whose life requires conditions limited to a narrow range of tolerance are called stenobionts ("steno" – narrow), and those adapted to live in conditions with a wide range of tolerance are called eurybionts ("eury" – wide). For example, shade-loving plants are stenobionts in relation to the effects of sunlight Sveta; The brown bear is eurybiontic in relation to climatic factors. It is known that organisms that are eurybiont to the main climatic factors are most widespread on planet Earth. It is worth considering that the body's tolerance range does not remain constant and unchanged throughout life; it can narrow or expand. For example, newborn representatives of mammals are more stenobionts to the effects of physical factors (and above all, temperature) compared to adult individuals.

Physical environmental factors

Ambient temperature is one of the most important limiting factors. Highlight stenothermic And eurythermic organisms (Fig. 1).

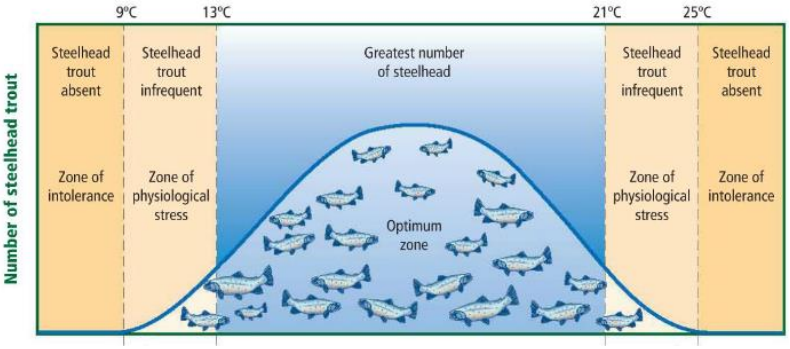


Fig. 1. *Limits of tolerance of eurythermal and stenothermal organisms*

Homeothermic animals have a higher tolerance limit compared to poikilothermic animals. In general, most living beings are able to live in a temperature range from 0 to 50º C, which is due to the

characteristics of cell protoplasm and protein denaturation in animals and the characteristics of photosynthesis in plant organisms. For example, at temperatures above 0º C, metabolic processes are activated in most perennial and annual plants; with an increase in temperature by 10º C, the intensity of photosynthesis increases 2 times, but only to a level of 30-35º C; with a further increase in temperature, the intensity of photosynthesis decreases, and at 50º C stops altogether.

The thermal state of the environment, determined by a complex of physical factors (temperature, humidity, air speed, radiant heat) in a limited space and influencing the heat exchange of living organisms, is designated by the term *microclimate.*

Monitoring the state of ambient temperature and measuring it is carried out using thermographs and a set of technical, research and meteorological thermometers, most often liquid ones. Together with thermographs, minimum and maximum liquid thermometers are also used to establish specific values for recorded temperature fluctuations.

Ambient relative humidity can be measured using aspiration psychrometers, and wind mobility can be measured using vane or cup anemometers. Wind speed changes under the influence of cyclonic activity of the atmosphere, and the passive movement of air masses is of a convective nature. Air movement promotes the movement of aeroplankton (spores, pollen, seeds, microorganisms and also insects and even small animals) and contributes to their settlement in limited areas. Under the influence of wind loads, the above processes can occur much more intensely and, in addition, the wind has a direct effect not only on living organisms, but also on the environments themselves, causing characteristic adaptations. For example, adaptation to flight as a means of searching for food or changing the terrain, etc.

Light and its role in the life of organisms. Natural light, the source of which is the Sun, is the most important environmental factor without which life on planet Earth is impossible. Sunlight is

the most important source of energy; it participates in the processes of photosynthesis, providing plants with the production of oxygen and organic compounds from inorganic ones. It should be remembered that only part of the solar spectrum with a wavelength in the range from 380 to 760 nm is involved in photosynthesis. This area is called *the physiologically active radiation region (PAR*). Within it, waves with a length of 600-700 nm (red-orange) and 400–500 nm (violet-blue) are of greatest importance for photosynthesis; waves with a length of 500-600 nm correspond to the yellow-green part of the spectrum and have the greatest reflectivity. Outside the PAR are the ultraviolet (UV) and infrared (IR) regions. UV radiation has a photochemical effect, and organisms are very sensitive to its effects. IR radiation has a greater thermal effect, which is important for climate formation, heating of water masses, and even for a direct increase in body temperature in poikilothermic organisms.

In addition, illumination is also important for the life of plant and animal organisms – a light value equal to the ratio of the luminous flux incident per unit area to its area, measured in lux (lx), as well as illumination intensity, which is also measured in *lx and* in in temperate latitudes in the summer at noon in sunny weather it reaches a value of 100,000 lx, and in the afternoon it decreases to 25,000 lux. Depending on the limits of tolerance to light and light intensity, all plant organisms are divided into: *light-loving, or heliophytes* (meadow grasses, cereals, weeds, fruit trees...), *shade-loving, or sciophytes* (plants of forest-steppe oak forests, taiga spruce forests, tropical forests) and those *that are not tolerant* (black elderberry, lily of the valley, golden currant, common mantle, etc.). Shade-tolerant plants have the widest range of light tolerance.

In addition, light has a signaling and regulatory significance, which is manifested, among other things, by *photoperiodism* in plants – the body's reaction to seasonal changes in the length of daylight hours.

Electromagnetic fields, in particular *the geomagnetic field of the Earth, are also* of great importance in the life of animals and humans. For example, it is known about the influence of changes in the intensity of the geomagnetic field on anthropometric indicators: with a decrease in the intensity of the magnetic field, an increase in the size of the skeleton of animals and humans is recorded. Electromagnetic fields are also universal carriers of information in the biosphere; they are associated with the migration of migratory birds, the migration of fish during the spawning period, etc.

The electrostatic field affects the content of air ions and the ratio of negatively and positively charged air ions) – the predominance of negative (so-called light air ions) leads to an increase in the germination of plant seeds and an increase in the vital activity of animals and humans.

The Earth's natural radioactive field, or field of ionizing radiation, is formed due to cosmic radiation, radionuclides included in rocks (potassium-40, uranium-238, thallium, thorium-232, radium-226), as well as radioactive gases – radon 222 and radon-220 (thoron). Fixed on the surface and in the near-surface part of the lithosphere. Natural radioactive background varies between 2-20 mSv /year; this level is considered safe. In cases where the above level of radioactivity is exceeded, so-called long-term effects, in particular mutagenic effects, may be observed.

Chemical factors and their significance in the life of organisms

Among the most important environmental factors of a chemical nature, we primarily pay attention to oxygen, nitrogen, carbon and water. The chemical composition of the atmosphere at the present stage of the evolution of planet Earth is quite homogeneous and is represented by: nitrogen and its compounds -78.8%; oxygen – 20.95%; argon and other inert gases – 0.9%; carbon dioxide, or carbon dioxide – 0.03-0.04% by volume. In the aquatic environment,

the amount of oxygen is 20 or more times less (at great depths) than in the atmosphere (Table 1).

Table 1

Oxygen in water and air environments

	Water environment	Air environment
The amount of oxygen in the environment	Sea and fresh waters contain 88.8% (by mass) bound oxygen; in small fast cold rivers the upper threshold reaches 12 mg/l, in lowland rivers, large flowing lakes and reservoirs – 9–7 mg/l, in small closed lakes and ponds – 5 mg/l; 3-6 mg/l in drinking water.	In the atmosphere, the content of free oxygen is 20.95% by volume and 23.12% by mass.
Factors that reduce the amount of oxygen in the environment	As the water temperature decreases, the amount of dissolved oxygen begins to decrease. With a subsequent decrease in temperature, aquatic plants and algae begin to die off, the intensity of photosynthesis is reduced to zero, and the content of dissolved oxygen in water depends only on the mechanical effect of air on water. Next comes a critical period in the life of the fish population of the reservoir – the establishment of a dense ice cover, which almost completely blocks the access of oxygen from the air to dissolve in the upper layer of water.	Environmental pollution, active and passive smoking. A decrease in the amount of atmospheric oxygen, and therefore its entry into the body, is largely facilitated by increased air humidity, accompanied by high temperature. Increase in altitude above sea level.
Factors that increase the amount of oxygen in the environment	High speed of air movement, as the intensity of mixing water and air increases, which is facilitated by powerful autumn wind-driven disturbances in river flows. In summer, during the intensive growth of algae and submerged aquatic vegetation in lowland rivers and lakes, the amount of oxygen is higher, as plants release oxygen into the water through the process of photosynthesis. The oxygen content of water is affected by the temperature of the water: the colder the water, the more oxygen it contains.	Regular ventilation of enclosed spaces.

Oxygen and carbon dioxide are limiting factors for the distribution of living organisms and life forms in the atmosphere and hydrosphere (Fig. 2).

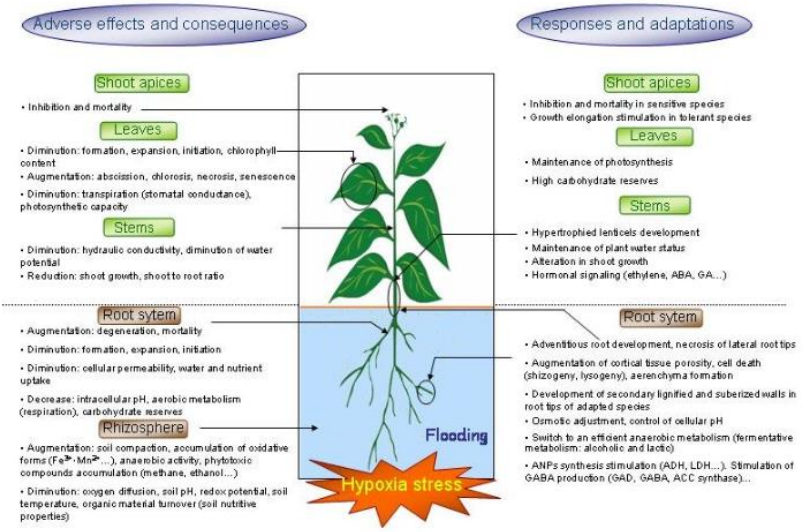


Fig. 2. *Scheme of ways of plant adaptation to hypo- and anoxia*

The carbon dioxide content in the soil reaches about 10%, and oxygen becomes a limiting factor for aerobic organisms. Among the biogenic macroelements, nitrogen and phosphorus act as the most important biogenic macroelements for all spheres of life, because phosphorus is the most important intracellular element, and nitrogen is a component of protein molecules. These elements participate in the biological cycle of substances and are fixed by most plant and heterotrophic animal organisms. The importance of phosphorus for plant productivity was described by J. Liebig in the 19th century and became one of the basic environmental laws. It is known that phosphorus deficiency is second only to water in its effect on the productivity

of biota. Potassium, calcium, sulfur and magnesium also play a vital role in the life of organisms: they perform structural, biochemical and regulatory functions. Biogenic microelements: iron, manganese, copper, zinc, boron, silicon, molybdenum, chlorine, vanadium and cobalt are included in enzymes, ensure the transfer and exchange of oxygen, regulate the processes of photosynthesis and nitrogen metabolism, etc. It is important to consider that not only a deficiency, but excess (due to environmental pollution or as a result of natural endemics) can act as limiting factors. Plays a role *in the life of organisms* the most important role. From a physiological point of view, water is a universal solvent that ensures the occurrence of most redox reactions, the most important structural component of protoplasm; From an environmental point of view, it is a living environment and a limiting factor for both flora and fauna, both in terrestrial and aquatic habitats.

All living organisms, depending on their need for water, and, consequently, on differences in habitat, are divided into a number of ecological groups:

- **aquatic or hydrophilic –** permanently living in water;
- **hygrophilic –** living in very humid habitats;
- **mesophilic –** characterized by a moderate need for water;
- **xerophilous –** living in dry habitats.

Based on the type of habitat and lifestyle, aquatic organisms are grouped into the following ecological groups.

Plankton are organisms that mostly move passively due to currents. There are **phytoplankton** (single-celled algae) and **zooplankton** (single-celled animals, crustaceans, jellyfish, etc.).

Nekton are animals that actively move in water (fish, amphibians, cephalopods, turtles, pinnipeds, cetaceans, etc.).

Benthos are organisms living at the bottom and in the soil. It is divided into **phytobenthos** (attached algae and higher plants) and **zoobenthos** (crustaceans, mollusks, starfish, etc.).

In addition, in some cases, **periphyton and neuston are isolated**. Periphyton are organisms attached to the leaves and stems of aquatic plants or other protrusions above the bottom of a reservoir. Neuston – organisms that live at the surface of water (mosquito larvae, water striders, duckweed, etc.).

For aquatic environments, water temperature, transparency, current, salinity, oxygen concentration, etc. are important. For the land-air environment, the most important characteristics are: the amount of precipitation, air humidity, available water supply, etc.

THEME 4
THE MAIN HABITATS (AQUATIC, TERRESTRIAL, SOIL, LIVING ORGANISMS) AND ENVIRONMENTAL FACTORS

The motivational statement

Habitat is a part of nature that surrounds living organisms and has a direct or indirect impact on them. From the environment, organisms receive everything necessary for life and in it they also secrete metabolic products. The environment of each organism consists of many elements of the inorganic and organic nature of the elements introduced by man and his production activities. At the same time, some elements may be partially or completely indifferent to the body, others are necessary, and others have a negative impact.

Habitat – "everything that surrounds organisms and directly or indirectly affects their condition, development, survival and reproduction" (Naumov 1963).

The habitat that provides the possibility of life of organisms on Earth is diverse. On the planet Earth, organisms inhabited four

environments of life, differing in the composition of environmental factors, the range of their variability.

On our planet, living organisms have mastered four main habitats, which differ greatly in the specifics of conditions. The aquatic environment was the first in which life originated and spread. Subsequently, living organisms mastered the ground-air environment, created and populated the soil. The fourth specific environment of life has become the living organisms themselves, each of which represents a whole world for the parasites or symbionts inhabiting it. In the process of evolution of organisms, adaptations (adaptations) to existence in a particular environment have been formed.

The objective: to form knowledge of the basic concepts and laws of general ecology, to generalize and systematize ideas about the environments of life, their properties, adaptations of organisms to them. To show the diversity of animals on Earth, their connection with the environment.

Questions for discussion

1 The specifics of the aquatic habitat.

2. The main characteristics of aquatic habitat: water-mass density, oxygen condition, the salt regime, the temperature regime, light conditions.

3 Terrestrial habitat. The basic properties of terrestrial habitat.

4. Soil as a habitat. Density and diversity of life in the soil.

5. Living organisms as a habitat.

6. Comparative characteristics of habitats and adaptation of living organisms to them

Independent work of students

1. Situational problems. Reference material, tables and recommended literature may be used. The situational problems should be reported in writing.

2. Discussion report prepared by the students on an individual task of a teacher.

Task 1

Answer the questions.

1. The fastest moving animals live in an environment:

a) terrestrial;

b) soil;

c) water;

d) in living organisms.

2. Name the largest animal that has ever existed (and still exists) on Earth. What kind of environment does it live in? Why can't such large animals arise and exist in other habitats?

3. Explain why in ancient times warriors determined the approach of enemy cavalry by putting their ear to the ground.

4. Ichthyologists face serious problems when preserving deep-sea fish for museums. Lifted onto the deck of the ship, they literally explode. Explain why this is happening.

5. Explain why deep-sea fish have either reduced or hypertrophied (enlarged) eyes.

6. If you mix water, sand, inorganic and organic fertilizers, will this mixture be soil?

7. Fill in the gaps by choosing one word from the pair in parentheses.

✓ Multicellular parasites living in human organs and tissues,... (threatened, not threatened) drying out;

✓ in their habitat there are fluctuations in temperature, salinity, pressure... (strong, weak);

✓ The environment in which they live is chemical for them... (aggressive, not aggressive);

✓ they... (have, do not have) protective covers;

✓ they... (have, do not have) organs related to the search for food;

- ✓ they are...(have, do not have) hearing;
- ✓ they... (have, do not have) organs of vision;
- ✓ the number of eggs they produce... (large, not large).

8. In which habitats do animals have the simplest structure of the hearing organ (it is necessary to compare closely related groups of animals)? Why? Does this prove that animals do not hear well in these environments?

9. Explain why freshwater mammals (whales, dolphins) have much more powerful thermal insulation covers (subcutaneous fat) than terrestrial animals living in harsh and cold conditions. For comparison: the temperature of salt water does not fall below -1.3 ° C, and on the land surface it can fall to -70 ° C).

10. In spring, many people burn last year's withered grass, justifying this by saying that fresh grass will grow better. Environmentalists, on the contrary, argue that this cannot be done. Why?

11. It rained. A bright hot sun came out from behind the cloud. On which territory in five hours the soil moisture content will be greater (the type of soil is the same):

a) on a freshly plowed field;

b) on a ripe wheat field;

c) on an unpassable meadow;

d) on a grazing meadow?

Explain why.

12. Explain why ravines are more often formed in non-forest natural zones: steppes, semi-deserts, deserts. What human activity leads to the formation of ravines?

13. It has been established that in summer, after the heat, more precipitation falls over the forest than over the nearby vast field. Why? Explain the role of the nature of vegetation in the formation of the level of aridity of certain territories.

14. In some countries and islands, the import of live goats is prohibited by law. The authorities are motivated by the fact that goats can harm the nature of the country and change the climate. Explain how it can be.

Task 2

Give a brief description of the main properties of the aquatic environment.

Water-mass density

_____

_____

Oxygen condition

_____

_____

The salt regime

_____

_____

Fresh water

_____

_____

Brackish waters

_____

_____

Salt water

_____

_____

Light conditions

_____

_____

The temperature regime

_____

_____

Task 3

Consider Figure 1 and place the depicted animals in the appropriate ecological group.

Neuston _____

Plankton_____

Nekton _____

Bentos_____

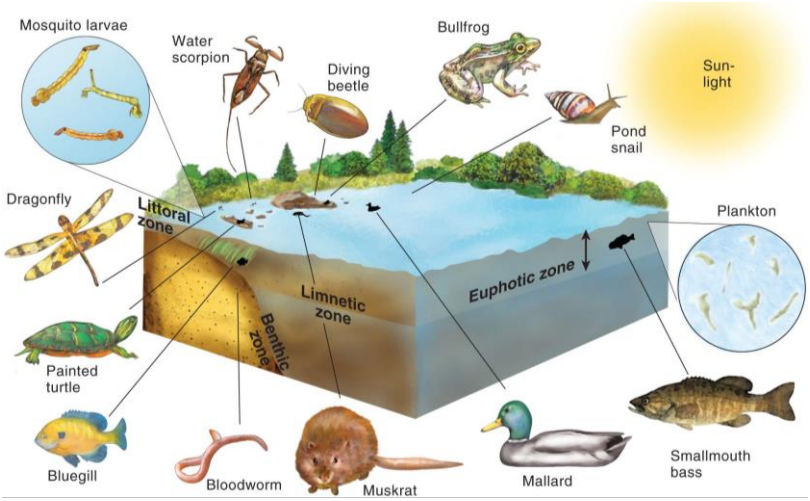


Fig. 1. *Inhabitants of a pond (freshwater reservoir) of the temperate zone*

Task 4

Fill in the blanks with appropriate words:

1. The place where organisms live is called …….

2. The plants and animals that live in water, it is called ……. habitat.

3. Plants and animals that live on land, it is called …….. habitat.

4. …… is a medium in aquatic habitat.

5. …….. is a medium in terrestrial habitat.

6. Soil, water and air are …… components of a habitat.

7. Plants put in shade for a longer time become …….

8. Animals living in …… have very much reduced eyes.

9. Plants growing in hot and dry places are called ……..

10. Desert plants have ……. root system.

11. Forests and trees act as …….

12. Animals depend on ……. for their food.

13. Matter is anything that has ……. and occupies ……...

14. The process of respiration involves …….. gases.

15. Some objects are categorised as living while others as ……..

Reference information

Habitat can be defined as a location in which a particular organism is able to conduct activities which contribute to survival and/or reproduction. This definition emphasizes the notion that the term habitat is organism- specific; that is, it focuses on the biotic and abiotic factors that affect the survival or reproduction of a particular type of organism, and on the areas that contain these factors. On our planet, living organisms have acclimated four basic habitats: aquatic, terrestrial, soil and organism as a habitat.

AQUATIC HABITAT

Water as a habitat has a variety of peculiar properties such as heavy density, heavy differential pressure, relatively low oxygen,

strong absorption of sunburst, etc. Inhabitants of aquatic habitat are hydrobiontes. They inhabit ocean, inland bodies and underground water.The ocean is categorized by several areas or zones (fig. 2).

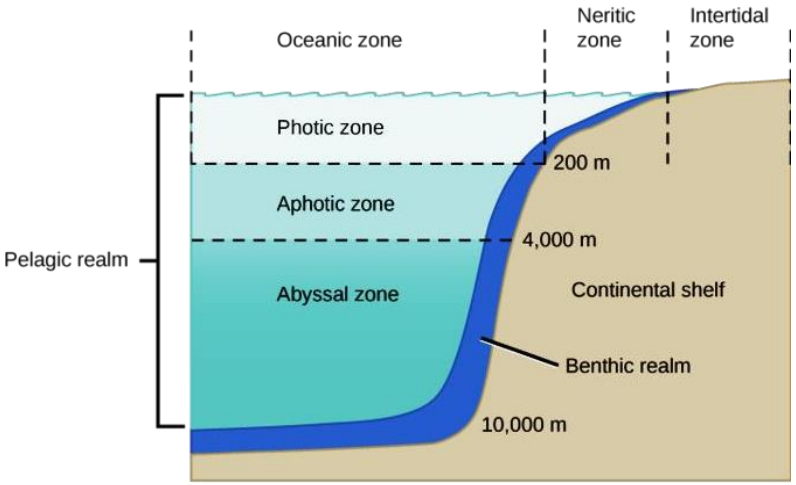


Fig. 2. *Oceanic zones*

All of the ocean's open water is referred to as the pelagic realm (or zone). The benthic realm (or zone) extends along the ocean bottom from the shoreline to the deepest parts of the ocean floor. Within the pelagic realm is the photic zone, which is the portion of the ocean that light can penetrate (approximately 200 m). At depths greater than 200 m, light cannot penetrate; thus, this is referred to as the aphotic zone. The majority of the ocean is aphotic, lacking sufficient light for photosynthesis. The deepest part of the ocean, the Challenger Deep (in the Mariana Trench, located in the western Pacific Ocean), is about 11,000 m deep. To give some perspective on the depth of this trench, the ocean is, on average, 4267 m deep. These realms and zones are relevant to freshwater lakes as well, as they determine the types of organisms that will inhabit each region.

The main characteristics of aquatic habitat:

● **Water-mass density**. The pressure increases with depth about 1*105 Pa (1 atm.) for every 10 m. Water-mass density is the condition of soaring in water and many hydrobionts are adapted precisely to this way of life. Suspended, floating in the water organisms are united in a special ecological group of hydrobionts – plankton ("planktos" – soaring).

Plankton is tiny aquatic organisms that cannot move on their own. They live in the photic zone. They include phytoplankton and zooplankton. Phytoplankton are bacteria and algae that use sunlight to make food. Zooplankton are tiny animals that feed on phytoplankton. The plankton consists of unicellular and colonial algae, protozoa, jellyfish, siphonophores, ctenophores, pteropodial and heteropodous mollusks, a variety of small crustaceans, benthic larvae, caviar and fish fry, and many others.

A special kind of plankton is the ecological group of neuston ("nein" – to swim) – the inhabitants of the surface water film on the border with the air environment.

The animals that are capable of rapid swimming and overcoming the strength of currents are united in the ecological group of nekton ("nectos" – floating). The representatives of nekton – fish, squid, dolphins.

Nekton are aquatic animals that can move on their own by ‘‘swimming” through the water.

They may live in the photic or aphotic zone. They feed on plankton or other nekton. Examples of nekton include fish and shrimp.

Benthos are aquatic organisms that crawl in sediments at the bottom of a body of water. Many are decomposers. Benthos include sponges, clams, and anglerfish.

● **Oxygen condition**. In oxygenated water its content does not exceed 10 ml per liter, this is 21 times lower than in the atmosphere. Oxygen enters the water mainly due to photosynthetic activity of

algae and diffusion from the air. Therefore, the upper layers of the water column are, as a rule, richer in this gas than the lower ones. The breathing of hydrobionts is carried out either through the surface of the body, or through specialized organs – gills, lungs, trachea. In this case the integument can serve as an additional respiratory organ.

- **The salt regime**. Maintaining the water balance of hydrobionts has its own specifics. The excessive amount of water in the cells leads to a change in their osmotic pressure and disruption in vital functions. Freshwater forms can not exist in the seas; the sea ones do not tolerate desalination. If the salinity of the water is subjected to change, the animals move in search of favourable environment.

FRESHWATER REGIONS

Freshwater is defined as having a low salt concentration– usually less than 1%. They include standing and running freshwater biomes. Standing freshwater biomes include ponds and lakes. Lakes are generally bigger and deeper than ponds. Some of the water in lakes is in the aphotic zone where there is too little sunlight for photosynthesis. Plankton and plants (such as the duckweed in Figure below) are the primary producers in standing freshwater biomes.

Ponds and Lakes

These regions range in size from just a few square meters to thousands of square kilometers. Many ponds are seasonal, lasting just a couple of months (such as sessile pools) while lakes may exist for hundreds of years or more. Ponds and lakes may have limited species diversity since they are often isolated from one another and from other water sources like rivers and oceans. Lakes and ponds are divided into three different “zones” which are usually determined by depth and distance from the shoreline.

Temperature varies in ponds and lakes seasonally. During the summer, the temperature can range from 4° C near the bottom to 22° C at the top. During the winter, the temperature at the bottom can

be 4° C while the top is 0° C (ice). In between the two layers, there is a narrow zone called the thermocline where the temperature of the water changes rapidly.

Streams and Rivers

These are bodies of flowing water moving in one direction. Streams and rivers can be found everywhere–they get their starts at headwaters, which may be springs, snowmelt or even lakes, and then travel all the way to their mouths, usually another water channel or the ocean. The characteristics of a river or stream change during the journey from the source to the mouth. At the start there are cool temperatures, clear water, and high oxygen levels. Freshwater fish such as trout and heterotrophs can be found there. Towards the middle of the stream diversity increases–numerous aquatic green plants and algae can be found. Toward the mouth of the river/stream, the water becomes murky from all the sediments that it has picked up upstream. Less light creates less diversity of flora, and because of the lower oxygen levels, fish that require less oxygen, such as catfish and carp, can be found.

Wetlands

A wetland is an area that is saturated with water or covered by water for at least one season of the year. The water may be freshwater or saltwater. Wetlands are extremely important biomes for several reasons:

- They store excess water from floods.
- They slow down runoff and help prevent erosion.
- They remove excess nutrients from runoff before it empties into rivers or lakes.
- They provide a unique habitat that certain communities of plants need to survive.
- They provide a safe, lush habitat for many species of animals, so they have high biodiversity.

MARINE REGIONS

Marine regions cover about three-fourths of the Earth's surface and include oceans, coral reefs, and estuaries. Marine algae supply much of the world's oxygen supply and take in a huge amount of atmospheric carbon dioxide. The evaporation of the seawater provides rainwater for the land.

Oceans

The largest of all the ecosystems, oceans are very large bodies of water that dominate the Earth's surface. Like ponds and lakes, the ocean regions are separated into separate zones: intertidal, pelagic, abyssal, and benthic. All four zones have a great diversity of species. Some say that the ocean contains the richest diversity of species even though it contains fewer species than there are on land.

The *intertidal zone* is where the ocean meets the land– sometimes it is submerged and at other times exposed, as waves and tides come in and out. Because of this, the communities are constantly changing.

The *pelagic zone* includes those waters further from the land, basically the open ocean. The pelagic zone is generally cold though it is hard to give a general temperature range since, just like ponds and lakes, there is a constant mixing of warm and cold water. Species include surface seaweeds, many species of fish and some mammals, such as whales and dolphins. Many feed on the abundant plankton.

The *benthic zone* is the area below the pelagic zone, but does not include the very deepest parts of the ocean. The bottom of the zone consists of sand, slit, and/or dead organisms. Here temperature decreases as depth increases toward the abyssal zone, since light cannot penetrate through the deeper water. Species include seaweed, bacteria, fungi, sponges, sea anemones, worms, sea stars, and fishes.

The deep ocean is the *abyssal zone*. The water in this region is very cold (around 3° C), highly pressured, high in oxygen content, but low in nutritional content. The abyssal zone supports many

species of invertebrates and fishes. Hydrothermal vents at mid-ocean ridges can also be found here.

Coral Reefs

Coral reefs are widely distributed in warm shallow waters. They can be found as barriers along continents (e.g., the Great Barrier Reef off Australia), fringing islands, and atolls. Naturally, the dominant organisms in coral reefs are corals. Corals are interesting since they consist of both algae and tissues of animal polyp. Besides corals, the fauna includes several species of microorganisms, invertebrates, fishes, sea urchins, octopuses, and sea stars.

Hydrothermal Vents

Hydrothermal vents are among the most unusual ecosystems on Earth since they are dependent on chemosynthetic organisms at the base of the food web. This ecosystem is entirely separate from the photosynthesis at the surface. Shrimp, clams, fish, and giant tube worms have been found in these extreme places.

Estuaries

Estuaries are areas where freshwater streams or rivers merge with the ocean. This mixing of waters with such different salt concentrations creates a very interesting and unique ecosystem. Micro-flora like algae, and macro-flora, such as seaweeds, marsh grasses, and mangrove trees (only in the tropics), can be found here. Estuaries support a diverse fauna, including a variety of worms, oysters, crabs, and waterfowl.

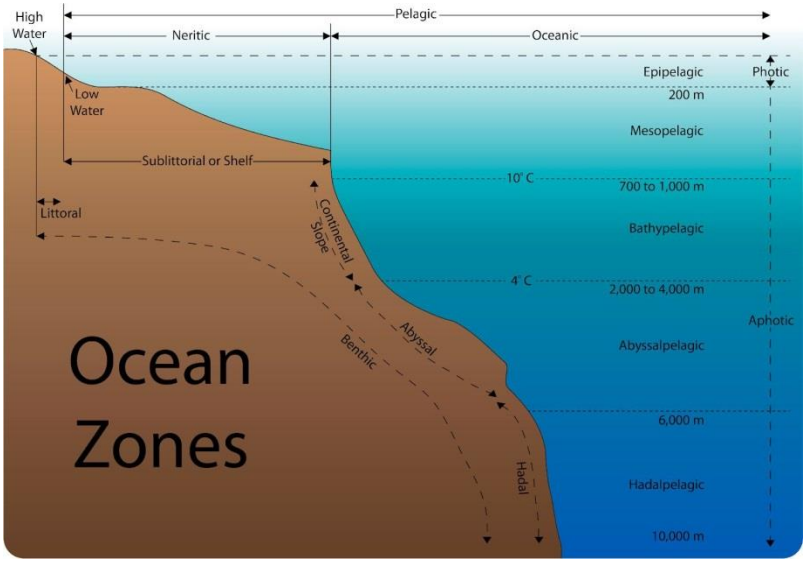
- **The temperature regime** of reservoirs is more stable than on land. The amplitude of annual temperature fluctuations in the upper layers of the ocean is no more than 10-15°C, in continental reservoirs – 30-35 ° C. Deep layers of water are characterized by a constant temperature. In equatorial waters, the average annual temperature of surface layers is + (26-27)°C, in polar waters – about 0°C and lower. In hot land sources, the water temperature can approach + 100°C, and in the underwater geysers at a high pressure at the ocean bottom the temperature of +380°C is recorded.

● **Light conditions**. Light in the water is much less than in the air. The rapid decrease in the amount of light with depth is due to the absorption of its water. The absorption of light is the stronger, the less the transparency of water, which depends on the number of particles suspended in it. In large bodies of standing water, including the ocean and lakes, the water can be divided into zones based on the amount of sunlight it receives:

The photic zone extends to a maximum depth of 200 meters (656 feet) below the surface of the water. This is where enough sunlight penetrates for photosynthesis to occur. Algae and other photosynthetic organisms can make food and support food webs.

The aphotic zone is water deeper than 200 meters. This is where too little sunlight penetrates for photosynthesis to occur. As a result, food must be made by chemosynthesis or else drift down from the water above.

The ocean is divided into many different zones, depending on distance from shore and depth of water.



Aquatic habitat and Dissolved Substances

Water in lakes and the ocean also varies in the amount of dissolved oxygen and nutrients it contains:

1. Water near the surface of lakes and the ocean usually has more dissolved oxygen than does deeper water. This is because surface water absorbs oxygen from the air above it.

2. Water near shore generally has more dissolved nutrients than water farther from shore. This is because most nutrients enter the water from land. They are carried by runoff, streams, and rivers that empty into a body of water.

3. Water near the bottom of lakes and the ocean may contain more nutrients than water closer to the surface. When aquatic organisms die, they sink to the bottom. Decomposers near the bottom of the water break down the dead organisms and release their nutrients back into the water.

TERRESTRIAL HABITAT

Terrestrial habitat is the most difficult on environmental conditions. Life on land required such adaptations, which were possible only if the level of organization of plants and animals was sufficient. Inhabitants of terrestrial habitat are aerobiontes.

A terrestrial habitat is an area of land with a similar climate that includes similar communities of plants and animals. Different terrestrial biomes are usually defined in terms of their plants, such as trees, shrubs, and grasses.

Terrestrial include grasslands, forests, deserts, tundra, …..

- Grasslands are characterized as lands dominated by grasses rather than large shrubs or trees and include the savanna and temperate grasslands.
- Forests are dominated by trees and other woody vegetation and are classified based on their latitude. Forests include tropical, temperate, and boreal forests (taiga).

● Deserts cover about one fifth of the Earth's surface and occur where rainfall is less than 50 cm (about 20 inches) each year.

● Tundra is the coldest of all the biomes. The tundra is characterized for its frost-molded landscapes, extremely low temperatures, little precipitation, poor nutrients, and short growing seasons. There are two main types of tundra, Arctic and Alpine tundras.

● Terrestrial habitat (**Fig. 3**) lying within the Arctic and Antarctic Circles do not have very much plant or animal life.

Fig. 3. *One of the terrestrial habitat s, taiga, is an evergreen forest of the subarctic, covering extensive areas of northern North America and Eurasia*

The basic properties of terrestrial habitat:

● **Gas structure of air** in ground layer of atmosphere is homogeneous enough concerning the maintenance of the main components (nitrogen – 78,1%, oxygen – 21 %, argon – 0,9 %, carbonic gas – 0,035 %) because of high diffused abilities of gases and constant intermixture by convection and wind flows.

● **Ground properties** and land topography also influence living conditions of land organisms, first of all plants. The properties of land surface having ecological influence on its inhabitants are edaphic factors of environment (from Greek «edaphos» – basis, soil).

● **Climate features**. The long-term mode of weather characterizes district climate. The concept climate includes not only average values of meteorological phenomena, but also their annual and

daily course, deviations from it and their repeatability. The climate is defined by geographical conditions of area. For the majority of land organisms, especially small, the climate of area is not so important as conditions of their habitat. Very often local elements of environment (relief, exposition, vegetation, etc.) change the mode of temperature, humidity, light, air movement in a concrete site so that it considerably differs from region climate conditions. Such local climate modifications in air-ground interface are called microclimate.

Climate is generally described in terms of temperature and moisture. Temperature falls from the equator to the poles. Therefore, major temperature zones are based on latitude. They include tropical, temperate, and arctic zones (see **Fig.4**). However, other factors besides latitude may also influence temperature. For example, land near the ocean may have cooler summers and warmer winters than land farther inland. This is because water gains and loses heat more slowly than does land, and the water temperature influences the temperature on the coast. Temperature also falls from lower to higher altitudes. That's why tropical zone mountain tops may be capped with snow.

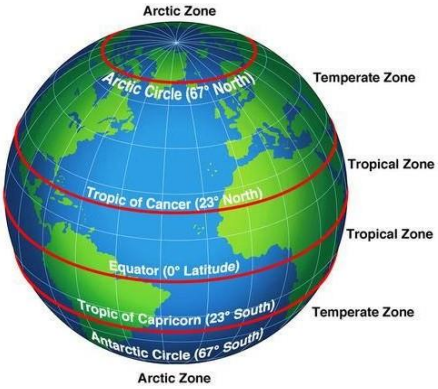


Fig. 4. *Temperature zones are based on latitude*

In terms of moisture, climates can be classified as arid (dry), semi-arid, humid (wet), or semi-humid. The amount of moisture

depends on both precipitation and evaporation. Precipitation increases moisture. Evaporation decreases moisture.

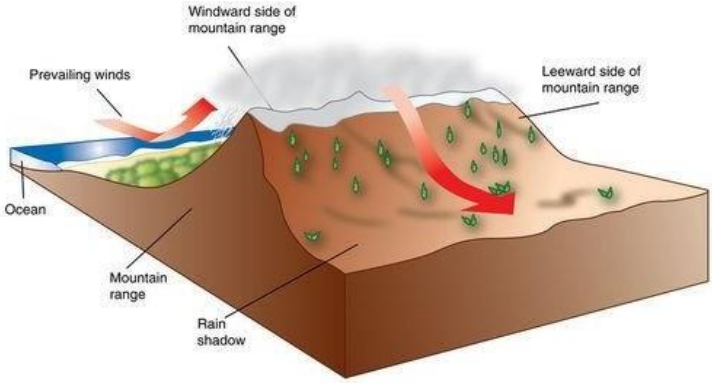


Fig. 5. *These diagrams show how precipitation is affected by the ocean and a mountain range*

Habitats with the highest amount of biodiversity, that is the most variation in plant and animal life, are near the equator (**Fig.6**).

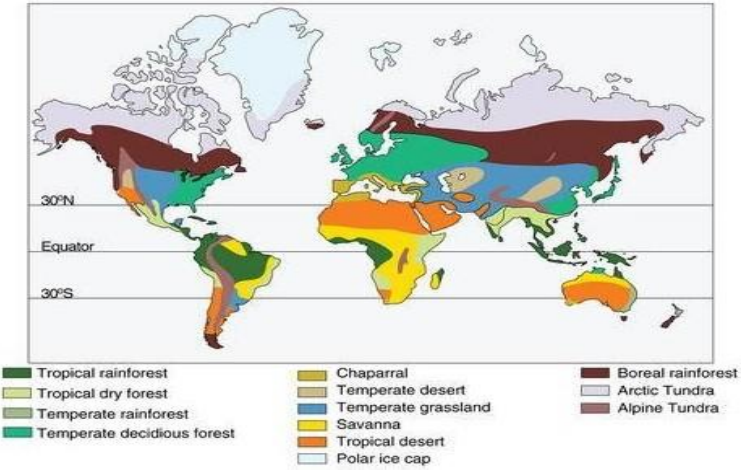


Fig. 6. *This map shows the locations of the Earth's 13 major terrestrial habitats*

Survey of Terrestrial habitat

Terrestrial habitats are classified by the climate and their biodiversity, especially the types of primary producers. The world map in Fig. 6 shows where 13 major terrestrial biomes are found.

SOIL AS A HABITAT

Soil structure results from the long-term interaction of climate, organisms, topography, and parent mineral material. Soil is a complex mixture of living and nonliving material upon which most terrestrial life depends. Inhabitants of soil are edaphobiontes.

Heterogeneity of conditions in soil is most sharply shown in a vertical direction. With depth a number of the major ecological factors influencing life of inhabitants of soil sharply changes. First of all it concerns soil structure. Soil structure can be observed by digging a soil pit, a hole in the ground 1 to 3 m deep. In a soil pit one can see one of the most significant aspects of soil structure, its vertical layering. Though soil structure usually changes gradually with depth, soil scientists generally divide soils into several discrete horizons. Soil profile is divided into O, A, B, and C horizons (fig. 7).

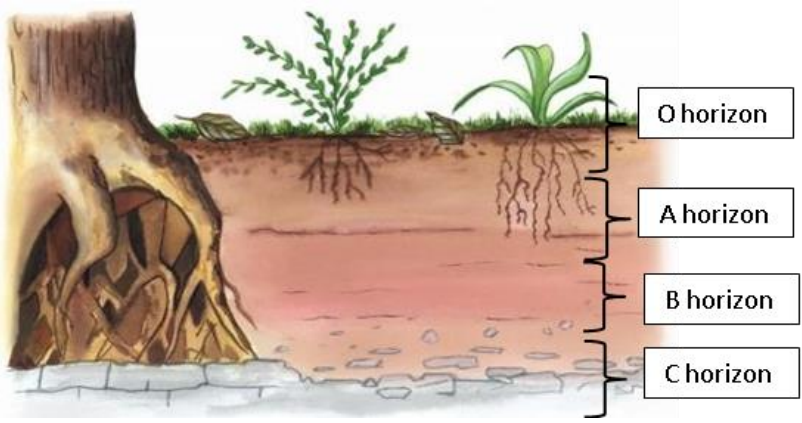


Fig. 7. *Generalized soil profile, showing O, A, B, and C horizons*

O – upper layer contains loose, somewhat fragmented plant litter. Litter in lower layer is highly fragmented.

A – mineral soil mixed with some organic matter. Clay, iron, aluminium, silicates, and soluble organic matter are gradually leached from A horizon.

B – depositional horizon. Materials leached from A horizon are deposited in B horizon. Deposits may form distinct banding patterns.

C – weathered parent material. The C horizon may include many rock fragments. It often lies on bedrock.

The moisture in soil is in various conditions:

1) combined water (hygroscopical and pellicular moisture) is strongly kept by the surface of soil particles;

2) capillary water occupies small pores and can move on them in various directions;

3) gravitational water fills larger emptiness and slowly filters downwards under the influence of gravity;

4) vaporous water is in soil air.

The structure of soil air is different. With depth the maintenance of oxygen strongly falls and concentration of carbonic gas increases. Because of the presence of decaying organic substances in soil air there can be a high concentration of such toxic gases as ammonia, hydrogen sulphide, methane, etc. While soil flooding or intensive rotting of plant residues, completely anaerobic conditions can arise in some places.

Temperature fluctuations are sharp only on a soil surface. Here they can even be stronger, than in a ground layer of air. However, with each centimeter deep into daily and seasonal temperature changes become ever less and on depth of 1-1,5 m practically are not traced any more

LIVING ORGANISMS AS A HABITAT

Many species of heterotrophic organisms throughout their life or part of the life cycle are found in other living beings whose bodies

are used as a habitat, significantly different in properties from the outside. Virtually there is not a single species of multicellular organisms that do not have internal inhabitants. The higher the organisation of hosts, the greater the degree of differentiation of their tissues and organs, the more diverse the conditions they can provide to their cohabitants. Inhabitants of organisms are endobionts.

Table1

Comparative characteristics of habitats and adaptation of living organisms to them

Environment	Characteristic	Adaptation of the organism to the environment
Aquatic habitat	The most ancient. Illumination decreases with depth. When diving, the pressure increases by 1 atmosphere for every 10 m. Lack of oxygen. The degree of salinity increases during the transition from freshwater to marine and oceanic waters. Relatively homogeneous (homogeneous) in space and stable in time	Streamlined body shape, buoyancy, mucous membranes, development of air-bearing cavities, osmoregulation
Terrestrial habitat	Sparse. Abundance of light and oxygen. Heterogeneous in space. Very dynamic in time	Development of the supporting skeleton, mechanisms of regulation of the hydrothermal regime. Release of the sexual process from the liquid medium
Soil habitat	Created by living organisms. It was mastered simultaneously with the ground-air environment. Lack or complete absence of light. High density.	The body shape is lumpy, mucous membranes or a smooth surface, some have a digging apparatus, developed muscles. Many

End of the table 1

Environment	Characteristic	Adaptation of the organism to the environment
	Four-phase (phases: solid, liquid, gaseous, living organisms). Inhomogeneous (heterogeneous) in space. In time, the conditions are more constant than in the terrestrial-aerial habitat, but more dynamic than in the aquatic and organismic.	groups are characterized by microscopic or small sizes as an adaptation to life in film water or in air-bearing pores
Living organisms as a habitat	Very ancient. Liquid (blood, lymph) or solid, dense (tissue). The greatest constancy of the environment in time of all habitats	Coadaptation of the parasite and the host, symbionts to each other, development of the parasite's protection against digestion by the host and the anchoring system in the environment, enhancement of sexual reproduction, reduction of vision, digestive system, synchronization of biorhythms

THEME 5
ADAPTATION OF ORGANISMS TO THE ENVIRONMENT AND LIVING CONDITIONS

Motivation statement

Representatives of the animal and plant world in the process of life are forced to adapt to many factors of continuously changing conditions. The dynamism of environmental factors in time and space depends on astronomical, helioclimatic, geological processes, which play a controlling role in relation to living organisms.

Traits that promote the survival of an organism are gradually enhanced under the influence of natural selection until maximum adaptability to existing conditions is achieved. Adaptation can occur at the level of cells, tissues and even the whole organism, affecting the shape, size, relationship of organs, etc. Organisms, in the process of evolution and natural selection, develop hereditarily fixed characteristics that ensure normal life in changed environmental conditions, i.e. adaptation. Knowledge of the patterns of adaptations is necessary to explain the mechanism of their occurrence and can be used in the practical work of pharmaceutical specialists.

Purpose of the lesson: to introduce the variety of anatomical, morphological, physiological and ethological manifestations of adaptation of organisms to the environment; general principles of adaptation at the level of the organism, to develop the ability to use knowledge of the laws of adaptation to explain the mechanism of their occurrence

Questions for discussion

1. Environmental factors. Types of environmental factors, examples of ecological factors and adaptations (genotypic and phenotypic levels of adaptation).

2. Patterns of the impact of environmental factors on the body: the rule of optimum in ecology; Liebig's minimum rule ecology; Shelford's rule of tolerance; rule of two levels of adaptation;

2. Patterns of the impact of environmental factors on the body: the ambiguity of the factor's effect on various functions of the body; the rule of interaction of factors; law of ecological duplication.

3. Adaptation of the body to environmental factors. Basic laws and rules of adaptation (Anatomical, physiological and behavioral adaptations).

4. Basic mechanisms for the formation of adaptations at the organism level.

Independent work of students

1. Presentation with abstract reports on the topic of the lesson (individual assignment).

2. Solving situational problems on the topic of the seminar.

3. Participation in a regulated discussion (the topic is indicated in the assignment for the practical lesson).

Topics of regulated discussion:

1. The need to know the laws of adaptation for students of the Faculty of Pharmacy.

4. Working with training tests

Test

After familiarizing yourself with the theoretical principles of the formation of adaptation mechanisms, complete the task (choose the correct judgments from the options below)

1. 1.Environmental factors can have both direct and indirect effects on organisms.

1.2. An individual's tolerance remains unchanged throughout life.

1.3. Any environmental factor has certain limits of positive influence on living organisms.

1.4. High specialization is characteristic only of organisms with a short life expectancy.

1.5. During evolution, similar life forms can arise in similar ecological conditions in systematically different groups of organisms.

1.6. The ecological niches of co-living species may partially overlap, and sometimes coincide completely.

1.7. A species is characterized by only one specific niche, regardless of its habitat and geographic area.

1.8. Organisms that are systematically distant from each other can occupy similar niches in ecosystems.

1.9. Organisms with a wide range of tolerance tend to have a better chance in the struggle for existence.

1.10. Any factor influencing living organisms can become either optimal or limiting, depending on the strength of its impact.

2.1. Adaptive biological rhythms differ from purely physiological rhythms in that they arose as adaptations:

a) to maintain the continuous life of organisms;

b) to regular environmental changes in the environment;

c) to episodic effects of biotic environmental factors;

d) to regulate the birth rate and mortality of organisms.

Reference material

Environmental factors are diverse, have different natures and specific actions. The following groups of environmental factors are distinguished:

1. *Abotic* (factors of inanimate nature):

a) climatic – lighting conditions, temperature conditions, etc.;

b) edaphic (local) – water supply, soil type, terrain;

c) orographic – air (wind) and water currents.

2. *Biotic* factors are all forms of influence of living organisms on each other: Plants Plants. Plants Animals. Plants Mushrooms. Plants Microorganisms. Animals Animals. Animals Mushrooms. Animals Microorganisms. Mushrooms Mushrooms. Fungi Microorganisms. Microorganisms Microorganisms.

3. *Anthropogenic* factors are all forms of activity of human society that lead to changes in the habitat of other species or directly affect their lives. The impact of this group of environmental factors is rapidly increasing from year to year.

Types of impact of environmental factors on organisms. Environmental factors have various impacts on living organisms. They may be:

- irritants that contribute to the appearance of adaptive physiological and biochemical changes (hibernation, photoperiodism);

- limiters that change the geographical distribution of organisms due to the impossibility of existence in these conditions;

- modifiers that cause morphological and anatomical changes in organisms;

- signals indicating changes in other environmental factors.

Adaptations (from Latin adaptatio – adaptation) *are* various adaptations to the environment developed in organisms during the process of evolution. Adaptations manifest themselves at different levels of organization of living matter: from molecular to biocenotic. The ability to adapt is one of the main properties of living matter, ensuring the possibility of its existence. Adaptations develop under the influence of three main factors: heredity, variability and natural (as well as artificial) selection.

Adaptation is a fundamental property of living nature. The habitat of any living creature, on the one hand, slowly and steadily changes over the life of many generations of the corresponding biological species, and on the other hand, it makes various demands on the body that change in short periods of individual life. Living

organisms are discrete units of metabolism. In the process of metabolism, the body consumes necessary substances from the environment and releases into it metabolic products that can be used by other organisms; By dying, the organism also becomes a source of nutrition for certain types of living beings. Metabolic processes in a living organism occur in a dynamic environment and are under the constant influence of a complex of factors. Maintaining a stable metabolism in changing environmental conditions is impossible without the formation of special adaptations.

There are three main ways for organisms to adapt to environmental conditions: the active path, the passive path, and the avoidance of adverse effects. *The active* ***path*** is strengthening resistance, developing regulatory processes that allow all vital functions of the body to be carried out, despite factor deviations from the optimum. For example, maintaining a constant body temperature in warm-blooded animals (birds and mammals), optimal for the occurrence of biochemical processes in cells.

Passive way – subordination of the vital functions of the body to changes in environmental factors. For example, the transition under unfavorable environmental conditions to a state of *anabiosis* (hidden life), when the metabolism in the body almost completely stops (winter dormancy of plants, preservation of seeds and spores in the soil, torpor of insects, hibernation of vertebrates, etc.).

Avoidance of Adverse Effects – development by the body of such life cycles and behavior that allow it to avoid adverse effects. For example, seasonal migrations of animals.

Typically, adaptation of a species to its environment is carried out by one or another combination of all three possible adaptation paths.

Adaptations can be divided into three types: morphological, physiological and ethological.

Morphological adaptations are accompanied by changes in the structure of the organism (for example, modification of the leaf in

desert plants). Morphological adaptations in plants and animals lead to the formation of certain life forms.

Physiological adaptations – changes in the physiology of organisms (for example, the ability of a camel to provide the body with moisture by oxidizing fat reserves).

Ethological adaptations – changes in behavior (for example, seasonal migrations of mammals and birds, hibernation in winter). Ethological adaptations are characteristic of animals.

THEME 6
POPULATION AND POPULATION INTERACTIONS

Motivational statement

The results of modern biological sciences show the exceptional importance of the population level of the organization as an "elementary unit of the evolutionary process", "the form of existence of a species in a particular ecosystem", "units of rational nature management and management of animal and plant resources", "elementary object of nature protection", "units of structural and genetic biodiversity", etc.

All this makes it possible to consider population ecology as a key link in modern evolutionary ecology and a subject of paramount importance in the formation of an ecocentric worldview necessary for the sustainable development of civilization.

One of the means of forming ecological thinking and understanding the mechanisms of ecosystem stability is the knowledge of the relationships between individuals of different populations in the biocenosis. V.N. Beklemishev (1951) also noted that "... biocenosis... is precisely the integration of species populations, not individuals."

The objective: to study the features of the organization and functioning of the population as a key unit of the species and biocenotic levels of the organization of biological systems.

Questions for discussion:

1. The concept of population.
2. The main characteristics of populations.
3. The population structure of the species (the degree of isolation of populations, biological, sexual, age, spatial and ethological structure of populations).
4. Population dynamics.
5. Interaction of species populations.

Independent work of students

1. Situational problems. Reference material, tables and recommended literature may be used. The situational problems should be reported in writing.
2. Discussion report prepared by the students on an individual task of a teacher.

Task 1

Choose the correct answer.

1. The most common type of population distribution is ____.

a) clumped
b) uniform
c) random
d) near-uniform
e) semi-random

2. ____ is the study of interactions among organisms and between organisms and their environment.

a) Environmentalism
b) Demography

c) Ecology

d) Biogeography

e) Paleontology

3. The most common form of population distribution arises from

a) an uneven distribution of resources.

b) limited dispersal ability.

c) asexual reproduction.

d) efforts to protect from predators.

e) all of these.

4. What is the interaction between species in which the fitness of one overpowers the presence and fitness of another called?

a) Competition

b) Mutualism

c) Parasitism

d) Commensalism

5. Who gave the following sentence "Two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior will be eliminated eventually"?

a) Gause's competitive exclusion principle

b) Mutation Theory

c) Theory of Special Creation

d) Theory of Organic Evolution

6. Where the interference competition does occur directly between individuals?

a) Two species have a common prey

b) One individual prevents the reproduction of others

c) Organism compete for space

d) Two separate species compete for the same resources and space

7. Where exploitation competition does occur indirectly?

a) One individual prevents the survival and reproduction of others

b) Two species have common prey

c) Two separate species compete for different resources and space

d) Organisms compete for common space

8. In which two species apparent competition occurs indirectly?

a) Compete for space

b) Fight for the same resources and mate

c) Have a common prey

d) Share the same resources in a territory

9. What is a competition between the individuals of two separate species for sharing the same resources in the same area known?

a) Apparent competition

b) Interspecific competition

c) Interference competition

d) Intraspecific competition

10. What is a biological interaction between organisms of different species in which each individual receives benefit known?

a) Parasitism

b) Competition

c) Commensalism

d) Mutualism

11. What happens to two species in mutualism?

a) Only one is benefited

b) Both live differently

c) Both are benefited

d) Only one is harmed

12. What kind of interaction is mutualism?

a) Negative Interspecific

b) Positive Intraspecific

c) Negative Intraspecific

d) Positive Interspecific

Task 2

Answer the questions.

1 Question:

Explain why most species with a high capacity for population growth (such as bacteria, flies, and cockroaches) tend to have small individuals, while those with a low capacity for population growth (such as humans, elephants, and whales) tend to have large individuals.

2 Question:

Three different species of animals, baboons, lions, and giraffes, living in a particular ecosystem called Serengeti National Park, constitute a _____.

3 Question:

The maximum rate at which a population could increase under ideal conditions is known as its:

a) total fertility rate

b) survivorship

c) intrinsic rate of increase

d) doubling time

e) age structure

4 Question:

What is the difference between population size and population density? How do the different patterns of patterns of population distribution affect size and density?

5 Question:

Which of the following is an example of a density-independent factor for population growth?

a. Fire.

b. Predators.

c. Competition for nesting sites.

d. Food availability.

Population:

Population refers to the number of specific organisms living in an area. However, the population of a region is influenced by a number of factors that can be classified as density-dependent or density-independent. These factors are not the only ones affecting a population, however.

6 Question:

How would population decline affect the environment?

Population:

The number of people on earth has doubled in the past 70 years, from about 3 billion in 1950 to over 7 billion today. The population explosion has both costs and benefits.

7 Question:

What are the dangers of small populations of a species from a genetic and evolutionary standpoint?

Population Genetics:

Population genetics is a field of study in genetics that deals with genetic variations in a population. It is used to study the differences between individual populations by examining traits like habitat, inherited traits, and adaptations.

Task 3

Population Ecology Crossword Puzzle

Across

1 A group of individuals of the same species that live in the same area at the same time.

4 The organism that a predator feeds upon.

7 This term refers to the number of individuals per unit area. (2 words)

8 The interaction between two different organisms in which one captures and feeds upon the other.

10 The number of deaths occurring in a given period of time. (2 words)

12 This term describes the range of area that is inhabited by a population. (2 words)

13 The number of individuals the environment can support over a long period of time. (2 words)

14 This survivorship curve indicates a constant death rate over the organism's life span. (2 words)

15 This survivorship curve indicates a low death rate in the early and middle stages of life, and a high death rate at the later stages of life. (2 words)

16 The study of human populations.

18 An organism that captures, kills, and eats another living organism.

19 This occurs when the members of a population are reproducing at a constant rate. (2 words)

21 This survivorship curve indicates a high death rate among the young. (2 words)

22 This is a graphical representation that shows the population of a country broken down by gender and age group. (3 words)

24 In this type of dispersion, the individuals are clustered together in groups. (2 words)

26 In this type of reproduction, an organism produces all of its offspring in a single event. (3 words)

27 The movement of individuals into a population.

28 A limiting factor that depends on population size. (3 words)

31 This type of curve on a graph represents exponential growth. (2 words)

32 The length of time an individual is expected to live. (2 words)

33 Patterns on a graph that show the likelihood of survival at different ages throughout the lifetime of an organism. (2 words)

34 In this type of dispersion, the location of one individual is independent of the location of the other individuals. (2 words)

35 The movement of individuals out of a population.

Down

2 A model of population growth in which growth slows or stops following a period of exponential growth. (2 words)

3 The organism that a parasite feeds on is called the_____.

4 An organism that lives in or on another living organism.

5 A term used to describe a dramatic change in birth and death rates in a country. (2 words)

6 The number of births occurring in a given period of time. (2 words)

9 A factor that affects all populations in similar ways, regardless of the size of the population. (3 words)

11 A space that an animal defends against encroachment by other individuals.

13 The interaction that occurs between organisms as they struggle to obtain the same limited resources.

17 In this type of reproduction, the organism produces a few offspring each year for several years. (2 words)

20 The amount by which a population's size changes in a given time. (2 words)

23 In this type of dispersion, individuals are separated by a fairly even distance. (2 words)

25 A factor that causes population growth to decrease. (2 words)

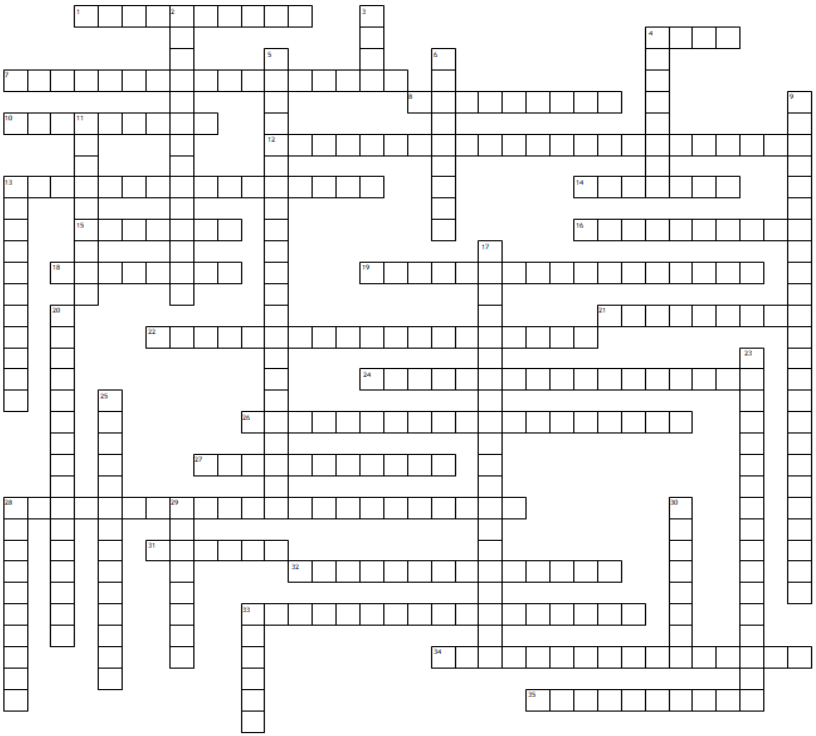
28 This term refers to the spatial distribution of individuals within the population.

29 Death rate and emigration will _____ the size of a population.

30 Birth rate and immigration will_____ the size of a population.

33 This type of curve on a graph represents logistic growth. (2 words)

Population Ecology Crossword Puzzle



Reference material

Population ecology is a sub-field of ecology that deals with the dynamics of species populations and how these populations interact with the environment.

Term "population" comes from Latin word populous (people) and in translation means "population". Ecologists usually define a population as a group of individuals of a single species inhabiting a specific area. A population of plants or animals might occupy a mountaintop, a river basin, a coastal marsh, or an island, all areas defined by natural boundaries.

Population – this is the group of one species individuals inhabiting certain territory and characterizing by this or other level of genetic information exchange (panmixture), morphobiological type and system of sustainable functional ties.

Ecologists study populations for many reasons. Population studies hold the key to saving endangered species, controlling pest populations, and managing fish and game populations. They also offer clues to understanding and controlling disease epidemics.

According to statistical (in 2023) data on the territory of living Earth Over 8,1 billion people. The largest population of the world is China (1.43 billion people), India (1.42 billion), USA (333 million), Indonesia (282 million), Brazil (213,9 million).

Dynamics of change of the world population was different throughout history humanity. Since the appearance of man on Earth for many thousands of population growth was negligible, then began to rise and now again decreases.

Populations, as groups, have a number of specific features that are not inherent in a single species.

MAIN CHARACTERISTICS OF THE POPULATION:

Abundance: Absolute number of individuals in population. The abundance of an organism, often considered as total population

size or the number of organisms in a particular area (density), is one of the basic measures in ecology.

Organisms generally are more abundant where conditions are favorable, such as locations with sufficient quantity and quality of food or nutrients, fewer herbivores or predators, fewer competitors, and optimal physical features. The physical features that affect abundance could be substrate type, moisture, light, temperature, pH, salinity, oxygen or CO2, wind, or currents.

Density of population is the number of individuals per unit area or volume. It is expressed when the size of individuals in the population is relatively uniform.

Fertility (natality) refers to the rate of reproduction or birth per unit time. It is an expression of the production of new individuals in the population by birth, hatching, germination or fission.

Mortality: the number of deaths in a population per unit time. The loss of individuals due to death in a population under given environmental conditions is called mortality. Mortality as well as fertility especially of higher organisms varies widely with age.

Population growth – the difference between fertility and mortality.

Population growth can be either positive or negative.

Growth rate – is the amount or speed of increase in size of population (per unit time).

The population has a certain organization. The distribution of species in the territory, correlation of groups according to sex, age, morphological, physiological, behavioral and genetic characteristics represent **the structure of the population**. It is formed, on the one hand, on the basis of the general biological features of the species, and on the other hand – under the influence of abiotic factors of the environment and populations of other species.

Biological structure of populations

The structure of the population is not stable. Growth and development of organisms, birth of new organisms, death from various causes, changing environmental conditions, increasing or decreasing number of enemies – all these lead to a change in various relations within the population. The direction of further changes in population largely depends on what structure of the population in a given period of time is.

Sexual structure of populations

The sex ratio of species and especially the proportion of proliferative females in the population are of great importance for the further growth of its numbers. The sex ratio in the population is established not only by genetic laws, but also under the influence of the environment. In some species, sex is initially determined not by genetic, but by environmental factors. For example, in the case of red forest ants (Formica rufa), the eggs laid at temperatures below +20°C develop males, at a higher level – almost exclusively females. The sex of Arisaema japonica plants depends on the accumulation of nutrients in the tubers. Plants with female flowers grow from large tubers, and from small tubers – males.

Age structure

Age distribution is another important characteristic of population, which influences natality and mortality. Mortality usually varies with age, as chances of death are more in early and later periods of life span. Similarly, natality is restricted to certain age groups, as for example, in middle age-groups in higher animals. According to Bodenheimer (1958), the species of a population can be divided into pre-reproductive, reproductive and post- reproductive groups. The species of pre-reproductive group are young, those of reproductive group are mature and those in post-reproductive group are old.

The ratio of various age groups in a population determines the reproductive status of the population. Rapidly increasing population contains a large proportion of young species, a stable population shows even distribution of species in reproductive age-group and a declining population contains a large proportion of old species.

The age state of the species is the stage of its ontogeny, at which it is characterized by definite relations with the environment. With age, the requirements of the species to the environment and the resistance to its individual factors naturally change very substantially. At different stages of ontogeny, habitat changes, changes in the type of nutrition, the nature of movement, and the overall activity of organisms can occur. Often the age- related ecological differences within the species are expressed to a much greater extent than the differences between species. For example, grass frogs on land and their tadpoles in water bodies, caterpillars, gnawing leaves, and winged butterflies sucking nectar are just different ontogenetic stages of the same species.

Three ecological age groups can be distinguished in the population:

- ✓ Preproductive
- ✓ Reproductive
- ✓ Post-productive

The duration of these ages in relation to the overall life expectancy varies greatly among different organisms.

In plants, the age structure of the cenopopulation, i.e., the population of a particular phytocenosis, is determined by the ratio of age groups.

For example, trees have both multiple life stages (seed, plant) and age classes within the plant stage (i.e., seedling, sapling, mature tree).

Analysis of the age structure helps to predict the population size during the life of the next generations.

Spatial distribution of populations

Organisms do not occur randomly in space. Any species of plant or animal may be found in some areas, while they are completely absent from others. Likewise, the individuals of any species are distributed in relation to each other in distinct patterns. The reasons for the readily apparent nonrandomness of the spatial distribution patterns of organisms are numerous, and the patterns result from processes acting throughout the whole life cycle of the organism, and on various spatial scales. Interactions between individuals and across species all take place in space as well as in time, and an understanding of spatial patterns is basic to understanding real – life ecological processes. Indeed, patterns of spatial distribution play an important role in shaping a wide range of ecological dynamics, such as intra- and interspecific competition, mating systems, predation, population genetics, and the spread of contagious diseases.

While there are few environments on earth without life, no single species can tolerate the full range of earth's environments. For each species, some environments are too warm, too cold, too saline, or unsuitable in other ways. At some point, the metabolic costs of compensating for environmental variation may take up too much of an organism's energy budget. Partly because of these energy constraints, the physical environment places limits on the distributions of populations. The environmental limits of a species are related to its niche. To the ecologist, the niche summarizes the environmental factors that influence the growth, survival, and reproduction of a species. In other words, a species' niche consists of all the factors necessary for its existence – approximately when, where, and how a species makes its living.

Three basic patterns of distribution: random, regular, or clumped

A random distribution is one in which individuals within a population have an equal chance of living anywhere within an area.

A regular distribution is one in which individuals are uniformly spaced.

In a clumped distribution, individuals have a much higher probability of being found in some areas than in others (fig. 1).

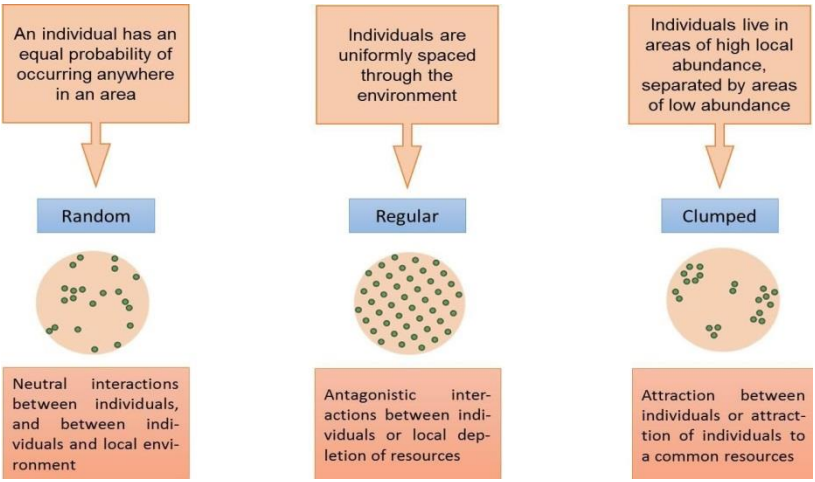


Fig. 1. *Spatial distribution of populations*

These three basic patterns of distribution are produced by the kinds of interactions that take place between individuals within a population, by the structure of the physical environment, or by a combination of interactions and environmental structure. Individuals within a population may attract each other, repel each other, or ignore each other. Mutual attraction creates clumped, or aggregated, patterns of distribution. An environment with patchy distributions of nutrients, nesting sites, water, and so forth fosters clumped distribution patterns. An environment with a fairly uniform distribution of resources and frequent, random patterns of disturbance (or mixing) tends to reinforce random or regular distributions.

Ethological structure of populations

The ethological or behavioral structure of the population is the system of relationships between members of one population.

Behavior of animals in relation to other members of the population depends primarily on whether a single or group way of life is peculiar to the species. The forms of joint existence of species in the population are extremely different.

A single way of life, at which the species of a population are independent and separate from each other, is typical for many species, but only at certain stages of the life cycle. Completely solitary existence of organisms in nature does not occur, since in this case it would be impossible to carry out their basic life function – reproduction. However, some species are characterized by very weak contacts between cohabiting individuals. These are, in particular, individual aquatic inhabitants with an external method of fertilization, in which there is no need to directly meet partners, for example, single actinia.

Family way of life. In the family way of life, the ties between parents and their generation are strengthened. The simplest kind of such connection is the care of one of the parents about the laying eggs: protection of the egg laying, incubation, additional aerating, etc.

In the family way of life the territorial behavior of animals is obviously expressed: various signals, marking, ritual forms of threat and direct aggression ensure possession of a site sufficient for rearing generation.

The larger groups of animals are flocks, herds and colonies. At the heart of their formation lies the further complication of behavioral links in populations.

Colonies. These are group settlements of sedentary animals. They can exist for a long time or arise only for the period of reproduction, as, for example, with many birds – rooks, gulls, loons, puffins, etc. The complexity of the interrelationships between species of the colony of

animals is extremely varied – from simple territorial aggregations of single forms to associations, where individual members perform, as organs in a coherent organism, different functions of species life.

The most complex colonies of social insects – termites, ants, bees. They arise on the basis of a greatly expanding family. In such colonies-families insects perform together most of the basic functions: reproduction, protection, provision of food for themselves and their generation, construction, etc.

Flocks (shoals, packs). These are temporary associations of animals that exhibit a biologically useful organization of actions. Flocks facilitate the performance of any function in the life of the species: protection from enemies, getting food, migration. The aggregating behavior is common among birds and fish, as for mammals it is common for many canids. Imitative reactions and orientation toward neighbors are highly developed in the flocks.

Herds. These are longer and more permanent animal associations than flocks. In herd groups, as a rule, all the basic functions of the life of the species are realized: foraging, protection from predators, migration, reproduction, rearing of young animals, etc. The basis of group behavior of animals in herds is the relationship of dominance-subordination based on individual differences between species.

Optimization of physiological processes leading to viability increase in the joint existence, was called the effect of the group. Life in the group through the nervous and hormonal systems is reflected in the course of many physiological processes in the animal's body. Isolated species have changes in metabolic rate, faster usage of reserve substances, viability decrease; they haven`t a number of instincts.

Population Dynamics

In nature populations are in continuous flux and their patterns of distribution and abundance result from a dynamic balance between factors that add species to populations, and factors that remove

species from populations. The dynamic population processes underlying distribution and abundance are the subject of ecology population dynamics, which is concerned with the factors influencing the expansion, decline, or maintenance of populations.

General changes in population size are due to four phenomena: fertility, mortality, immigration and emigration of species.

The distinction is made between the absolute and specific fertility. The first one is characterized by the total number of born species. For example, if in a reindeer population of 16,000 animals, 2,000 deer appeared during the year, this number also expresses the absolute fertility.

The specific one is calculated as the average change in the number of species per specific time interval (in this case, it is one newborn per 8 members of the population for the year).

The size of the fertility depends on many factors. Great importance is given to the proportion of species capable to reproduction at a given period that is determined by the ratio of sexes and age groups.

Mortality in populations also depends on many factors: the genetically programmed life expectancy of species, their genetic and physiological usefulness, the impact of unfavorable physical conditions of the environment, the impact of predators, parasites, diseases, etc. These factors are different at different stages of the life cycle of each generation.

Emigration: It is one way movement of species out of the population. This movement is permanent and causes spread of a species to new areas. Emigration under natural conditions occurs when there is overcrowding in the population and is generally regarded as an adaptive behaviour that regulates the population on a particular site and prevents over-exploitation of the habitat.

This type of dispersal offers new opportunity to the species of a population to interbreed with those of the other population leading to more genetic heterozygosity and adaptability.

Immigration: This is one way movement of species into the population. It leads to rise in density of population. It may result in decreased mortality among the immigrants or decreased reproductive capacity of the species.

There are two fundamentally different aspects of population dynamics: modification and regulation.

Modification is a random deviation of numbers resulting from a variety of factors not related to population density.

Regulation is the return of population after deviation to the initial state, which occurs under the influence of factors determined by population density.

Modifying factors, causing changes in the number of populations, do not themselves experience the impact of these changes. Thus their action is one- sided. These factors include all the abiotic influences of the environment on organisms, the quality and quantity of their food, etc.

Favorable weather conditions can cause a massive outbreak of species reproduction and overpopulation of the territory occupied by it, as, for example, in the case of herd locusts. The negative impact of modifying factors, on the contrary, reduces the population size sometimes to its complete disappearance.

Regulatory factors do not simply change the population size, but smooth out its fluctuations, bringing after regular deviation from the optimum to the previous level. This happens because the effect of their impact is stronger if population density is higher. The regulatory forces are inter- specific and intraspecific interactions of organisms.

The study of factors that affect growth, stability and decline of populations is population dynamics.

All populations undergo three distinct phases of their life cycle:

- ✓ growth;
- ✓ stability;
- ✓ decline.

Population growth occurs when available resources exceed the number of species able to exploit them. Reproduction is rapid, and death rates are low, producing net increase in the population size. Population stability is often proceeded by «crash» since the growing population eventually outstrips its available resources. Stability is usually the longest phase of population's life cycle. Decline is the decrease in the number of species in population, and eventually leads to population extinction. Nearly all populations will tend to grow exponentially as long as there are resources available. Most populations have the potential to expand at an exponential rate, since reproduction is generally a multiplicative process.

Two of the most basic factors that affect the rate of population growth are the birth rate, and the death rate. The intrinsic rate of increase is the birth rate minus the death rate.

Two modes of population growth (fig. 2).

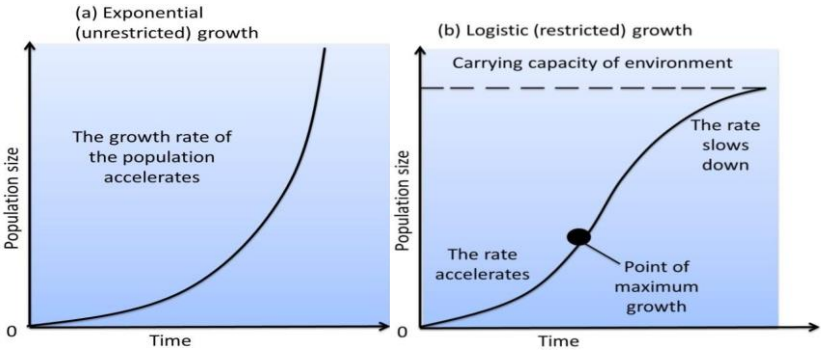


Fig. 2. *Population growth*

The Exponential curve (also known as a J-curve) occurs when there is no limit to population size. The Logistic curve (also known as an S-curve) shows the effect of a limiting factor (in this case the carrying capacity of the environment).

The environment is the ultimate cause of population stabilization.

Two categories of factors are commonly used: **physical environment** and **biological environment**.

Three subdivisions of the biological environment are competition, predation, and symbiosis.

Physical environment factors include food, shelter, water supply, space availability, and (for plants) soil and light.

One of these factors may severely limit population size, even if the others are not as constrained.

The Law of the Minimum states that population growth is limited by the resource in the shortest supply.

Extinction is the elimination of all individuals in a group. **Local extinction** is the loss of all individuals in a population. **Species extinction** occurs when all members of a species and its component populations go extinct. Scientists estimate that 99 % of all species that ever existed are now extinct.

The ultimate cause of decline and extinction is environmental change.

Changes in one of the physical factors of the environment may cause the decline and extinction; likewise the fossil record indicates that some extinctions are caused by migration of a competitor. Dramatic declines in human population happen periodically in response to an infectious disease. Bubonic plague infections killed half of Europe's population between 1346 and 1350, later plagues until 1700 killed one quarter of the European populace. Smallpox and other diseases decimated indigenous populations in North and South America. Human populations have continued to increase, due to use of technology that has disrupted natural populations.

Destabilization of populations leads to possible outcomes:

– population growth as previous limits are removed;

– population decline as new limits are imposed.

Agriculture and animal domestication are examples of population increase of favored organisms.

Interactions Between Populations

The traditional approach to population interactions has been to consider just the direct pairwise interactions. In this simplistic view of things, two populations may or may not affect each other; if they do, the influence may be beneficial or adverse. By designating a detrimental effect with a minus, no effect with a zero, and a beneficial effect with a plus, all possible population interactions can be conveniently classified. When neither of two populations affects the other, the interaction is designated as (0, 0). Similarly, a mutually beneficial relationship is (+, +) and a mutually detrimental one is (–, –). Other possible interactions are (+, –), (–, 0), and (+, 0), making a total of six fundamentally different ways in which populations can interact (Table 11.1).

Table 1

Summary of Direct Pairwise Interactions Between Two Populations Species

Type of Interaction	A	B	Nature of Interaction
Competition	–	–	Each population inhibits the other
Predation, parasitism, and Batesian mimicry	+	–	Population A, the predator, parasite, or mimic, kills or exploits members of population B, the prey, host, or model
Mutualism, Müllerian mimicry	+	+	Interaction is favorable to both (can be obligatory or facultative)
Commensalism	+	0	Population A, the commensal, benefits whereas B, the host, is not affected
Amensalism	–	0	Population A is inhibited, but B is unaffected
Neutralism	0	0	Neither party affects the other

Competition (–, –) takes place when each of two populations affects the other adversely. Typically, both require the same resource(s) that is (are) in short supply; the presence of each population inhibits the

other. If the resource is another population (a prey species), competition is indirect and mediated by means of resource depression – this type of competition is termed **exploitation competition**. Other kinds of competition also occur. For example, competition can also be direct, as in agonistic encounters such as allelopathy or interspecific territoriality (known as **interference competition**). Predation (+, –) occurs when one population affects another adversely but benefits itself from the interaction. Usually a predator kills its prey and consumes part or all of the prey organism. (Exceptions include lizards losing their tails to predators and plants losing their leaves to herbivores.) Parasitism (+, –) is essentially identical to predation, except that the host (a member of the population being adversely affected) is usually not killed outright but is exploited over some period of time. Thus, parasitism can in some ways be considered as a "weak" form of predation; Batesian mimicry and herbivory could be placed here. Interactions that benefit both populations (+, +) are classified as mutualisms. In some mutualisms, the association is obligatory (neither population can exist without the other), but in others the interaction is facultative because it is not an essential condition for survival of either population (Müllerian mimicry). When one population benefits while the other is unaffected, the relationship is termed commensalism (+, 0). Amensalism (–, 0) is said to occur when one population is affected adversely by another but the second is unaffected. Neutralism (0, 0) occurs when the two populations do not interact and neither affects the other in any way whatsoever; it is thus of little ecological inter- est. True neutralism is likely to be very rare or even nonexistent in nature because there are probably indirect interactions between all the populations in any given ecosystem, although their significance may be minimal.

Three of the six population interactions, competition, predation, and mutualism, are of overwhelming importance; an entire chapter is devoted to competition and another to predation. Mutualisms are considered later in this chapter.

Mutualistic Interactions and Symbiotic Relationships

Symbiosis means "living together." Usually the term is used only to describe pairs of organisms that live together without harming one another, thereby excluding parasitism (+, –) and amensalism (–, 0), in which one party is affected adversely. Hence, symbiotic relationships include mutualism (+, +), commensalism (+, 0), and neutralism (0, 0). Obligate mutualisms can be distinguished from facultative ones. As pointed out before, these various types of interactions can change in evolutionary time and grade into one another.

Although mutualism is a symmetric relationship, there may nevertheless usually be an asymmetry in costs versus benefits to each of the parties concerned (a conflict of interests arises even in mutualistic relationships!). Mutualisms may evolve from parasitic relationships.

Commensalism occurs when one population is benefited but the other is unaffected (+, 0). Small epiphytes such as bromeliads and orchids, which grow on the surfaces of large trees without obvious detriment to the tree, might be an example. A well- documented case of commensalism is the association between cattle egrets and cattle. These egrets follow cattle that are grazing in the sun and capture prey (crickets, grasshoppers, flies, beetles, lizards, frogs) that move as cattle approach. The number of cattle egrets associated with cattle is strongly dependent on the activities of the cattle; thus, Heatwole observed fewer egrets than expected on a random basis near resting cattle, but nearly twice as many egrets as expected (if the association were entirely random) accompanied cattle that were actively grazing in the sun. Since the birds seldom take prey (such as ticks and other ectoparasites) directly from the bodies of the cattle, the mammals probably benefit little from their relationship with egrets. Moreover, egret feeding rates and feeding efficiency are markedly higher when these birds are associated with cattle.

THEME 7
BIOCENOSIS AS A MULTI-SPECIES BIOLOGICAL SYSTEM

The motivational statement

The biocenosis includes interconnected living organisms living in a given area, i.e. it is an important structural component of the natural community. Each organism lives surrounded by many other organisms, entering into a variety of relationships with them with both negative and positive consequences for itself, and ultimately cannot exist without this living environment. The biocenosis includes interconnected living organisms living in a given area, i.e. it is an important structural component of the natural community. For the first time the term "Biocenosis" was introduced by the German biologist Mobius and is currently one of the main concepts in the structure of ecological knowledge.

The objective: to form knowledge about the biocenosis as the most important component of the general ecology, to get acquainted with the main parameters and characteristics of the biocenosis, species, spatial, etc

Questions for discussion

1. The concept of biocenosis.
2. Structures of biocenosis (species, spatial, ecological).
3. Relations of organisms in biocenoses (predator-prey, parasite-host relations, commensalism, neutralism, amensalism, competition).
4. Connections in biocenoses (trophic, topical, phoric, fabric).
5. Ecological niche.
6. Cenotic strategies of species.

Independent work of students

1. Solving situational problems.
2. Discussion report prepared by the students on an individual task of a teacher.

Task 1

Choose the correct answer.

Food chain quiz multiple choice questions answers:

1. Food chains are met with only in the

a) Sea

b) Cities

c) Forests

d) In all the places

2. The herbivores are also called

a) Primary consumers

b) Secondary consumers

c) Tertiary consumers

d) None of these

3. The order of organism in an aquatic food chain is

a) Bacteria > Seal > Diatom > Fish > Crustacea

b) Crustacea > Seal > Fish > Polar Bear > Diatom

c) Polar Bear > Diatom > Seal > Crustacea

d) Diatom > Crustacea > Fish > Seal > Bacteria

4. In a food chain, the total amount of living material is depicted by

a) Pyramid of biomass

b) Pyramid of energy

c) Pyramid of number

d) Trophic levels

5. Ecosystem creates

a) Food chain

b) Food web

c) Both the above

d) None of the above

6. Which of the food chains directly depends on solar radiations?

a) Predator

b) Grazing

c) Detritus

d) None of these

7. A plant being eaten by a herbivorous which in turn is eaten by a carnivorous makes

a) Food chain

b) Food web

c) Omnivorous

d) Interdependent

8. In a food chain of grassland ecosystem, the top consumers are

a) Carnivores

b) Herbivores

c) Either carnivores or herbivores

d) Bacteria

9. A food chain starts with

a) Nitrogen fixing organisms

b) Photosynthesis

c) Respiration

d) Decomposers

10. In food web hyaenas and vultures are

a) Primary consumers

b) Predators

c) Scavengers

d) Decomposers

11. Which of the following food chain may not be directly dependent upon solar energy?

a) Grazing

b) Detritus

c) Soaking

d) Depleting

12. In a food chain, the total amount of living material is depicted by

a) Pyramid of energy

b) Pyramid of numbers

c) Pyramid of biomass

d) All of these

13. In a food chain herbivores are

a) Primary producers

b) Primary consumers

c) Secondary consumers

d) Decomposers

14. In an ecosystem, there are more prey than predators. This relationship is called

a) Food webs

b) Predator–prey relationship

c) Pyramid of number

d) Succession

15. Food chain consists of

a) Producer, consumer and decomposer

b) Producer, carnivore and decomposer

c) Producer and primary consumer

d) Producer, herbivore and carnivore

16. The large carnivores or the tertiary consumers exist at which level of the food chain __

a) First

b) Second

c) Third

d) Fourth

17. Ecosystem has two components

a) Plants and animals

b) Weeds and trees

c) Biotic and abiotic

d) Frog and men

18. In a food chain, which of the following produces in the largest amount

a) Producers

b) Decomposers

c) Tertiary consumers

d) Primary consumers

19. The second order consumer in a food chain is

a) Cattle

b) Deer

c) Tiger

d) Goat

20. In a food chain, lion is a

a) Secondary consumer

b) Primary consumer

c) Tertiary consumer

d) Secondary producer

21. The food chain in which microbes split energy rich compounds of the producer community is

a) Parasitic food chain

b) Detritus food chain

c) Predators food chain

d) Producer food chain

22. We refer to the following as the food chain

a) Large number of animals near a source of food

b) Transfer of food energy from the green plants through a series of consumer organisms

c) Large number of human beings forming a human chain near a source of food

d) None of these

23. Which is the correct sequence in the food chain in a grassland?

a) Grass > wolf > deer > buffalo

b) Bacteria > grass > rabbit > wolf

c) Grass > insect > birds > snakes

d) Grass > snake > insect > deer

24. First link in any food chain is a green plant because

a) Green plants can synthesize food

b) They can eat everything

c) Fixed at one place

d) None of the above

25. Which group of living organisms given below is a link in food chain between green plants and hawk?

a) Grasshopper, frog and snake

b) Grasshopper, rat and snake

c) Millipedes, centipedes and sparrow

d) Earthworm, hen and rat

26. When food energy passes from herbivores to carnivores?

a) Some energy is increased

b) Some energy is decreased

c) Remain unchanged

d) Not relevant

27. Carnivores are

a) Usually primary consumers

b) Usually secondary consumers

c) Usually secondary or tertiary consumers

d) Usually decomposers rather than consumers

28. The number of primary producer within a specified area would be maximum in

a) Pond ecosystem

b) Grassland

c) Desert
d) Forest ecosystem

29. Herbivores are called

a) Primary consumers
b) Secondary producers
c) Key industry animals
d) All the above

30. Detritus food chain starts from

a) Dead organic matter
b) Green plants
c) Zooplanktons
d) None of the above

31. Generally the food chain has how many trophic levels

a) One
b) Two
c) Three or Four
d) Three

32. Snake generally belongs to

a) Saprophytes
b) Primary consumer
c) Second trophic level
d) None of these

33. With regard to ecological food chain, man is a

a) Producer
b) Consumer
c) Both producer and consumer
d) Producer and decomposer

34. If the plant producer dies in the ecosystem, then the system is

a) Seriously affected
b) Cannot produce food
c) Can have more producers
d) Hardly affected

35. Which must be preserved in an ecosystem, if the system is to be maintained?

a) Producers and carnivores

b) Producers and decomposers

c) Carnivores and decomposers

d) Herbivores and carnivores

36. When peacock eats snakes which eat insects thriving on green plants, the peacock is

a) A primary consumer

b) A primary decomposer

c) Final decomposer

d) The apex of food pyramid

37. 10% energy transfer law in food chain was first given by

a) Lindemann

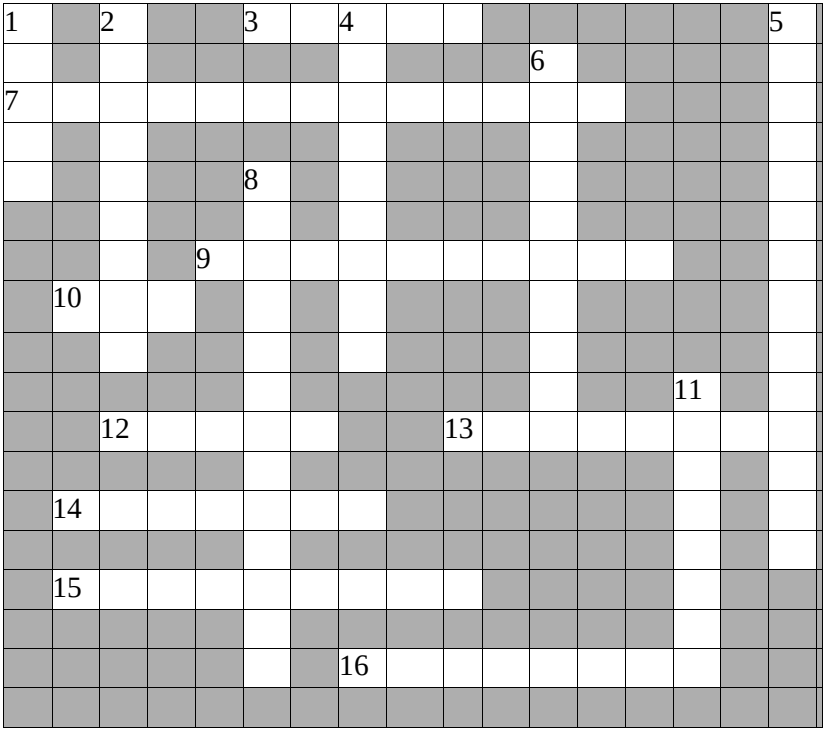
b) Tansley

c) Elton

d) Odum

Task 2

Food Chains, Food Webs, Biomass Pyramids and Cycle Crossword Puzzle



Across	Down
3. Reuse of water is known as the water__.[5] 7. Loss of water through leaves of plants.[13] 9. Scientific name for bacteria and fungi that break down dead matter and wastes.[10]	1. Important chemical that cycles or is reused.[5] 2. Animal that eats other animals that are already dead e.g. crab.[9] 4. Meat-eater.[9]

10. A network of food chains is a food___.[3] 12. Series of organisms showing feeding relationships is a food__.[5] 13. Animal that eats both animal and plant matter.[8] 14. Total dry weight of organisms in each level of a food chain or biomass pyramid.[7] 15. Plant-eater.[9] 16. Plant that begins a food chain.[8]	5. Plant process changing carbon dioxide and water into sugar and oxygen.[14] 6. Burning.[10] 8. Rain, snow and hail.[13] 11. Organism that obtains nutrients by eating another organism.[8]

Reference information

Biocenoses arose on the basis of the biogenic cycle and provide it in specific natural conditions.

Biocenosis is a dynamic, self-regulating system, the components of which (producers, consumers, reducers) are interconnected.

This word is formed by the fusion of two Latin words: "bios" – life and "cenosis" – common. This term denotes the totality of microorganisms, fungi, plants and animals that live in one territory, interconnected and interacting among themselves.

Therefore, it can be said that biocenosis are the plants, animals and microorganisms that inhabit a territory known as a biotope. The components of the biocenosis are as follows:

- **Phytocenosis:** refers to all the vegetables that live in common.
- **Zoocenosis:** refers to the animals that live in the biotope.
- **Microbiocenosis**: are microorganisms such as bacteria and viruses that live in the ecosystem.

Biocenosis has a structure that is derived according to the number of individuals that form it. Let's see what are the different structures that it can form:

✓ **Individuals:** refers to each of the living organisms that live in the biotope, be they plant, animal or microorganism.

✓ **Species**: it is a set of individuals who have both external and internal characteristics similar. These living things can reproduce with each other and will lead to fertile offspring.

✓ **Populations:** they are all individuals of the same species living at the same time in the same place. These living beings have to share natural resources and territory.

✓ **Community:** It is made up of all living beings of various species that inhabit the same place. These living things must also compete for natural resources.

All the various structural aspects of biocenosesare closely interrelated. As a rule, the more complex the spatial structure is organized, the richer and more diverse is its species representation. Over time, the structure of the biocenosis changes in insignificant limits. Such a state of relative stability that arises during the interaction of constituent elements is called homeostasis.

Spatial structure

Biocoenosis has its own structure in space, which can be both vertical and horizontal.

The vertical structure is formed as a result ofdistribution of different species of plants and animals at different altitude levels of the biosystem, which leads to the formation of longline. Such a system is largely determined by the stratification of the plant community, namely the horizons of the location of the most productive parts of plants, such as the root system and photosynthetic foliage. For phytocenosis is characteristic of both above-ground and underground stratum. The first is manifested in the possibility of joint growth of a variety of plant species that have a different need for sunlight. This is most pronounced in the forests of the temperate climatic belt, where there are tree and shrubby upper layers, slightly below the semi-shrubs

and grasses, and directly above the surface of the earth is the above-ground layer, usually consisting of mosses or lichens.

Underground stratum in biological systemsallows the phytocenosis to make full use of soil moisture, due to the different depth of the root system of plants. Steppe regions are characterized by a three-level arrangement: the most deeply embedded core systems, then the roots of various cereal crops, and quite close to the surface – tubers, bulbs and root systems of annual plants.

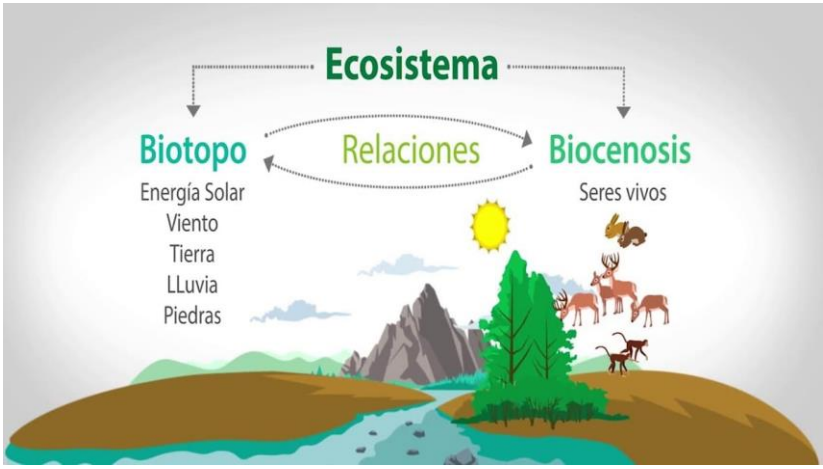


Fig. 1. *Factors limiting the distribution of biocoenosis*

Biocenosis is impaired by various barriers that interrupt the area of distribution. In a biological community, external living organisms do not interfere, and the external physical and chemical environment and its modifications are decisive. For example, **the amount of light that exists in the ecosystem and its intensity is a limitation of biocenosis**. Variations in temperature, humidity, wind regime, cloud cover and many more variables are limiting the area of distribution of the biocenosis.

We are going to analyze what are the factors that limit the biocenosis in its distribution:

- **Physical barriers**: we can point to the physical barrier as the earth itself. In the case of aquatic animals or vice versa, both land and water become a physical barrier. Aquatic animals can only live in an aquatic ecosystem and terrestrial animals in the terrestrial ecosystem.
- **Climatic barriers:** On those where climatic variables affect to a large extent. The most important variable is temperature. For example, there are animals that require a certain degree of temperature to live and cannot spread in all areas.
- **Biological barriers:** when there are enemies or predators, different diseases and lack of food are considered as biological barriers. This is because certain species can no longer change their range due to these barriers.

The transition zones that exist between the barriers that we have named are called ecotones. It can be a very narrow line under a large region and this transition line usually houses organisms that are mixed with both communities. Ecotones **they are normally good landscapes that are home to a lot of biodiversity.** The most representative examples of when barriers limit living things are the main biomes. The main biomes are as follows: tundra, savanna, fall, forest, grassland, wasteland, desert, mangrove, and forest. These biomes cover the earth's surface and are characterized by a dominant **association** that characterizes the entire landscape as a whole.All terrestrial biomes with all the organisms that inhabit them and the environment that live within nature is what makes up the biosphere. From this point of view, we can consider that the entire biosphere as a whole is a great biocenosis.

Fluctuations and changes

The biocenosis is not always stable and there are also some changes and characteristics that vary. The main changes usually

include changes in the number of individuals or fluctuations of a species over time. Here you have to analyze the context of the space. For example, we analyze the variation in the number of individuals or the fluctuation of the species during a certain time in a specific habitat. Fluctuations in most cases are usually present in a regular cyclical manner today depending on some factors.

Let's analyze what are the main factors:

- **Environmental changes:** it may be that the presence of a season of drought or floods may vary the number of individuals over time. In many cases the populations can react by increasing by decreasing the number of individuals.
- **Migrations:** It is a totally extended biological process and it represents the movements of individuals due to a modification of the habitat.
- **Disproportion between company and predator**: if there are external impacts that reduce prey and predator populations, the rest of the animal populations will also be affected.

We must know that the existing link between living beings is very important and is what determines the development between the dominant species.

The most important quantitative indicators of biocenoses are biodiversity (the total number of species in it) and biomass (the total mass of all types of living organisms in a given biocenosis).

Types of biocenosis structures:

- ✓ species,
- ✓ spatial (vertical (tiered)
- ✓ and horizontal (mosaic) organization of the biocenosis) and trophic.

Biocenosis is the ratio of species that occupy certain ecological niches.

Types of biocenoses:

- Natural (river, lake, meadow, etc.)
- Artificial (pond, garden, etc.)

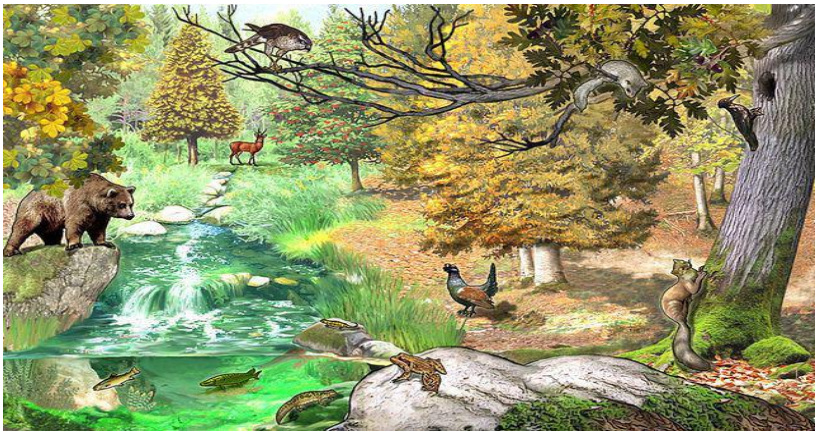


Fig. 2. *Natural biocenoses*

Natural biocenoses are Unification of living beings, created by nature itself. Such communities are natural systems that develop, develop and function according to their own specific laws. German ecologist V. Tischler highlighted **the following features** that characterize such entities:

1. There are communities of ready-made elements, which can act as representatives of individual species, and whole complexes.

2. Individual parts of the community can be replaceable. Thus, one species can be superseded and completely replaced by another, having similar requirements to the conditions of existence, without negative consequences for the entire system.

3. Due to the fact that in the biocenosis the interests of different species are opposite, the entire superorganism system is based and exists due to the balancing of oppositely directed forces.

4. Each natural community is built on the quantitative regulation of one species by others.

5. The dimensions of any superorganismic systems depend on external factors.

Fig. 3. *Artificial biological systems*

Biocoenosis artificial are created, supportedand are governed by man. Professor BG Johannzen introduced the concept of anthropocenosis into the ecology, that is, artificially created by people of the natural system, for example, a square, a terrarium or an aquarium. Among the artificial biocenoses are allocated agrobiocenoses (agrocenoses) – communities created by man for obtaining any products.

These include:

- ✓ reservoirs;
- ✓ channels;

- ✓ ponds;
- ✓ drained swamps;
- ✓ pastures;
- ✓ fields for growing various crops;
- ✓ forest shelter belts;
- ✓ artificially renewed plantations.
- ✓ agrophytocenosis as the basis of vital activity;
- ✓ lack of system self-regulation;
- ✓ low species diversity;
- ✓ domination of domestic animals or cultivated plants;
- ✓ obtaining additional support from a person (control of weeds and pests, fertilization, etc.);
- ✓ the impossibility of a long existence without human participation.

However, it should be noted that even the poorest in Species diversity of agrocenosis includes dozens of species of organisms belonging to different ecological and systematic groups. Any field, sown by man fodder or crops, is a biocenosis inhabited by different living organisms. Examples – this is the field of rye or wheat, where besides the main crop, weeds also live; and various insects (both pests and their antagonists); and many microorganisms and invertebrates.

Food Chain

A Food Chain is a series of organisms that are dependent on the next as a source of food. Organism feed on each other. These organisms take part at various biotic levels and form food chains. A trophic level is each step or level in the food chain. They show the direction of energy in an environment. The producers or **autotrophs** which produce food by the process of photosynthesis are at the first trophic level. Autotrophs or producers fix up the solar energy & make it available for consumers, which are also known as **Heterotrophs**.

The food chain is the straight chain of organisms that starts with the producer and then the energy is transferred from the producer to

the carnivores and ends with the decomposer in the food web. The food chain explains the feeding relationship of organisms.

Those who produce their own food by changing the organic energy into chemical energy are known as autotrophs and in the process known as photosynthesis that organisms have chlorophyll for making food. Thus, they are called Producers or Autotrophs. Some organisms which are dependent on the producers as a source of food are termed, **consumers**. Consumers are also known as **herbivores**. Those who feed on the producers are known as primary consumers and place on the second trophic level and they occupy the second trophic level. Those who feed on primary consumers are known as small carnivores or secondary consumers and secondary consumers occupy the third trophic level. Large carnivores which feed on secondary consumers or small carnivores are known as tertiary consumers and they form the fourth trophic level.

The food chain has four main components those are:

1. **Sun:** Plants use solar energy for the process of photosynthesis.

2. **Producer:** These are the organisms that produce food themselves through the process of photosynthesis. Producers are also known as **Autotrophs**. Solar energy is converted into chemical energy which transfers from one trophic level to the other as a source of energy. Producer Example-Algae, green plants, cyanobacteria, etc.

3. **Consumer:** These are the organisms that consume the food produced by the producers, also known as **heterotrophs**. Heterotrophs are those organisms that cannot make their own food and depends on other for food. The consumer can be **herbivores**, i.e., that organism that feeds upon green plants, or carnivores i.e., organisms that feed upon another organism. Consumers are the largest part of any food chain.

4. **Decomposers:** Organisms that break down complex organic substances into simple inorganic substances, which then go into the soil and they are an important part of maintaining the nutrients cycle in the environment.

The food we consume acts as fuel to our body and it provides energy and helps in maintaining homeostasis. Due to the interactions among the components of the environment energy flows from one component of the system to another component. Autotrophs absorb energy from sun rays and convert it into chemical energy. It is this energy that supports all the activities.

The energy pass in a **unidirectional upward movement** from producer to decomposer. When one form of energy is converted into another form of energy, some amount of energy or a huge amount of energy is lost to the environment and can't be used again.

Another aspect of the food chain is that some chemicals enter our body through the food chain and start accumulating in the body this is known as **Biomagnification**.

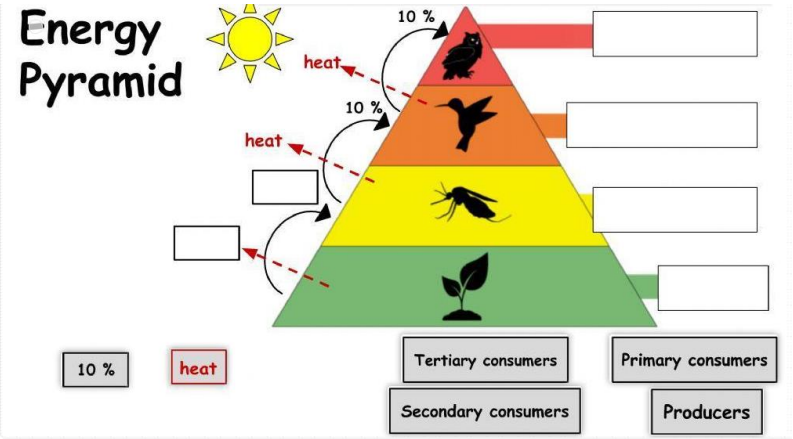
Humans use various chemicals and pesticides to protect crops from pests and other diseases. These chemicals reach soil or water bodies when they are washed off. On the one side, from the soil, these are absorbed by the plants along with water & minerals. On the other side, the water bodies, are taken up or consumed by aquatic plants & animals. In this way, chemicals enter the food chains. These chemicals are not degradable. So they go on accumulating at each trophic level. It's human beings who occupy the topmost level of the food chain. It can also be defined as a process in which the maximum concentration of chemicals gets accumulated in the body of organisms occupying the topmost trophic level. This is the reason wheat, rice, fruits, vegetables, and meat contains varying amount of chemicals.

Fig.4. *Food Chain*

Law of Leinweber

This is also known as the 10% rule.

- This law states that the energy passed from one trophic level to the next level will only the 10% of the previous tropic level.
- The flow of energy is unidirectional and always in the upward direction.
- There is a max. loss of energy as heat loss so for the next level they have less amount of energy to transfer.



THEME 8
ECOLOGICAL SYSTEMS. ECOSYSTEM HOMEOSTASIS. BIOLOGICAL PRODUCTIVITY AND ECOSYSTEM DYNAMICS

The Motivation statement

V.I. Vernadsky said: "No living organism is in a free state on Earth. All organisms are inextricably and continuously connected, first of all, with nutrition and respiration – with the material and energy environment surrounding them. They cannot exist outside of it in natural conditions."

Living organisms are closely related to each other and to their habitat: fish live in water, wolves, foxes, hares – in the forest. Providing the vital activity of each other, they form stable communities, and in combination with the habitat – a stable system, which is called "ecosystem" (from the Greek "ecos" – dwelling, habitat).

Knowledge of the ecosystem structure of the habitat allows a person to optimally interact with nature. Knowledge of the laws of

ecosystem productivity, the ability to quantify the energy flow are of extreme practical importance. The primary products of agrocenoses and human exploitation of natural communities are the main source of food supplies for humanity. No less important is the secondary products obtained at the expense of agricultural and commercial animals, since animal proteins include a number of essential amino acids for humans that are not present in plant foods. Accurate calculations of the energy flow and the scale of ecosystem productivity make it possible to regulate the circulation of substances in them in such a way as to achieve the greatest yield of products beneficial to humans. In addition, it is necessary to have a good understanding of the permissible limits for the removal of plant and animal biomass from natural systems in order not to undermine their productivity.

The objective*:* to form knowledge about the ecological system, to get acquainted with dynamic changes and components of biological productivity of ecosystems.

Questions for discussion

1. The concept of ecosystems, the doctrine of biogeocenoses.
2. Ecological groups of organisms: producers, consults and reducers.
3. Energy flow in ecosystems.
4. Biological productivity of ecosystems: primary and secondary products, pyramid rule, distribution of biological products.
5. Ecosystem dynamics: cyclical changes, successions and digressions, agroecosystems.

Independent work of students

1. Solving a situational professionally oriented task, making a decision in the protocol.
2. Watching a video on the topic of the lesson.
3. Performing test tasks on the topic "Ecological systems".

Task

Establish a correspondence between organisms and the ecological roles that these organisms have in ecosystems (for each position given in the first column, select the appropriate position from the second column and mark the result in column 3)

The body	Role in ecosystems	Mutual relationships (food chain)
1. 1) birch 2) the wolf 3) *Lathraéa (lat)*- are parasitic plants on the roots of other plants and are completely devoid of chlorophyll. 4) *Armillaria mellea (known as honey fungus that iive on trees and woody shrubs).* 5) Fomitopsis betulina (is a common bracket fungus and, as the name suggests, grows almost exclusively on birch trees) 6) chlorella	1) producer 2) consumer 3) decomposer	
2. 1) pine tree 2) *Leccinum(lat)*- Leccinum is a genus of fungi in the family Boletaceae, forming ectomycorrhizal associations with trees. 3) Dung beetles (are beetles that feed on feces). 4) Fomitopsis betulina (is a common bracket fungus and, as the name suggests, grows almost exclusively on birch trees) 5) moss 6) the wolf	1) producer 2) consumer 3) decomposer	

The body	Role in ecosystems	Mutual relationships (food chain)
3. 1) *Armillaria (lat)* – is a genus of fungi that live on trees and woody shrubs. 2) *Pisum sativum(lat)* - Peas are annual plants, with a life cycle of one year. 3) Ergot or ergot fungi (refers to a group of fungi of the genus Claviceps) This fungus grows on rye and related plants, and produces alkaloids that can cause ergotism in humans and other mammals who consume grains contaminated with its fruiting structure (called ergot sclerotium). 4) Bacillus subtilis (known also as the hay bacillus or grass bacillus, is a Gram-positive, catalase-positive bacterium, found in soil and the gastrointestinal tract of ruminants, humans and marine sponges. 5) Acidithiobacillus – is a genus of the Acidithiobacillia in the phylum "Pseudomonadota". Currently, the genus comprises ten species which are capable of obtaining energy by oxidizing sulfur compounds, with certain species also utilizing both ferrous and ferric iron. 6) The European polecat (*lat- Mustela putorius)*, also known as the common polecat, black polecat and forest polecat, is a mustelid species native to western Eurasia and North Africa, feeds on small rodents, birds, amphibians and reptiles.	1) producer 2) consumer 3) decomposer	
4. 1) Buttercup (lat.- *Ranúnculus)*- is a large genus of flowering plants in the family Ranunculaceae. Ranunculus species are used as food by the larvae of some Lepidoptera species.	1) producer 2) consumer 3) decomposer	

The body	Role in ecosystems	Mutual relationships (food chain)
2) Denitrifying bacteria (bacteria that reduce nitrates to molecular nitrogen) 3) Dodder (amarbel)- (lat.-Cuscuta (/kʌsˈkjuːtə/), is a genus of over 201 species of yellow, orange, or red (rarely green) parasitic plants. 4) the hare 5) oak 6) *Armillaria mellea (known as honey fungus that iive on trees and woody shrubs).*		
5. 1) Bark beetles (lat-*Scolytinae)- m*ost species are typical tree–eating insects, usually settling under the bark, less often in the bark or wood of trees; 2) *Trichoderma-* is a genus of fungi in the family Hypocreaceae that is present in all soils, where they are the most prevalent culturable fungi. 3) Mosses – are small, non-vascular flowerless plants in the taxonomic division Bryophyta 4)Saprotrophic bacteria are bacteria that are typically soil-dwelling and utilize saprotrophic nutrition as their primary energy source 5) Dragonfly larvae 6) Cyanobacteria, are a phylum of gram-negative bacteria[4] that obtain energy via photosynthesis.	1) producer 2) consumer 3) decomposer	
6. 1) Bacillus subtilis (known also as the hay bacillus or grass bacillus, is a Gram-positive, catalase-positive bacterium, found in soil and the gastrointestinal tract of ruminants, humans and marine sponges.	1) producer 2) consumer 3) decomposer	

The body	Role in ecosystems	Mutual relationships (food chain)
2) Fomitopsis betulina (is a common bracket fungus and, as the name suggests, grows almost exclusively on birch trees) 3) the hare 4) Cyanobacteria,are a phylum of gram-negative bacteria[4] that obtain energy via photosynthesis. 5) *Mucor* is a microbial genus are commonly found in soil, digestive systems, plant surfaces, some cheeses, rotten vegetable matter and iron oxide residue in the biosorption process. 6) Red clover is a herbaceous, short-lived perennial plant, t is widely grown as a fodder crop, valued for its nitrogen fixation, which increases soil fertility.		
7. 1) Coastal vegetation 2) Carp is a very large clade of ray-finned fish mostly native to Eurasia. 3) Amphibian larvae 4)Phytoplankton are photosynthesizing microscopic protists and bacteria that inhabit the upper sunlit layer of marine and fresh water bodies of water on Earth. Paralleling plants on land, phytoplankton undertake primary production in water,[2] creating organic compounds from carbon dioxide dissolved in the water. 5) Plants of the bottom 6) Great pond snail (lat.- *Lymnaea stagnalis*), is a species of large air-breathing freshwater snail, an aquatic pulmonate gastropod mollusk in the family Lymnaeidae.	1) producer 2) consumer 3) decomposer	

The body	Role in ecosystems	Mutual relationships (food chain)
8. 1) Mosses, ferns 2) *Anodonta* (is a genus of freshwater mussels in the family Unionidae, the river mussels) 3) A spruce, is a tree of the genus *Picea*, a genus of about 35 species of coniferous evergreen trees in the family Pinaceae, found in the northern temperate and boreal (taiga) regions of the Earth. 4) A mold (or mould),a large and taxonomically diverse number of fungal species form molds. 5) Putrefactive bacteria 6) An amoeba (is a type of cell or unicellular organism with the ability to alter its shape, primarily by extending and retracting pseudopods) and Infusoria	1) producer 2) consumer 3) decomposer	
9. 1) The Sable (*Martes zibellina*) is a species of marten, a small omnivorous mammal primarily inhabiting the forest environments of Russia, from the Ural Mountains throughout Siberia, and northern Mongolia. 2) A Spruce, is a tree of the genus *Picea*, a genus of about 35 species of coniferous evergreen trees in the family Pinaceae, found in the northern temperate and boreal (taiga) regions of the Earth. 3) Bees 4) Red clover is a herbaceous, short-lived perennial plant, t is widely grown as a fodder crop, valued for its nitrogen fixation, which increases soil fertility. 5) The Cyperaceae- are a family of graminoid (grass like), monocotyledonous flowering plants known as sedges. 6) The coyote (*Canis latrans*) is a species of canine native to North America.	1) producer 2) consumer 3) decomposer	

Task 2

Test

1. Indicate in which direction food and energy connections are carried out:

1) decomposers → producers → reducers

2) decomposers → producers → consumers

3) decomposers → consumers → producers

4) producers → consumers → decomposers

2. Organisms decomposing organic substances to mineral substances, ending the consumption of solar energy in the biogeocenosis:

1) producers

2) consumers of the first order

3) consumers of the II order

4) decomposers

3. Producers of organic substances in the ecosystem

1) producers

2) consumers

3) decomposers

4) predators

4. Group of the microorganisms living in the soil belongs to:

1) producers

2) consumers of the first order

3) consumers of the II order

4) decomposers

5. The main consumer of carbon dioxide in the biosphere are

1) producers

2) consumers

3) decomposers

4) detritus (is dead particulate organic material, as distinguished from dissolved organic material)

Multiple choice

6. Which of the following examples are true for the food chain of eating out?

1) begins with fallen plants

2) the last link in the chain are the decomposers

3) about 10% of energy is transferred from one trophic level to another

4) there are no producers in the chain

5) producers and consumers are present

6) the length of the chain depends on the productivity of the ecosystem.

7. Which of the listed organisms are classified as reducers?

1) Denitrifying bacteria (bacteria that reduce nitrates to molecular nitrogen)

2) The **Eurasian griffon vulture** (***Gyps fulvus***)

3) *Lathraéa* (latin) – are parasitic plants on the roots of other plants and are completely devoid of chlorophyll.

4) *Mucor* (microbial genus are commonly found in soil, digestive systems, plant surfaces, some cheeses, rotten vegetable matter and iron oxide residue in the biosorption process)

5) *Penicillium* is a genus of ascomycetous fungi that is part of the mycobiome of many species and is of major importance in the natural environment, in food spoilage, and in food and drug production.

6) The golden jackal (*Canis aureus*), also called common jackal, is a wolf-like canid that is native to Eurasia.

8. The consults in ecosystems are:

1) wheat and potatoes

2) *Armillaria mellea (known as honey fungus that iive on trees and woody shrubs)* and Leccinum (a genus of fungi in the family Boletaceae, forming ectomycorrhizal associations with trees).

3) putrefaction bacteria and penicilli

4) *Lathraéa* (parasitic plants on the roots of other plants and are completely devoid of chlorophyll) and Dodder (a genus of over 201 species of yellow, orange, or red (rarely green) parasitic plants).

5) the hare and the mole

6) Fomitopsis betulina (a common bracket fungus grows almost exclusively on birch trees) and ergot fungi

Reference material

An ecological system is any combination of organisms and inorganic components in which the circulation of substances can be carried out.

development.

"Ecosystem" and "biogeocenosis" are similar concepts in essence, but if the first of them is applicable to denote systems that provide a cycle of any rank, then "biogeocenosis" is a territorial concept that refers to such land areas that are occupied by certain units of vegetation cover – phytocenoses.

The Food Chain is a series in which it is possible to trace the ways of spending the initial dose of energy.

The Trophic Level is the place of each link in the food chain.

Eating out chains (or pasture chains, or consumption chains) are trophic chains that begin with photosynthetic organisms.

Detritus chains of decomposition are chains that begin with the dead remains of plants, corpses and animal excrement.

The primary production of the community is the organic mass created by plants per unit of time.

Gross primary production is the amount of substance produced by plants per unit of time at a given rate of photosynthesis.

Secondary production is an increase in the mass of the consumers per unit of time.

The rules of the product pyramid: at each previous trophic level, the amount of biomass created per unit of time is greater than

at the subsequent one. Graphically, this rule is expressed in the form of pyramids tapering upwards and formed by rectangles of equal height placed on top of each other, the length of which corresponds to the scale of production at the corresponding trophic levels. The product pyramid reflects the laws of energy consumption in food chains.

The rule of the biomass pyramid: the total mass of plants turns out to be greater than the biomass of all phytophages and herbivores, and the mass of those, in turn, exceeds the mass of all predators.

In those trophic chains where energy transfer occurs mainly through predator–prey connections, **the rule of the pyramid of numbers** is often maintained: the total number of individuals participating in the food chains decreases with each link. This is due to the fact that predators, as a rule, are larger than their food objects and several or many victims are needed to maintain the biomass of one predator.

Ecosystem Dynamics:

Cyclical changes in communities reflect the daily, seasonal and long-term periodicity of external conditions and manifestations of endogenous rhythms of organisms.

The daily transformations are usually more pronounced the greater the difference in temperature, humidity and other environmental factors during the day and at night.

Seasonal variability is expressed in changes not only in the state and activity, but also in the quantitative ratio of individual species depending on their breeding cycles, seasonal migrations, the death of individual generations during the year, etc.

Long-term variability depends on changes in meteorological conditions (climatic fluctuations) over the years or other external factors affecting the community (for example, the degree of river flooding).

A succession series is a sequential series of communities gradually and naturally replacing each other in succession.

Types of succession shifts: 1) with the participation of both autotrophic and heterotrophic populations 2) with the participation of only heterotrophs.

Case problems for independent activity

Task 1

Find three errors in the given text "Food chains and ecological pyramid". Specify the numbers of the proposals in which mistakes were made, correct them. Give the correct wording.

1) Producers include organisms capable of producing organic substances from inorganic, and consumers include organisms that consume ready–made organic substances

2) As an example of a first-order consumer in the taiga ecosystem, a wolf can be cited

3) An ecological pyramid is a graphical representation of the relationship between producers and consumers of all trophic levels in an ecosystem

4) Ecological pyramids are most often made up to display biomass, numbers and energy at levels

5) The rule of the ecological pyramid states that when moving from one trophic level to the next, approximately 1% of energy is saved

6) In pasture food chains, herbivores are at the first trophic level

7) In marine ecosystems, the pyramid of biomass is inverted – there are fewer producers in the sea than there are consumers.

Task 2

What is the maximum number of second-order consumer with an average weight of 5 kg that can feed in a community whose surface receives $5*10^8$ kcal of solar energy, if 1 kg of predator body contains 500 kcal of energy, and the efficiency of photosynthesis with a forest is 1%? (The process of energy transformation from one trophic level to another proceeds in accordance with Lindeman's rule).

THEME 9
THE BIOSPHERE AND THE PLACE OF MAN IN IT

Motivation statement

Biosphere (greek. bios – life, sphaira – ball, sphere) is a complex outer shell of the Earth, inhabited by organisms that together make up the living substance of the planet. This is one of the most important geospheres of the Earth, which is the main component of the natural environment surrounding humans. Man, like other living beings, is directly dependent on the surrounding nature. But unlike them, a person actively influences the biosphere through work, the scale of which is steadily increasing. Human mastery of various types of energy (mechanical, electrical, atomic), the development of new technologies of agricultural and industrial production contribute to a significant transformation of the biosphere. In the early stages of human existence, his activities did not disturb the balance in the biosphere. With the increase in the number of people and the development of civilization, the intensity of our society's use of natural resources began to increase dramatically. Man becomes a powerful environmental factor that upsets the balance in the biosphere.

The pace of socio-economic development of mankind over time is increasingly outpacing the pace of natural evolutionary development, and the scale of human impact on nature has begun to exceed all known geological processes. Unwisely expanding the boundaries of his ecological niche, which he occupied in the biosphere as its natural element, man in the process of productive activity increasingly changed other parameters of the biosphere. As a result, in the modern period, the established rates of natural biochemical cycles are disrupted in the biosphere, the climate is changing, the structure and composition of the gene pool is deteriorating, the ozone layer capacity is decreasing, etc.

Large-scale anthropogenic activity not only disrupts the development of biospheric processes, but also alienates humanity from nature. It is no longer in organic unity, neither with biotopes, nor with biocenoses as a whole. Most often, a person acts as an external factor in relation to the latter, while striving to subordinate nature to his interests. Most of its activities go beyond ecosystem laws and sometimes develop contrary to them. In the end, these global changes may prove fatal for a person, and he may lose his place in the biosphere. For the first time in many millennia, man has entered into a major conflict with the biosphere.

The objective: to familiarize students with the concept of the biosphere, its structure, properties (according to V.I. Vernadsky). To form an idea of a person's place in the biosphere.

Questions for discussion

1. Biosphere, concept, composition, boundaries.
2. Properties of the biosphere according to V.I. Vernadsky.
3. Classification of natural ecosystems of the biosphere.
4. The main types of anthropogenic impacts on the biosphere (atmospheric air, hydrosphere, lithosphere, biotic communities).
5. Special and extreme impacts on the biosphere.

Independent work of students

1. Discussion of the report prepared according to the individual assignment of the teacher.
2. Performing a test task on the topic of the lesson.

Task

Test

Choose the correct answer (or several) from the suggested options:

01. The biosphere includes

1) the entire hydrosphere and the lower part of the atmosphere

2) the upper parts of the hydrosphere and lithosphere and the lower part of the atmosphere

3) the entire hydrosphere, the lower part of the atmosphere and the upper part of the lithosphere

4) the entire hydrosphere, atmosphere, and upper part of the lithosphere

02. The natural environment is

1) combination and interaction of abiotic and biotic systems and components of the lithosphere, atmosphere, hydrosphere and biosphere

2) physical, chemical and biological environmental factors

3) combination of abiotic and biotic systems

4) combination and interaction of components of the lithosphere, atmosphere, hydrosphere and biosphere

03. The components of the natural environment are

1) rocks, air, surface and underground waters, soils, vegetation, wildlife.

2) atmosphere, hydrosphere, stratosphere

3) air, surface and underground waters, soils

4) vegetation and wildlife

04. Anthropogenic factors are

1) climatic factors

2) factors of biological nature

3) factors caused by human activity

4) factors of chemical nature

05. The part of natural resources that can be involved in economic activity with the given technical and socio-economic capabilities of society, provided that the human environment is preserved, is called:

1) natural resource potential

2) natural conditions

3) components of nature

4) anthropogenic environment

06.Permissible norms of anthropogenic load are the maximum possible anthropogenic impacts:

1) on natural resources that do not lead to a violation of the sustainability of ecological systems

2) to nature, in which there are no adverse changes in the biota

3) on the environment, in which there are no adverse changes in the state of human health

07. Maximum permissible emissions are emissions of harmful substances into the atmosphere:

1) in concentrations not exceeding MPC

2) in concentrations established for each source of pollution, provided that the surface concentration of these substances does not exceed the MPC

3) in concentrations established for each source of pollution, provided that the concentration of these substances in the sanitary protection zone does not exceed the MPC

08. The main natural sources of atmospheric air pollution:

1) wind erosion

2) volcanism

3) forest fires

4) agriculture

09. Anthropogenic sources of atmospheric air pollution include:

1) transport

2) heavy industry

3) public utilities

4) chemical and pharmaceutical industry

10. The most dangerous pollutants of the atmosphere are:

1) heavy metals, carbon, sulfur and nitrogen oxides

2) inorganic dust, nitrogen oxide, ammonia

3) hydrogen sulfide, phenol, soot

4) organic and inorganic dust

11. The main sources of pollution of reservoirs are:

1) waste water of industrial enterprises

2) domestic waste water

3) water transport

4) industrial emissions of pollutants into the atmosphere.

12.The main types of water pollution are as follows:

1) chemical

2) bacterial

3) radioactive

4) mechanical and thermal

13. The consequences of pollution of the hydrosphere may be as follows:

1) changing the physical properties of water

2) accumulation of chemicals

3) reducing the amount of dissolved O2

4) changing the state of the biota

14. The biosphere is a global ecosystem and is characterized by such property as:

1) regeneration

2) globalization

3) self-regulation

15. The essence of V.I.Vernadsky's teaching consists in:

1) establishment of the feedback law of interaction in the "man-biosphere" system

2) identification of homeostatic mechanisms of biosphere stability

3) recognition of the exceptional role of "living matter" that transforms the appearance of the planet

4) determination of the upper and lower boundaries of the biosphere within the planet

16. The biosphere as the global ecosystem of the Earth consists of... parts

1) physical and chemical

2) planetary and space

3) abiotic and biotic

4) material and energy

17. In the total mass of the living matter of the biosphere, animals make up:

1) 1,4%

2) 0, 8%

3) 93,7%

4) 98,0%

18. The highest stage of development of the biosphere, when intelligent human activity becomes the determining factor of development on Earth, is called:

1) the biosphere

2) biotope

3) exosphere

4) the noosphere

5) the anthroposphere

6) technosphere

19. The cyclic process of chemical transformations and displacements of matter in nature that goes with the expenditure of deep energy of the Earth and redistributes matter between the biosphere and deeper horizons of the Earth is called:

1) environmental

2) biogeochemical

3) geological

4) biological

20. The main reasons for the loss of biological diversity, reduction in the number and extinction of animals are:

1) habitat disturbance environmental pollution

2) excessive mining

3)direct destruction in order to protect products

4) unintentional destruction

Reference material

Biosphere – in the modern sense is considered as a global ecosystem (ecosphere). Like any ecosystem, the biosphere consists of an abiotic and biotic part. *The abiotic part is represented by:* 1) the soil and its underlying rocks to a depth where there are still living organisms in them that enter into an exchange with the substance of these rocks and the physical environment of the pore space; 2) atmospheric air to heights at which life manifestations are still possible; 3) the aquatic environment of oceans, rivers, lakes, etc. *The biotic part consists of* living organisms of all taxa that perform the most important function of the biosphere, without which life itself cannot exist: the biogenic current of atoms. Living organisms carry out this current of atoms through their respiration, nutrition and reproduction, ensuring the exchange of matter between all parts of the biosphere

Vernadsky 's teaching about the biosphere

According to modern ideas, **the biosphere** is a special shell of the Earth, containing the entire totality of living organisms and that part of the planet's substance that is in continuous exchange with these organisms. These ideas are based on the teachings of V. I. Vernadsky (1863-1945) about the biosphere, which is the largest generalization in the field of natural science in the XX century. The exceptional significance of his teachings in full growth manifested itself only in the second half of the last century. This was facilitated by the development of ecology, and above all global ecology, where the biosphere is a fundamental concept. The teaching of Vernadsky's Biosphere is an integral fundamental teaching organically connected with the most important problems of the preservation and development of life on Earth, which marks a fundamentally new approach to the study of the planet as a developing self–regulating system in the past, present and future.

According to Vernadsky's ideas, the biosphere includes living matter (i.e. all living organisms), biogenic (coal, limestone, oil, etc.), inert (living things do not participate in its formation, for example, igneous rocks), biocosal (created with the help of living organisms), as well as radioactive matter, cosmic matter origin (meteorites, etc.) and scattering of atoms. All these seven different types of substances are geologically related.

The essence of Vernadsky's teaching lies in the *recognition of the exceptional role of "living matter"* that transforms the appearance of the planet. The total result of its activities over a geological period of time is huge. According to V. I. Vernadsky, "there is no chemical force more constantly acting on the earth's surface, and therefore more powerful in its final consequences than living organisms taken as a whole." It is living organisms that capture and transform the radiant energy of the Sun and create an infinite variety of our world.

The second most important aspect of Vernadsky's teaching is the idea he developed about the *organization of the biosphere,* which manifests itself in the coordinated interaction of living and inanimate, the mutual adaptability of the organism and the environment. V. I. Vernadsky also substantiated the most important ideas about the forms of transformation of matter, the ways of biogenic migration of atoms, i.e. the migration of chemical elements with the participation of living matter, the accumulation of chemical elements, about the driving factors of the development of the biosphere, etc.

The most important part of Vernadsky's teaching about the ***biosphere is the idea of its origin and development.*** The modern biosphere did not arise immediately, but as a result of a long evolution. The highest stage of the development of the biosphere is the ***noosphere*** (the "thinking shell", the sphere of reason). V. I. Vernadsky wrote that this is "the sphere of interaction between nature and society, within which reasonable human activity becomes the main determining factor of development." The formation of the noosphere

"is not an accidental phenomenon on our planet", "the creation of a free mind", "human genius", but "a natural phenomenon that manifests itself dramatically materially in its consequences in the human environment". In other words, the noosphere is a human environment in which the natural processes of metabolism and energy are controlled by society.

According to Vernadsky, man is a part of the biosphere, its "definite function". Emphasizing the close connection between man and nature, he admitted that the prerequisites for the emergence of the human mind took place back in the days of animals, the predecessors of Homo sapiens, and its manifestation began millions of years ago, at the end of the tertiary period. But as a new geological force, only man could manifest himself.

Our planet has a heterogeneous structure and consists of concentric shells (geospheres) – internal and external. The inner ones include the core, the mantle, and the outer ones – ***the lithosphere (Earth's crust), the hydrosphere, the atmosphere and the complex shell of the Earth – the biosphere.*** For the first time ***the term "biosphere"*** was introduced into science by geologist from Austria E. Suess in 1875. The role and importance of the biosphere for the development of life on our planet turned out to be so great that already in in the first third of the XX century, a new fundamental scientific direction in natural science emerged – ***the doctrine of the biosphere***, the founder of which is the great Russian scientist Vernadsky.

Lithosphere (Greek. "cast" – stone) – the stone shell of the Earth, including the Earth's crust with a thickness (thickness) from 6 (under the oceans) to 80 km (mountain systems) The Earth's crust is composed of rocks. The share of various rocks in the earth's crust is not the same – more than 70% falls on basalts, granites and other igneous rocks, about 17% – on rocks transformed by pressure and high temperature, and only a little more than 12% – on sedimentary

crust – the most important resource for humanity. It contains combustible minerals (coal, oil, oil shale), ore (iron, aluminum, copper, tin, etc.) and non-metallic (phosphorites, apatites, etc.) minerals, natural building materials (limestones, sands, gravel, etc.).

Hydrosphere (Greek. "gidor" – water) – the water shell of the Earth. It is divided into surface and underground. The surface hydrosphere is the water shell of the surface part of the Earth. It includes the waters of oceans, seas, lakes, rivers, reservoirs, swamps, glaciers, snow covers, etc. All these waters are permanently or temporarily located on the earth's surface and are called surface waters.

The surface hydrosphere does not form a continuous layer and intermittently covers the earth's surface by 70.8%. Underground hydrosphere – includes the waters located in the upper part of the earth's crust. They are called underground. From above, the underground hydrosphere is bounded by the earth's surface, its lower boundary cannot be traced

Atmosphere (Greek. atmos (steam) is the gas envelope of the Earth, consisting of a mixture of various gases, water vapor and dust (Table 6.3 according to N. Reimers, 1990). The total mass of the atmosphere is 5,15–1015 tons. At an altitude of 10 to 50 km, with a maximum concentration at an altitude of 20-25 km, there is an ozone layer protecting the Earth from excessive ultraviolet radiation, which is fatal for organisms. The atmosphere, hydrosphere and lithosphere closely interact with each other. Almost all surface exogenous geological processes are caused by this interaction and take place, as a rule, in the biosphere.

The biosphere is the outer shell of the Earth, which includes part of the atmosphere up to a height of 25-30 km (up to the ozone layer), almost the entire hydrosphere and the upper part of the lithosphere to a depth of about 3 km.

Extreme destructive effects on the natural environment

Extreme destructive impacts on the natural environment can be *anthropogenic* (military actions, accidents, catastrophes) and natural (natural disasters). Territories in which, as a result of accidents, catastrophes, military operations or natural disasters, negative changes in the environment occur that threaten human health, the state of natural ecological systems, the genetic fund of plants and animals, are declared *zones of an ecological emergency*.

Anthropogenic impacts are understood as activities related to the realization of economic, military, recreational, cultural and other human interests that make physical, chemical, biological and other changes to the natural environment.

The special types of anthropogenic impact on the biosphere include:

1) environmental pollution by hazardous waste;

2) noise impact;

3) biological contamination;

4) exposure to electromagnetic fields and radiation and some other types of effects.

Noise exposure is one of the forms of harmful physical effects on the environment. Noise pollution occurs as a result of unacceptable excess of the natural level of sound vibrations. From an ecological point of view, in modern conditions, noise becomes not just unpleasant to the ear, but also leads to serious physiological consequences for humans. Tens of millions of people suffer from noise in urbanized areas of the developed countries of the world.

Biological pollution is understood as the introduction into ecosystems as a result of anthropogenic impact of uncharacteristic species of living organisms (bacteria, viruses, etc.) that worsen the conditions of existence of natural biotic communities or negatively affect the human health.

ANTHROPOGENIC IMPACTS

TARGETED IMPACTS	AREAL	BIOSPHERE
	POINT	
	STATIC	
	DYNAMIC	
	LONG – TERM	
	SHORT – TERM	
	DEEP	
	NEAR – SURFACE	
	DIRECT	
	INDIRECT	
	MECHANICAL, PHYSICAL, CHEMICAL, BIOLOGICAL	

Fig. 1. *Classification of targeted anthropogenic impacts on the biosphere*

Chapter 2
HUMAN ECOLOGY (MODULE 2)

THEME 10
BIOSOCIAL NATURE OF MAN AND ECOLOGY

Motivational statement

Man is the highest stage of living organism's development on the Earth. He, according to I. T. Frolov (1985), is "a subject of the socio-historical process, the development of material and spiritual culture on Earth, a biosocial being, genetically related to other forms of life, but he is separated from them thanks to the ability to produce tools, possessing articulate speech and consciousness, creative activity and moral self-awareness."

The objective: to study the features of the biosocial nature of man, the evolutionary features of the species, the influence of the artificial environment on human evolution.

Questions for discussion

1. Man as a biosocial being.
2. Man as a biological species (evolutionary features, heredity, natural selection).
3. The artificial environment and human evolution.
4. Population characteristics of a person (population growth, age pyramid).
5. Natural resources of the Earth as limiting factors for human survival.

Independent work of students

1. Solution and discussion of a situational problem.

2. Viewing and discussion of the educational video film “Last Ones Surviving. The Mystery of Man is a film about the origin and evolution of man."

3. Listening and discussing abstracts prepared by students on the individual instructions of the teacher.

4. Working with tests on the topic of the lesson.

Test task

Choose one correct answer.

01. Social adaptation is...

1) the process of integrating an individual into the social system, entering the social environment through mastering its social norms, rules and values, knowledge, and skills that allow him to function successfully in society;

2) bringing inter-individual and group behavior into conformity with the norms and values prevailing in a given society, class, social group in the process of socialization (by acquiring knowledge about this society, class, etc.);

3) the mechanism by which a person perceives and evaluates information about another person that comes to him.

02. Biological adaptation is...

1) adaptation of the structure and functions of the body, its organs and cells to environmental conditions;

2) a feature of an organism, consisting of interconnected and interacting elements and having the ability to develop and adapt to the environment.

3) adaptation of the organism to external conditions in the process of evolution, including morphophysiological and behavioral components;

03. Human ecology studies...

1) general laws of relationship between a person (or group of people) and the biosphere, the influence of the natural and social environment on a person (or group of people);

2) the interaction of humans and other living organisms with each other and with their habitat;

3) the influence of various factors and environmental conditions on the human body and public health.

04. The human gene pool is...

1) the totality of genes of a given organism;

2) the entire set of genes of the population living in a specific historical territory, and therefore the human population;

3) a set of external and internal characteristics of an organism acquired as a result of ontogenesis.

05. Society is...

1) human community, the specifics of which are the relationships between people, their forms of interaction and association;

2) exchange of information and interaction between people based on perception and understanding of each other;

3) general foundations of human existence, social behavior niya of individuals and various forms of joint life activity.

Reference material

The biosocial nature of a person is reflected in the fact that his life is determined by a single system of conditions, which includes both biological and social elements. This necessitates not only its biological, but also its social adaptation, i.e., bringing inter-individual and group behavior into conformity with the norms and values prevailing in a given society, class, social group in the process of socialization (by assimilation of knowledge about this society, class and etc.). Human biological adaptation is very different from that in the animal world, since it strives to preserve not only its biological, but also social functions with the increasing importance of the social factor. The latter circumstance has important ecological significance and is reflected in the ecological approach to the definition of the concept “human”.

The general laws of the relationship between a person (or a group of people) and the biosphere, the influence of the natural and social environments on a person (or a group of people) are studied by the science of human ecology.

Man as a biological species

Man is an integral part of the living, and he cannot exist in natural conditions outside the biosphere and living matter of a certain evolutionary type.The family of hominids, to which man belongs, arose in the equatorial part of the Earth, and the genus Man – in eastern Africa and South Asia. In early eras on Earth, there were several species of hominids belonging to two subfamilies: australopithecus and just humans, of which only one species has survived – Homo sapiens – Homo sapiens. Echoes of the fact that until recently Neanderthals and humans lived on Earth at the same time are the surviving legends about the "Bigfoot". Many scientists believe that Homo sapiens is divided into two subspecies – Neanderthals and modern humans.

There are a number of turning points in the evolution of living matter on the planet, the last of which in this evolutionary succession is the appearance of man, Homo sapiens.

This happened quite recently – 3.5–5 million years ago, which, compared to the 4 billion years of development of the living world, is an insignificant part of it.

Primitive man, until recently (before the advent of agriculture), was actually an ordinary omnivorous consumer of natural ecosystems. Being engaged in gathering and hunting, he created short-term small settlements, moving from place to place in search of areas with richer vegetation and other food. At this time and even earlier, human influence on the surrounding nature was small. Even 1.5 million years ago, human life expectancy did not exceed 20 years, and the size of its entire population on Earth was about 500 thousand individuals.

However, a person not only depends on the environment, but also influences it. But unlike animals, man has intelligence. Intelligence allowed him to find an "antidote" against one of the most important factors – the lack of food resources: agriculture – cattle breeding and farming. This happened about 10 thousand years ago. Man began to build his own ecological system.

Man's ability to think and the creation of the necessary tools allowed him, at least temporarily, to overcome the action of ordinary abiotic and biotic factors. B, Nebel (1993) believes that a person was able to overcome their effects:

1) producing food in abundance (although there are still problems with its distribution);

2) creating reservoirs and supplying water to populated areas and fields;

3) creating means of combating predators and many pathogens;

4) having built homes and learned to heat or cool them at will;

5) winning in competition with other species.

A person, having learned to overcome the action of limiting factors, nevertheless has not yet won a 100% victory over them. As Yu. Odum (1975) notes, he can supply a room with conditioned air, but he cannot consider himself independent of the climate.

Thus, although man is a social being, nature itself will always be a factor in human existence. The artificial environment also affects humans, i.e., feedback occurs here, but it affects both biological and social processes occurring in human populations.

Human heredity

The genetic program created during the formation of the species Homo sapiens defines it as a biological species.

Social relations also influence the human gene pool.

The gene pool is the entire set of genes of the population (of any biological species) living in a specific historical territory, and therefore

of the human population. Various social conditions determine the formation of people of a certain genotype, that is, a certain combination of genes transmitted by parents and ensuring a person's life.

Natural selection played a decisive role in the evolution of Homo sapiens. Modern humans arose during the last ice age, approximately 40–50 thousand years ago. As we have already noted, during this period he was engaged in hunting, gathering, and much later – cattle breeding, agriculture and crafts, and only in the last two or three centuries did industrial production rapidly develop. Throughout this history, the role of the natural environment has gradually decreased and the role of the artificial environment in human life has increased. At the same time, the magnitude and qualitative nature of the pressure of natural selection changed.

Thanks to social change and the development of medicine in developed countries, the pressure of natural selection has been significantly reduced. Nevertheless, man, being a biosocial being, has not freed himself from the action of general biological laws that are universal for all living things.

The built environment and human evolution

The driving force of evolution is natural selection, the pressure of which in developed countries in general, and especially in urban systems, is significantly reduced.

But zonal geographical conditions continue to operate; even the formation, regardless of ethnicity, of zonal adaptive types of humans has been noted: tropical, desert, high-mountain, continental, temperate, arctic.

Taking into account the indicated genetic characteristics of man and the fact that he has occupied spaces where environmental influences are largely opposite, we can state: man, unlike animals, has placed the species in the conditions of a very wide ecological niche, characterized by a general orientation of adaptation.

"Self-adjustment" of body systems to the environment indicates the possibilities of human survival in new conditions, which allows us to look optimistically at the future of all humanity, without predicting its death. Examples of "self-tuning" of human body systems when the environment changes include: acceleration processes, adaptive dynamics of the sex ratio in the population, the physiological reaction of the body to conditions of high mountains, high latitudes, hypokinesia and weightlessness, etc.

A person not only adapts, but is firmly "tied" to his environment, both in individual and species aspects (Urban Environment..., 1990). Data from space biology show that a person, adapting to new conditions in space, returning to Earth, is forced to again develop his previous skills – to deadapt.

Approximately the same thing happens if it is not a person who changes the environment, but the environment changes in the place of his residence, in production, etc. For example, the noise of the mechanisms in the workshop, the level of pollution, etc., has increased, say, for some time. But if these changes occur quickly and powerfully, then evolutionary processes, selection mechanisms, no longer have time, "lag behind," and adaptation becomes impossible. Such a sharp imbalance in the system causes stressful situations that lead to human diseases, including genetic disorders – mutagenic phenomena.

In the urban environment, traditional environmental factors are supplemented by such factors as desynchronosis (inconsistency in adaptation of geographic zonality during translatitudinal and transmeridian migrations), transport fatigue, electromagnetic fields, symbiotic bacterial-viral flora, medical interventions, information richness of the environment, viral transduction (transfer of genetic material from one cell to another using a virus), etc.

There is a problem of assessing the quality of the urban environment. In natural ecosystems, indicator species can be used. But

man, unlike animals, retains his species-specific morphofunctional characteristics regardless of changing living conditions thanks to labor socio-historical activity, as a result of which a new "artificial" environment was created. Therefore, assessing the state of a person's environment is possible only through the state of health of the person himself.

Human population characteristics

The human population, i.e. the population of a special species – Homo sapiens, has the same properties as the animal population, but the nature and form of their manifestations differ significantly due to the action of factors such as the artificial environment, socio-economic conditions and others, called a single the term is society.

All people on Earth form a population system – humanity. The growth of this population is limited by available natural resources and living conditions, socio-economic and genetic mechanisms (Reimers, 1994).

But if human behavior is truly reasonable, then, according to Yu. Odum (1975), he must: 1) study and understand the form of his own population growth; 2) determine quantitatively the optimal size and configuration of the population in connection with the capacity of a given area; 3) be ready to accept "cultural regulation" where "natural regulation" is ineffective.

Natural resources of the Earth as a limiting factor for human survival

Resources are something extracted from the natural environment to satisfy one's needs and desires" (Miller, 1993). Human needs can be divided into material and spiritual (the beauty of nature, recreational resources, etc.).

So, natural resources are natural objects and phenomena that people use to create material wealth that ensures not only the

maintenance of human existence, but also a gradual increase in the quality of life.

Man, thanks to his ever-increasing material needs, cannot be content with the gifts of nature only to the extent that he should not upset its balance, i.e., about 1% of the resources of the natural ecosystem, so he has to use those natural resources that have been accumulated for billions and millions of years in the bowels of the Earth. To create material wealth, people need metals (iron, copper, aluminum, etc.) and non-metallic raw materials (clay, sand, mineral fertilizers, etc.), as well as forest products (timber for the production of pulp and paper, etc.) and much more.

THEME 11
HUMAN POPULATION CHARACTERISTICS

Motivational statement

Human population is synonymous with the concept of "Earth population". The human population has the same properties as the animal population, but the nature and form of these manifestations differ significantly due to the action of factors such as the artificial environment, socio-economic conditions, etc., called by a single term – society. All people on earth form a single population system – humanity. This system is limited by available natural resources and living conditions. At the same time, the human population is experiencing continuous growth. And reasonable human behavior implies studying the form of one's own population growth, determining the quantitatively optimal size and configuration of the population in connection with the capacity of a given area, and accepting "cultural regulation" where "natural regulation" is not effective.

The objective: to form an idea of the human population as one of the fundamental concepts of human ecology.

Questions for discussion

1. The concept of human population, definition.
2. Basic structures of the human population.
3. Dynamic population indicators.
4. Types of age composition of the population.
5. Types of population reproduction.

Independent work of students

1. Solving a situational professionally oriented problem, documenting the solution in a protocol.
2. Working with training test tasks.

Test task

Select one or more correct answers

01. Elderly representatives make up a large proportion in populations:

a) rapidly growing;
b) in a stable condition;
c) with reduced numbers;
d) in which there is no clear pattern of growth.

02. The ratio of population representatives by age is called:

a) average life expectancy in the population;
b) age composition of the population;
c) physiological fertility;
d) ecological fertility.

03. The most stable populations are those consisting of:

a) from one generation (generation);
b) two generations;
c) three generations;
d) several generations and descendants of each of them.

04. The population is characterized by the following properties:

a) birth rate, death rate;

b) area of the territory;

c) distribution in space;

d) habitat, living conditions.

05. Age structure of the population:

a) determined by external conditions;

b) does not depend on the life cycle of the species;

c) depends on the intensity of mortality and the magnitude of the birth rate;

d) depends on the size of the population.

06.Evolutionary significance of populations:

a) maintain the genetic constancy of the species

b) capable of accepting exclusively beneficial mutations

c) give rise to new species

07. Population sign:

a) uniformity of size of individuals

b) relatively stable genetic constancy

c) mainly consist of individuals of different species

08. The population is characterized by the following property:

a) habitat

b) area of territory

c) birth rate

09. The sexual structure of the population is:

a) quantitative ratio of male and female representatives in the population

b) quantitative ratio of male representatives in the population

c) quantitative ratio of female representatives in the population

10. The age structure of the population is:

a) distribution of population representatives by age and hierarchy

b) distribution of population representatives by age and their article

c) distribution of population representatives by age

11. The spatial structure of the population is:

a) spatial arrangement of population representatives

b) spatial location of some representatives of the population

c) spatial arrangement of all organisms

12. Mortality is:

a) the number of representatives who should have died

b) the number of individuals killed per unit of time

c) the number of individuals that died a year earlier

13. All components of the habitat that affect life activity populations are called:

a) abiotic factors

b) biotic factors

c) driving factors of evolution

d) environmental factors

14. Self-regulation of population numbers is ensured by:

a) the occurrence of isolation

b) modification variability

c) hereditary variability

d) the effect of limiting factors.

Reference material

Population is any collection of individuals of the same species capable of self-reproduction. It is isolated in space and time from other similar populations of the same species more or less.

A human population is a community of people occupying a certain territory for a long time with ecologically similar conditions and united by a common origin, which is expressed in common hereditary qualities.

The human population, like any type of living organism, is a system with a certain structure. It can be divided into spatial, gender, size-age and other structures.

Current population – part of the population that is located in a given locality at the time of registration, regardless of place of permanent residence

The permanent population is the part of the population that permanently resides in a given locality, regardless of its actual location at the time of registration.

Population aging is a steady process of increasing the proportion of older people and decreasing the proportion of children, especially intense since the beginning of the 20th century.

Sex structure reflects the sex ratio of a population; this indicator is especially important for species with predominant sexual reproduction. The human population is bisexual, its sex ratio is close to 1:1, which is genetically fixed. However, approximately 5% more boys are born than girls. However, since mortality at all ages is higher for males than for females, these differences first level out by the age of 20–25 years, and in older ages women already dominate.

The age structure of a population is the ratio in the population of individuals of different ages, representing one or different offspring of one or several generations.

The sex and age structure of populations depends on two main reasons: the biological characteristics of the species and the specific environmental conditions of its existence.

The age pyramid reflects the structure of the population of a given area or state as a whole and it contains information about the number of each age category of people, the nature of population growth, the positive or negative impact of living conditions, etc.

Pyramids are built in age-number coordinates. Each age class for different animals, depending on their life expectancy, has different intervals, and for humans – an interval of five years. It is depicted as a horizontal “lying column”, the length of which is equal to the size of the given age class. The “youngest” column fits into the base of the pyramid, the “eldest” one crowns it.

According to the age composition, progressive, regressive and stationary types of the population are distinguished:

Progressive type of population – the proportion of children aged 0-14 years exceeds the proportion of the population aged 50 years and older. The progressive type of population ensures a further increase in the population.

Regressive type – the proportion of people aged 50 years and older exceeds the proportion of the population from 0-14. The regressive type threatens the nation with extinction.

Stationary type – the ratio of these groups is approximately the same.

The genetic structure of a population is determined by the variability and diversity of genotypes, the frequencies of variations of individual genes – alleles, as well as the division of the population into groups of genetically similar individuals, between which, when crossed, there is a constant exchange of alleles.

Population size is the number of individuals (representatives of a population) within a certain spatial unit – an area, a river basin, a sea area, a region, a district, etc.

The size of the human population, like the population of any type of living organism, almost never remains constant. It is constantly undergoing changes caused by numerous natural and social factors.

Changes in human population size per unit time (N/t) are defined as follows:

$$N/t = (B + im) – (D + em),$$

N – population size

t – time

B – birth rate, or the number of babies produced by the adult women in the population;

D – mortality, or the number of dead individuals in a population, regardless of the cause of their death – old age, illness, death from accidents, in military conflicts, natural disasters, etc.;

im – immigration, or influx of individuals from other populations into a population;

em – emigration, or outflow of individuals from a given population to other populations.

All these parameters have the dimension “individual time-1"

Natural population growth (NP) is the absolute value of the difference between the number of births and deaths over a certain period of time, showing the excess of the birth rate over the death rate.

Its value can be either positive or negative:

$$N - M = E,$$

N is the total number of births, M is the total number of deaths.

Natural population growth can be: 1) positive (E>0), when the birth rate exceeds the death rate; 2) zero (E=0), when the birth rate is equal to the death rate; 3) negative (E < 0).

EP = ((number of births per year – number of deaths per year)/average annual population) x 1000

Fertility, or birth rate, is the process of renewing new generations.

The crude birth rate is calculated by dividing the number of births per year N by the average annual population.

Mortality, or mortality rate, is the number of individuals dying in a population per unit time. Mortality is a demographic process that includes the entire totality of deaths in a given population over a certain period

The overall mortality rate is calculated similarly by dividing the number of deaths per year by the average annual population, multiplied by 1000. This indicator is an important social criterion for the quality of life of the population.

Mortality assessment levels: very low (less than 7%), low (7-10%), medium (11-15%), high (16-20%), very high (more than 21%).

Demographic characteristics of the population:

- ✓ place of residence (urban and rural population);
- ✓ gender (men and women, including by age);
- ✓ age.

Natural population movement is the continuous change in the size and structure of the population as a result of births, deaths, marriages and divorces. Changes in the age and sex structure of the population are also included in the natural movement of the population due to the close relationship of its changes with all demographic processes. Natural movement includes birth rate, death rate, and natural increase.

Population reproduction is a process of generational change. Types:

Expanded reproduction – the number of subsequent generations is larger than previous ones.

Narrowed reproduction – the number of new generations is smaller than previous ones.

Simple reproduction – the number of subsequent generations is equal to the number of previous ones.

The family structure of the population (grouping of the population according to its marital status) characterizes the number of families and the share of each group in the total number of families in the following areas: 1) completeness and incompleteness of the family – families with and without a married couple; 2) the structure of two-parent families according to the number of generations living in them simultaneously – a married couple without children; married couple with children; a married couple without children with the parents or grandparents of the spouses; a married couple with children and with parents or grandparents; a married couple without children with direct relatives (brothers, sisters); married couple with children and collateral relatives (other relatives); 3) the family's reproductive prospects – the spouses are no older than 30 years old and have been married for no more than 5 years; 4) distribution of families by number of members – grouping families by the number of family members: 2, 3, 4, 5, 6, 7 or more; 5) distribution of families by type of consumption – groups of families with and without dependents; families with dependents of children, working age and older than working age; families with state dependents – pensioners and scholarship holders.

Case problem No. 1.

In the Central district of the city of N. in the reporting year:

Average annual population	28675 persons
Number of births	189 children
Number of deaths	254 persons

Assignment: calculate and estimate natural population growth and total fertility rate.

Case problem No. 2.

In the Central district of the city of N. in the reporting year:

Average annual population	28675 persons
Number of births	189 children
Number of deaths	254 persons

Assignment: calculate and estimate natural population growth and mortality

THEME 12
AGRICULTURAL ECOSYSTEMS

Motivational statement

In the process of interaction with nature, humanity has constantly solved the primary task of life support – the production of food (the only source of human energy). A person receives quite a lot of different types of products from natural ecosystems. Nevertheless, the main source of funds to meet its needs is agriculture. The process of transition from gathering to primitive, and subsequently to more advanced farming systems, to more advanced farming in general, stimulating the growth of food production, contributed to an increase in the importance of the agricultural sector in the formation of primary biological products. This greatly favored the growth of the world's population. Human agricultural activity is changing natural

ecosystems. In addition, a person is able to form artificial ecosystems and maintain their existence in order to obtain agricultural products. These artificial ecosystems are called agroecosystems.

The objective: to form knowledge about the structure of ecosystems, to learn how to make a description of natural and artificial ecosystems, to explain the differences between them and their significance; to know the principles of sustainable functioning and methods of conservation of agroecosystems resources.

Questions for discussion

1. Agroecosystem, agrocenosis – definitions of concepts, examples. Basic requirements for agroecosystems: stability, plasticity, inertia.
2. Agricultural landscape: concept, negative impact of human activity, directions of optimization.
3. Principles of sustainable functioning and methods of conservation of agroecosystems resources.
4. Differences between natural and agricultural ecosystems.
5. The structure of the agroecosystem.
6. Classification of agroecosystems (by types of land use, by reproduction of soil fertility, by energy balance).
7. Soil-biotic complex (SBC) as the basis of agroecosystems.

Independent work of students

Choose one answer

01. Why can't a field sown with cultivated plants be considered a natural ecosystem?

1) there are no food chains
2) there is no circulation of substances
3) in addition to solar, additional energy is used
4) plants are not arranged in tiers in space

02. Agrocenoses are characterized by

1) the dominance of monoculture

2) reducing the number of pests

3) the diversity of the types of organisms included in them

4) reducing the competitiveness of cultivated plants

03. The peculiarity of the rye field as an agroecosystem

1) a large number of species

2) lack of reducers

3) long power supply chains

4) short-term existence

04. An ecosystem in which artificial selection is carried out, aimed at increasing the productivity of agricultural crops, and the effect of natural selection is weakened

1) agrocenosis

2) nature reserve

3) biogeocenosis

4) national park

05. The similarity of artificial and natural ecosystems is that they

1) contain the same number of links in the power supply networks

2) have the same productivity of plant biomass

3) cannot exist without human participation

4) contain the same functional groups of organisms

06. The agroecosystem of the orchard differs from the ecosystem of the oak grove

1) absence of pests and parasites

2) longer power circuits

3) less stability

4) closed circulation of substances

07. Agrocenoses include

1) meadow clover community

2) field with seeded peas

3) forest community

4) meadow cereal community

08. Agroecosystems are less stable than ecosystems, since they

1) there are no producers and reducers

2) limited species composition of plants

3) animals occupy the first trophic level

4) a closed cycle of substances and energy transformations

09. Introduction of agrocenoses of legumes into crop rotations contributes to

1) reduction of acreage

2) reducing soil erosion

3) accumulation of nitrogen in the soil

4) enrichment of the soil with phosphorus compounds

10. The introduction of fertilizers into the soil is accompanied by pollution of the plant habitat when

1) fertilization in autumn

2) fertilization in early spring

3) improper tillage

4) violation of norms and terms of fertilization

11. An example of agrocenosis can be

1) wooded meadow

2) wheat field

3) water-meadow

4) floodplain of the river

12. In which ecosystem is the circulation of substances open?

1) feather grass plain

2) wheat field

3) coniferous forest

4) oak grove

Reference material

Agroecosystem is an ecological system that unites a piece of territory (geographical landscape) occupied by an economy producing agricultural products. The agroecosystem includes: soils with their populations (animals, algae, fungi, bacteria); fields-agrocenoses; livestock; fragments of natural and semi-natural ecosystems (forests, natural forage lands, swamps, reservoirs); man.

The main features of the agroecosystem are determined by a person who stands at the top of the ecological pyramid and is interested in obtaining the maximum amount of agricultural products.

Agroecosystems include fields, orchards, vineyards, protective forest strips, etc. Without human support, agroecosystems quickly disintegrate, returning to their natural state.

The components of the agroecosystem are agricultural lands on which grain, tilled, fodder and industrial crops are grown, as well as meadows and pastures.

The basis of agroecosystems are *agrocenoses.*

Agrocenoses (Greek: agros – field) are biocenoses on agricultural land. The main elements of agrocenoses in agricultural ecosystems are:

1) cultivated plants sown or planted by man;

2) weeds;

3) microorganisms of the rhizosphere of cultivated and weed plants;

4) nodule bacteria on the roots of legumes that bind free nitrogen in the air;

5) mycorrhizal fungi on the roots of higher plants;

6) bacteria, fungi, actinomycetes, algae, free-living in the soil;

7) invertebrates living in the soil and on plants;

8) vertebrates (rodents, birds, etc.) living in soil and crops;

9) fungi, bacteria, viruses-parasites (semi-parasites) of cultivated and weeds;

10) bacteriophages are parasites of microorganisms.

Currently, about ten percent of the land is occupied by agrocenoses. In agrocenoses, the vegetation cover is represented by one or few species. The replacement of a complex vegetation cover with a monoculture leads to a sharp restructuring of the phytophagous complex. Species unable to feed on cultivated plants may disappear. In agrocenoses, the number of entomophages is also sharply decreasing.

Agrocenoses are regulated by human activity. They have high productivity, but low environmental sustainability. In the formation of agroecosystems, their *stability* is of fundamental importance – the ability to preserve and maintain the value of their parameters and structures in space and time without changing the nature of their functioning.

Parameters of agroecosystem *stability* are functions, modes and properties of soil; structure, organization and productivity of agrophytocenosis; structure and organization of microbial community; intensity and balance of biogeochemical cycle; information flows.

Agroecosystems must have *plasticity*, which means their ability to return to the previous area of stable equilibrium after temporary exposure to a natural or anthropogenic factor; *inertia*, due to which internal connections are preserved during the transition from one area of stable equilibrium to another. The preservation and improvement of soil fertility is a central link in ensuring the sustainability of agroecosystems.

An agricultural landscape is an ecosystem formed as a result of the agricultural transformation of the natural landscape. Thus, an agricultural landscape is understood as a landscape, in most of which natural vegetation has been replaced by crops and plantings of agricultural plants.

Human activity leads to significant and sustainable changes in the natural environment. In agroecosystems, these include the processes of

erosion and deflation; contamination of soils and natural waters with chemicals washed out of mineral fertilizers; eutrophication of reservoirs; compaction, acidification and reduction of biological activity of soils; changes in species composition, abundance and distribution of flora and fauna, etc. In this regard, there is an obvious need for a system of environmental stabilizing measures.

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Optimization of the agricultural landscape is a set of measures to preserve or modify existing and form new connections between various components of the landscape in order to use it rationally, preserve useful properties and prevent their possible loss, establish the fullest possible correspondence of the natural potential of the landscape to the socio–economic functions assigned to it by a person.

In order to achieve optimal functioning of agricultural systems adapted to specific conditions, it is important to observe the principle of adequacy, interconnection and subordination of natural, technological, economic and social characteristics.

The ecological and social significance of agricultural landscapes is determined by their role in the life support of society and in regulating the quality of the environment. The intensity of the use of biological resources of agricultural landscapes should be limited by their ability to renew.

The agrosphere is a global system that unites the entire territory of the Earth transformed by human agricultural activity.

Table 1

Agroecosystem resources and methods of their conservation

Agroecosystem resources	Resource conservation methods
Renewable: – humus content in the soil – nitrogen content in the soil – hydrochemical and hydrological regimes	Soil protection tillage; saturation of crop rotations with soil-restoring crops; full use of manure
	Activation of biological nitrogen fixation processes; application of manure and nitrogen mineral fertilizers
	Rationing of water intakes for irrigation; exclusion of drainage of swamps; prevention of agricultural and man-made soil pollution
Non – renewable: – stocks of fluorine, potassium and other elements of nutrition; – biodiversity	Application of mineral fertilizers
	Reduction of arable land area; reduction of pasture loads; rational use of forest plantations; use of restorative successions

Distinctive features of agroecosystems

Natural systems and agroecosystems have their own energy flows and the possibility of its accumulation, internal and external cycles of substances, have the ability to regulate these processes, which differ significantly from each other.

The first difference between natural and artificial ecosystems (agroecosystems) ***is in the different direction of selection.*** Natural selection, rejecting non–viable forms of organisms and their communities, leads the organization of natural ecosystems to their fundamental property – sustainability. With a lack of light, heat and moisture, nutrients, those competing species that are able to go through the entire life cycle and leave offspring survive.

Agrobiocenoses are outside the sphere of natural selection, these systems are created and maintained by humans. Artificial selection is primarily aimed at increasing the yield of agricultural crops, and the yield is not associated with resistance to adverse factors.

The second difference is related to the incoming energy. Natural ecosystems use the only source of energy – the sun. The efficiency of using solar energy is small, but natural ecosystems sustainably exist on this amount of energy, transforming it in various food chains. Agrobiocenoses, along with solar energy, receive additional. The share of anthropogenic energy is 5-10% of the total. Such energy includes: human muscular efforts, fertilizers, pesticides, irrigation, agricultural machinery, etc. Energy investments are always accompanied by material ones, which affects the biological cycle in agrocenoses. In general, the efficiency of good sowing during the growing season does not exceed 1.0–4.0%.

The third difference is the diversity of the ecological composition of the phytocenosis. The diversity of the ecological composition of the phytocenosis ensures the stability of the production process with fluctuations in weather conditions in different years. The oppression of some plants in natural ecosystems leads to an increase in the productivity of others. As a result, the ability to create products in different years remains. The agrocenosis of field crops is a monodominant, single–variety community. The effect of adverse factors is equally reflected in all plants of the agrocenosis. The inhibition of the growth and development of one crop cannot be compensated by the increased growth of other plants. As a result, the stability of the agrocenosis is lower than in natural ecosystems.

The fourth difference is the presence of plants with different phenological rhythms. The presence of a wide range of plants with different phenological rhythms allows natural ecosystems to carry out the production process continuously throughout the growing

season, most fully and economically spending resources of heat, moisture and nutrients.

In agroecosystems, the growing season of cultivated plants is shorter than the growing season. In agrobiocenosis, plant growth is simultaneous and the sequence of development stages is largely synchronous. Therefore, the time of interaction of plants and their residues with the soil is much shorter than in natural systems, which negatively affects the metabolic processes in the system. Aboveground plant residues enter the soil for a short period of time, only in late summer and early autumn, their mineralization is carried out only in the next season, which negatively affects the level of soil fertility.

Fifth, one of the most significant differences between natural ecosystems and agroecosystems ***is the degree of compensation of the cycle within the ecosystem.*** In natural ecosystems, the entry of matter into the cycle for a certain period is on average approximately equal to the exit of matter from the cycle.

Anthropogenic impact violates the compensation (closure) of the biological cycle. In agroecosystems, some substances are permanently removed from the ecosystem. In agrocenoses with plant products, 50.0–60.0% of organic matter is removed. Even the application of fertilizers cannot compensate for the batteries carried out with the harvest.

A decrease in the humus content worsens the conditions for the development of beneficial microflora, including "soil-cleaning", contributes to the loss of reserves of subsurface energy, nutrition elements, promotes the strengthening of the process of flushing and leaching, that is, causes the degradation of the basis.

The sixth difference is that natural systems are autoregulatory, agroecosystems are man–controlled. A person in agroecosystems controls or changes the influence of natural factors. In this connection, it is necessary to find conditions for increasing crop yields with minimal costs of matter and energy, at which soil fertility was preserved and increased.

Structure of the agroecosystem

Agroecosystem is an autotrophic ecosystem, the main source of energy for which is the sun. The additional (anthropogenic) energy that a person uses when cultivating the soil and spent on the production of tractors, fertilizers, pesticides, etc., does not exceed 1% of the solar energy absorbed by the agroecosystem. Like a natural ecosystem, the agroecosystem consists of organisms of three main trophic groups: *producers, consumers and decomposers (reducers)*.

Producers in the agroecosystem are cultivated plants, grasses of hayfields and pastures, trees of gardens, forest plantations and natural forests that are part of it. The producers are also the satellites of cultivated plants – weeds.

Consumers in the agroecosystem – humans and farm animals. The consumers also include pests of field crops (from insects to ground squirrels and hamsters); parasites (often dangerous for farm animals); useful insects (predatory and pollinators); birds, symbiotic organisms (mycorrhizal fungi and nitrogen fixing bacteria).

Animal detritophages crush plant residues and facilitate the activity of bacteria. The role of earthworms is especially important. The soil that has passed through the digestive system of the earthworm with plant residues is glued into dense lumps, which improves its structure. These lumps are enriched with potassium, phosphorus and nitrogen in the form of compounds available to plants. In addition, worms, breaking through the passages, loosen the soil and facilitate the penetration of roots into it. In well-watered soil, the biomass of worms can be up to 10-20 tons per 1 ha. There are special farms where earthworms are bred, which are brought to the fields to increase the yield.

Decomposers (reducers) in the agroecosystem are mainly bacteria. They maintain soil fertility by turning crop residues into humus, and humus and manure introduced into the fields into simpler organic and mineral substances available to plants.

However, among the decomposers there are not only soil fertility restorers, but also its destroyers. Nitrifying and denitrifying bacteria convert ammonium forms of nitrogen into nitrates, which are easily washed out of the soil, and nitrogen gas escaping into the atmosphere.

The energy entering the agroecosystem is transmitted through food chains. There are two main (main) food chains in the agroecosystem: plant – man; plant – cattle – man.

Classification of agroecosystems

There are **five types of land use**, for each of which agroecosystems are classified.

1. Agricultural or field land use – *rain-fed, irrigated and melon agroecosystems* (rotation of cereals, legumes, fodder, root crops, vegetables, industrial and medicinal crops).

2. Plantation and garden land use – *plantation agroecosystems* (tea bush, cocoa tree, coffee tree, sugar cane), *garden agroecosystems* (fruit orchards, berry fields, vineyards).

3. Pasture land use – *pasture agroecosystems* (driving pastures: tundra, desert, mountain; forest pastures; improved pastures: hayfields, cultivated meadows).

4. Mixed land use – *mixed agroecosystems* characterized by an equivalent ratio and combination of several types of land use, as well as processes for obtaining both primary and secondary biological products.

5. Land use for the production of secondary biological products – *agro-industrial ecosystems* (territories of intensive "industrialized" production of milk, meat, eggs and other products based on the prevailing processes of supplying the system with matter and energy from the outside).

According to the reproduction of soil fertility, there are three basic types of agroecosystems:

1. The nature-intensive type is characterized by incomplete reproduction of natural fertility, which leads to a drop in its level.

2. The nature conservation type is characterized by the simple reproduction of natural fertility and, as a consequence, the preservation of its level.

3. The nature-improving type is aimed at expanded reproduction and increasing the level of natural fertility. Currently, the nature-intensive type predominates. It should be noted that in proportion to the type of reproduction of soil fertility, the efficiency of anthropogenic energy introduced into agroecosystems changes.

The energy balance of ecosystems, which varies depending on the climatic zone, objectively determines the formation of ecosystems' adaptability to the "optimal" absorption of radiant energy possible under specific conditions. The adaptability of the energy balance of the ecosystem, corresponding to the energy consumption for heat exchange and transpiration, everywhere determines the productive efficiency of both natural and artificial cenotic formations.

The energy features of various natural zones of the planet allow us to distinguish 5 main (global) types of agroecosystems:

1. Tropical type. It is characterized by a high supply of heat, contributing to continuous vegetation. Agriculture is mainly carried out on the basis of the functioning of agroecosystems with a predominance of perennial crops (pineapples, bananas, cocoa, coffee, perennial cotton, etc.). Annual crops here yield several harvests per year. A special feature is the continuous need for the investment of anthropogenic energy due to the constant conduct of field work throughout the year.

For agroecosystems of this type, the equivalence of natural and anthropogenic processes of mass and energy exchange is inherent.

2. Subtropical type. The intensity of anthropogenic flows of substances and energy is less; the discreteness and dispersion of these flows are manifested. Basically, it is characterized by the presence of two growing seasons – summer and winter. Perennial plants grow that have a well-defined period of vegetative rest

(grapes, walnuts, tea, etc.). Annual plants of the summer period are represented by corn, rice, soy, cotton, etc.

3. Moderate type. Agroecosystems are characterized by only one (summer) growing season and a long ("non-working") period of winter rest. There is a very high demand for the investment of anthropogenic energy in spring, summer and the first half4.

4. Polar type. Agriculture is of a focal nature. Agroecosystems are significantly limited geographically and by types of cultivated crops (leafy vegetables, barley, some root crops, early potatoes). of autumn.

5. Arctic type. There are no agroecosystems of open ground. Cultivation of cultivated plants is excluded due to the very low temperatures of the warm period: in the summer months there are long cold spells with negative temperatures. It is possible to use closed ground.

Table 2

Classification of agroecosystems by energy criterion

Global type of agroecosystem	Characteristic	The energy exchange features
Tropical type	High availability of heat, the predominance of perennial crops, several harvests per year (the predominant perennial crops are pineapples, cocoa, coffee).	Equivalent to natural energy exchange and mass exchange
Subtropical type	Two vegetation periods (winter and summer) are characteristic (there is a discreteness and dispersion of the flows of matter and energy). Perennial crops with a pronounced dormancy period prevail (the predominant perennial crops are tea, grapes, walnuts, citrus fruits).	Some additional energy investments are needed.
Moderate type	Only one growing season is characteristic, the winter dormancy period is quite long.	Only one growing season is characteristic, the winter dormancy

End of the table 2

Global type of agroecosystem	Characteristic	The energy exchange features
	High demand for the investment of anthropogenic energy. The predominant perennial crops are pome and stone fruit.	period is quite long. High demand for the investment of anthropogenic energy. The predominant perennial crops are pome and stone fruit.
Polar	Agriculture of a focal nature (small fields with rapidly maturing crops). There is a very high need for the investment of anthropogenic energy. The predominant perennial crops are sea buckthorn, berry bushes.	Significant differences in the flows of energy and matter.
Arctic	Farming only in the closed ground. Exists only with additional anthropogenic energy.	Radical differences in the flows of energy and matter.

On the territory of modern Russia, agroecosystems of a moderate type are dominant with all the ensuing requirements for the organization of their rational functioning.

Soil-biotic complex (SBC) as the basis of agroecosystems

Soil (V.V. Dokuchaev) is an independent natural mineral–organic body formed from the surface layers of rock as a result of the impact of living organisms on them in certain climatic conditions.

The inherent property of the soil is fertility. Emphasizing this basic property of the soil, V.R. Williams called the soil a loose surface horizon of the terrestrial globe, capable of producing a crop of plants.

Soil fertility is its ability to meet the needs of plants for nutrients, air, biotic and physico–chemical environment, including thermal regime, providing biogenic productivity of vegetation.

Edaphic factors (from Greek. edaphos – soil) – soil conditions of plant growth. Are divided into:

- chemical – soil reaction, soil salt regime, elementary chemical composition of soil, exchange capacity and composition of exchange cations;

- physical – water, air and thermal regimes, density and thickness of the soil, its granulometric composition, structure, etc.;

- biological – plant and animal organisms inhabiting the soil (Khrustalev, Matishev, 1996).

The soil consists of solid, liquid, gaseous and living parts, or phases. Their ratio is not the same not only in different soils, but also in different horizons of the same soil. Naturally, there is a decrease in the content of organic substances and living organisms from the upper horizons of soils to the lower ones and an increase in the components of the parent rock from the lower horizons to the upper ones.

The composition of the soil includes four important components:

1) mineral base (50-60% of the total volume);

2) organic matter (up to 10%);

3) air (15-25%);

4) water (25-35%).

The mineral part of the solid phase of the soil consists of the parent rock crushed to varying degrees, which accounts for 80-97% of the solid phase of most soils. As a result of weathering, the simplest compounds are formed in it, easily soluble in water. The mineralogical composition of the solid part of the soil largely determines its fertility. The composition of mineral compounds includes the following chemical elements: Si, Al, Fe, K, N, Mg, Ca, P, S; significantly less trace elements are contained: Cu, Mo, I, B, F, Pb, etc.

The organic part of the solid phase of the soil consists of undecomposed and slightly decomposed remains of plants, animals, insects, bacteria, decomposition products of plant residues by bacteria and fungi, various organic acids and their salts.

The replenishment of the soil with organic matter occurs due to the decomposition of plant residues (fallen leaves, stubble, plant roots), the introduction of manure, peat, organic-mineral compost, green mass of plants grown on green fertilizer into the soil.

Decomposition of organic residues is associated with the release of heat. *The liquid fraction*, that is, the soil solution, is an active component of the soil that carries out the transfer of substances inside it, removal from the soil and supply of plants with water and dissolved nutrients. It usually contains ions, molecules, colloids and larger particles, sometimes turning into a suspension. The composition of the liquid fraction includes: water with organic and mineral compounds dissolved in it. Water in the soil contains from 0.1 to 60% of the weight of absolutely dry soil. The liquid part participates in the supply of plants with water and dissolved nutrients. Soil moisture is retained in the spaces between its particles. Part of the water seeps through the soil, that is, passes through the soil profile, forming groundwater; the rest of the water remains in the soil due to surface tension forces or is adsorbed on the surfaces of quartz crystals or clay.

Air, as well as water, is retained in the soil in the intervals between its particles. This soil air, or the gaseous part of the soil, fills the pores that are not occupied by water. The amount and composition of soil air, which includes nitrogen, oxygen, carbon dioxide, volatile organic compounds and others, are unstable and are determined by the nature of many chemical, biochemical, biological processes occurring in the soil.

For example, the amount of carbon dioxide varies significantly in the composition of soil air depending on the annual and daily cycle. The fluctuation in the composition of the gaseous state of the soil is a consequence of the different intensity of the release of this gas by microorganisms and plant roots.

The living part of the soil consists of soil microorganisms (bacteria, fungi, actinomycetes, algae, etc.) and representatives of

many groups of invertebrates – protozoa, worms, mollusks, insects and their larvae, penetrating the horizons of the soil of vertebrates, etc. The active role of living organisms in the formation of soils determines its belonging to the biocosmic natural bodies – the most important components of the biosphere. They live mainly in the upper layer of the soil, near the root system of plants or directly on it, where the inhabitants get their food.

Saprophytes play an important role in the decomposition of decomposers. As a result, an amorphous mass is formed – humus – of dark brown or black color, which accounts for 1-20% of the soil. Humus – from the Latin word "earth" (soil) – is humus, a collection of dark-colored organic substances of the soil; the main organic substance of the soil containing nutrients necessary for higher plants. Humus is formed from the remains of plants and animals as a result of complex biochemical transformations depending on the heat capacity of the soil, moisture and aeration.

On Earth, **five typological groups of soils** occupy a leading position in terms of prevalence:

- soils of humid tropics and subtropics, mainly red earth and yellow earth, characterized by rich mineral composition and high mobility of organic matter;
- fertile soils of savannas and steppes – chernozems, chestnut and brown soils with a strong humus layer;
- poor and extremely unstable soils of deserts and semi-deserts belonging to different climatic zones;
- relatively poor soils of temperate forests – podzolic, brown and gray forest soils;
- permafrost soils, usually low-power, podzolic, gley, depleted of mineral salts with a poorly developed humus layer.

Examples of situational professionally oriented tasks for practical training

Task 1

Study the agrocenosis of a wheat field and divide the inhabitants into 3 groups (producers, consultants, reducers).

Task: to make 3 food chains characteristic of this agroecosystem.

The vegetation of the wheat field is made up, in addition to the wheat itself, also various weeds: white mar, field bodyak, yellow clover, field bindweed, creeping wheatgrass. In addition to voles and other rodents, there are grain-eating and predatory birds, foxes, wagtails, earthworms, ground beetles, bug harmful turtle, aphids, insect larvae, ladybug, rider. The soil is inhabited by earthworms, beetles, bacteria and fungi that decompose and mineralize straw and wheat roots left after harvesting.

Task 2

Conduct a comparative analysis of the ecological characteristics of any natural ecosystem and agroecosystem located in the Volgograd region. Make a conclusion about what their similarities are, and by what environmental criteria they differ.

THEME 13
INDUSTRIAL AND URBAN ECOSYSTEMS

Motivational statement

As a result of human activity, significant changes occur in the environment. In order to meet their increasing needs, man changes natural ecosystems and even destroys them, and builds artificial anthropogenic ecosystems. One of the variants of anthropogenic systems are industrial-urban ecosystems (urban systems).

The urban system is characterized by the presence of a number of new significant factors (physical, chemical, biological and social).

A significant part of ecosystems is under the constant influence of these factors in cities and in the territories adjacent to cities, as well as in places inaccessible to humans, but inhabited by representatives of flora and fauna. Knowledge of the main harmful factors of the urban system and ways to protect organisms from their harmful effects is necessary for the development of industrial and urban ecosystems, because it allows you to predict the environmental consequences of anthropogenic impacts.

The objective: to form an idea of the quality of the urban environment as a factor that can have a negative impact on human and animal health, the state of plants and ecosystems; to get acquainted with the methods of assessing anthropogenic environmental impact on models of broadband electromagnetic radiation and aeroion composition of air.

Questions for discussion

1. Industrial and urban ecosystems. Ecosystem characteristics of the city.
2. Differentiation of urban areas into functional zones.
3. Factors of the urban environment: classification, influence on biological systems and humans.
4. Socio-environmental factors, the impact on human health from a biomedical perspective.
5. Consequences of the urbanization process
6. The main measures to improve the environment of urbanized territories.

Independent work of students

1. Work with tests on the topic of the lesson.

Test task

Select one /several/all variants of correct answers and put a "+" sign

1. Ecosystem characteristics of the city:

1) polymorphism

2) complexity;

3) addiction;

2. The most important component of the ecosystem of a modern city are:

1) well-maintained dwellings

2) roads and transport

3) services and entertainment

4) green spaces

5) the totality of industrial enterprises

3. Anthropogenic sources of pollution of the urban environment do not include:

1) transport

2) agriculture

3) volcanoes and geysers

4) industrial enterprises

5) urban economy

4. The severity of the impact of pollutants on the human body is determined by 3 main factors:

1) chemical nature of the pollutant, its concentration and stability in the external environment

2) the nature of the source of pollution, the concentration of the contaminant and the duration of its effect on organisms

3) the aggregate state of the pollutant, its stability in the external environment and the area of contamination

4) the nature of the source of pollution, the chemical nature of the pollutant and its ability to self-destruct

5. An indicator of the quality of the urban environment is:

1) public health

2) overuse

3) the level of production development

4) demographic explosion

6. The role of green spaces is as follows:

1) regulate the gas composition of the atmosphere

2) release oxygen

3) absorb carbon dioxide

4) increase the humidity of the air

5) reduce the air temperature in the warm season

6) reduce the speed of air movement

7. Socio-ecological factors of the urban environment affecting the health of the population:

1) physical inactivity

2) overeating

3) information abundance

4) psychoemotional stress

8. Violation of human biological rhythms in an urban environment can be caused by:

1) electric lighting

2) intense rhythm of life

3) atmospheric air pollution

9. Which of the listed enterprises cannot be located in the sanitary protection zone:

1) pharmaceutical industry enterprises

2) food industry enterprises

3) procurement enterprises, as well as wholesale warehouses of food raw materials and food products,

4) warehouses for the storage of agricultural products,

5) complexes of water supply facilities for the preparation and storage of drinking water

10. Consequences of absorption of light rays (visible and ultraviolet spectrum) by polluted atmospheric air of cities:

1) ambient light illumination decreases

2) the level of UV radiation is reduced

3) the temperature and humidity of the air changes

4) anthropogenic foci of rickets are formed.

11. On the territory of recreational zones and zones, specially protected areas, it is not allowed to place:

1) new and expansion of existing industrial enterprises

2) communal and warehouse

3) objects that are not directly related to the operation of recreational, recreational and environmental facilities.

12. Transport problems of urbanized territories:

1) increasing the duration of a citizen's stay in transport

2) transport fatigue, transport neuroses

3) air pollution

4) epidemiological risk

5) increased noise and vibration levels

6) traffic injuries

2. Hearing and discussion of abstracts prepared by students on the individual assignment of the teacher.

3. Practical work. Measurement and assessment of anthropogenic environmental pollution by factors of physical nature on the model of broadband electromagnetic radiation and aeroion composition of air.

3.1. Assessment of parameters of electric and magnetic fields at workplaces equipped with a PC using the device BE-meter-AT-002.

3.1.1. Get acquainted with the instructions for organizing work with the meter of electric and magnetic fields BE-meter-AT-002.

3.1.2. Under the supervision of the teacher, evaluate the parameters of electric and magnetic fields at workplaces equipped with a PC using the VE-meter-AT-002 device.

3.1.3. Record the total measurement results in the protocol (Table 1) and compare with the normative data, formulate a conclusion.

Table 1

The actual value of the measured parameter

№ p/n	The measured parameter	Permissible values (remote control)	The measurement value in front of the screen (at levels (from the floor, m):			Background values	The value above the remote control
			1.0	1.5 m	0.5 m		
1	2	3	4a	4b	4c	5	6
1	Monitor _____ The intensity of the electro-magnetic field by the elec-trical component, V / m in the frequency range 5 Hz-2 kHz at a distance of 50 cm around the VDT	25 V / m					
2	The intensity of the electro-magnetic field by the elect-rical component, V / m in the frequency range 2-400 kHz at a distance of 50 cm around the VDT						

End of the table 1

1	2	3	4a	4b	4c	5	6
3	Magnetic flux density, (nT) in the frequency range 5Hz-2 kHz	250 nT					
4	Magnetic flux density, (nT) in the frequency range 2-400 kHz	25 nT					

3.2. Control when measuring the aeroion composition of indoor air using the device "Small-sized aeroion meter MAS-01.

3.2.1.Get acquainted with the instructions for organizing work with device "Small-sized aeroion meter MAS-01.

3.2.2. Under the supervision of the teacher, evaluate the parameters of electric and magnetic fields at workplaces equipped with a PC using the VE-meter-AT-002 device.

3.2.3. Record the total measurement results in the protocol (Table 2) and compare with the normative data, formulate a conclusion.

Table 2

The actual value of the measured parameter

Research stage	Negative aeroions	Positive aeroions	Ratio
1st stage (at the beginning of the first hour)			
Stage 2 (at the end of the first hour)			
Stage 3 (at the beginning of the second hour, after conducting through ventilation of the room)			

Reference material

The emergence of industrial –urban ecosystems was caused mainly by the processes of urbanization.

Urbanization is the growth and development of cities, an increase in the share of urban population at the expense of rural areas, the process of increasing the role of cities in the development of society.

The process of urbanization is due to: the natural growth of the urban population, the transformation of rural settlements into urban ones, migration from rural to urban areas, the pendulum movement of the population from the rural environment and the nearest small towns to large cities (for work, for cultural and household needs)

Population growth and its density are a characteristic feature of cities.

A person creates these complex urban systems himself, pursuing the goal of improving living conditions, and not only by simply "protecting himself" from limiting factors, but also by creating for himself a new artificial environment that increases the comfort of life. This leads to the separation of a person from the natural environment and to the disruption of natural ecosystems.

In some approximation, the city can be compared with a single complex organism that actively exchanges matter, energy and information with the surrounding natural and agricultural territorial complexes and other cities.

The urban system is an unstable natural and anthropogenic system, with the development of the city, they are increasingly differentiated into functional zones – industrial, residential, forest park.

Industrial zones are areas of concentration of industrial facilities of various industries (metallurgical, chemical, machine–building, electronic, etc.). They are the main sources of environmental pollution.

Residential zones are areas of concentration of residential buildings, administrative buildings, cultural, educational facilities, etc.

Forest park zone is a green area around the city, cultivated by man, i.e. adapted for mass recreation, sports, entertainment. Its sections are also possible inside cities, but usually there are urban parks – tree plantations in the city, occupying quite extensive territories and also serving citizens for recreation. Unlike natural forests, urban parks and in the city (squares, boulevards) are not self-sustaining and self-regulated systems.

The forest park zone, city parks and other areas of the territory designated and specially adapted for people's recreation are called *recreational zones.*

The deepening of urbanization processes leads to the complication of the city's infrastructure. A significant place occupied by *transport* and *transport facilities* (automobile terminals, gas stations, garages, service stations, railways with their complex infrastructure, including underground – metro; airfields with a service complex, etc.). *Transport systems* cross all functional zones of the city and have an impact on the entire urban environment.

The environment surrounding a person – is a combination of abiotic and social environments that jointly and directly affect people and their economy. According to N. F. Reimers, it can be divided into the *natural environment* itself and the *natural environment transformed by man* (anthropogenic landscapes up to the artificial environment of people – buildings, asphalt roads, artificial lighting, etc., i.e. to the artificial environment).

Urban ecosystems (territories of cities and their populations) are heterotrophic anthropogenic ecosystems in which there is no element of self–regulation.

Urban ecosystems are characterized by the following features:

Polymorphism – a combination of natural (hydrosphere, atmosphere, etc.) and anthropogenic (buildings, infrastructure elements, etc.) subsystems.

Therefore, it is difficult to optimize cities, because it is impossible to solve the problem by reconstructing only one kind of structure

The complexity of the urban system – any entity functions as part of a larger/smaller subsystem, so it is impossible to take into account all internal and external relations.

Urban ecosystems require input from outside and export outside, i.e. they are not capable of self–regulation, they are dependent on external influence – they are regulated by a person. The existence of urban systems depends on the energy of fossil fuels and atomic energy raw materials, is artificially regulated and maintained by man.

The urban environment and urban–type settlements are part of the *technosphere,* i.e. the biosphere, radically transformed by man into technical and man-made objects.

In urban areas, in urban ecosystems, it is possible to distinguish a group of systems that reflect the complexity of the interaction of buildings and structures with the environment, which are called *natural-technical systems.* They are closely connected with anthropogenic landscapes, with their geological structure and relief

Consequences of the urbanization process:

1. Destruction of the natural landscape

2. Atmospheric air pollution (road transport is the main source of urban air pollution. Motor transport is the leader in terms of environmental damage, in all types of negative impacts: air pollution – 95%, noise – 49.5%, climate impact – 68%).

3. Increased noise and vibration

4. Pollution of the coastal water area

5. Changes in climatic characteristics in urbanized territories (parameters of change compared to rural areas):

The average annual temperature in winter is 0.5-1 degrees higher, in summer – 1-2 degrees;

The wind speed is 20-30 less%;

Fogs are 100% more in winter; 30% more in summer%;

Absorption of light rays (visible and ultraviolet spectrum) by polluted atmospheric air of cities. As a result, ambient light illumination decreases by 40-50%, the level of UV radiation decreases by 30% in winter, by 5% in summer (light (solar) starvation develops, anthropogenic foci of rickets).

Transport problems of urbanized territories:

- increase in the duration of a citizen's stay in transport;
- transport fatigue;
- transport neuroses;
- air pollution;
- epidemiological risk;
- increased noise and vibration levels;
- traffic injuries;

Epidemiological consequences of urbanization

Factors supporting epidemics: crowding in cities, congestion of city centers by people, increased daily contacts, reduced body resistance.

The main directions of solving urban problems

1. Architectural and planning direction: zoning of the city territory, sanitary protection zones, rational placement of television antennas, relay stations.

Example: "Industrial relocation" – removal of industrial enterprises polluting the environment outside the city. Fixing the boundaries of cities (stopping their spread). Using the achievements of ecological architecture for the construction of new cities and the reconstruction of old ones: the growth of cities up and down (development of underground and infrastructure)

2. Sanitary and technical direction: modernization of vehicles, improvement of sound-proofing qualities of building structures, noise-protective screens, sewage treatment plants.

Example: Greening of urban transport by increasing the share of public transport (primarily electric traction), the use of cars with low fuel consumption and the gradual transfer of transport to environmentally friendly fuel.. Recycling of solid household waste: separate collection, sorting, processing. Resource conservation (water) and energy supply in all areas of public utilities.

3. Legislative direction. The legislation in the field of urban development, Law on the Protection of Atmospheric Air.

4. Administrative direction: rational organization of traffic flows ("green wave", intersection of streets at different levels, reduction of the number of trucks in areas with dense residential buildings); restriction of sound signals of street transport; control of atmospheric air quality, noise levels, EMF intensity and others public utilities. Economic mechanisms of influence.

5. The attractiveness of the city for residents: cleanliness, landscaping, small architectural forms. Example of "Ecopolis".

6. Formation of a healthy lifestyle of a citizen.

Purpose: to expand the range of adaptive protective mechanisms of the body of city residents.

Ecopolis = Ecocity

Ecopolis is an ecological settlement of a new type – an ecologically clean social multidisciplinary center of ecovillage on a regional scale, located in the suburbs of a large city, away from large industrial enterprises and close to agricultural enterprises.

Principles of ecopolis construction:

1. Proportionality of architectural forms to human growth.

2. The unity of water and green areas ("the illusion of being inscribed").

3. Elements of apartment landscaping (balconies, roofs of houses, vertical landscaping of streets). A set of rules. Urban planning. Planning and development of urban and rural settlements extraction. The urban area should be zoned – zones are divided depending on the type of functional use. The list of functional zones includes zones of residential, public-business and mixed development, industrial development, engineering and transport infrastructure, recreational zones, agricultural use zones, special purpose zones, including zones of military and other regime facilities, cemeteries, and other special purpose zones.

4.4. Urban and rural settlements, depending on the population size are divided into groups in accordance with table 3.

Table 3

Urban and rural settlements depending on the projected population

Groups	Population, thousand people	
	Cities	Rural settlements
The largest	> 1000	-
Sized cities	500 – 1000 250 – 500	> 5 3 – 5
Large	100 – 250	1 – 3
Medium-sized cities	50 – 100	0.2 – 1
Small*	20 – 50 10 – 20 10	0.05 0,2 0,05

** Urban-type settlements are included in the group of small towns.*

4.18. The planning structure of urban and rural settlements should have: compact placement and interconnection of functional zones; rational zoning of the territory in conjunction with the system of public centers, engineering and transport infrastructure; effective use of the territory depending on its urban value; comprehensive consideration of architectural and urban traditions, natural-climatic, landscape, national and other local features; environmental protection, historical and cultural monuments.

5. Residential areas

5.1 Residential areas should be provided for in order to create a comfortable, healthy and safe living environment for the population. Residential areas are occupied by: residential buildings of various types (multi-storey multi-storey, medium and small storeys); manor houses with apartment and household plots; detached, built-in or attached objects of social and cultural services to the population; garages and parking lots for cars; religious objects.

6. Public and business zones

6.1 Public and business zones are designed to accommodate healthcare facilities, culture, trade, catering, social and communal services, entrepreneurship, secondary vocational and higher professional education facilities, administrative, research institutions, religious buildings, parking lots of motor transport, business and financial facilities

7.1 Distances between residential buildings, residential and public, as well as industrial buildings should be taken on the basis of calculations of insolation and illumination in accordance with the requirements, illumination standards given in SP 52.13330-2016, as well as in accordance with fire protection requirements.

Distances should be taken between the long sides of residential buildings: for residential buildings with a height of two or three floors – at least 15 m; four floors – at least 20 m; between the long sides and the ends of the same buildings with windows from living rooms – at least 10 m.

7.4 The area of the landscaped territory of the microdistrict (block) of multi-apartment residential development (excluding the sites of general education and preschool educational organizations) must be at least 25% of the area of the block.

8. Production zones, transport and engineering infrastructure zones

8.1 *Industrial zones*, engineering and transport infrastructure zones include: communal zones, zones for housing and communal

facilities, housing and communal services, transport facilities, wholesale trade facilities; industrial zones – zones for industrial enterprises that require sanitary protection zones with a width of more than 50 m, as well as railway access roads.

8.2 Within the industrial and sanitary protection zones of enterprises, it is not allowed to place: residential houses, landscape and recreational zones, recreation areas, territories of resorts, sanatoriums and rest homes, territories of cottage development, as well as other territories with normalized indicators of habitat quality; sports facilities, playgrounds, general education and preschool educational organizations, medical and preventive and health-improving institutions of general use.

8.3. As part of the industrial zones of cities, industrial zones may be formed, intended for the placement of industrial enterprises, depending on the sanitary classification of production, scientific and industrial, communal and warehouse. Enterprises of food, medical, pharmaceutical and other industries with a sanitary protection zone up to 100 m should not be located on the territory of industrial zones with enterprises of metallurgical, chemical, petrochemical and other industries with harmful industries.

Sanitary protection zones are established in relation to existing, planned for construction, reconstructed construction facilities that are sources of chemical, physical, biological effects on the human environment, in case of formation of chemical, physical and (or) biological effects beyond their contours exceeding sanitary and epidemiological requirements.

Depending on the amount and degree of harmfulness of the substances emitted into the atmosphere, all enterprises are divided into 5 classes. In accordance with this, there are 5 sanitary protection zones: 1-1000 m; 2-500 m; 3- 300m; 4-100m; 5-50m.

It is not allowed to place within the boundaries of the sanitary protection zone:

a) residential buildings, buildings of educational and medical organizations, recreation organizations for children and their health improvement, open-type sports facilities, recreational areas and gardening;

b) pharmaceutical industry enterprises, food industry enterprises, procurement enterprises, as well as wholesale warehouses of food raw materials and food products, warehouses for the storage of agricultural products, complexes of water supply facilities for the preparation and storage of drinking water.

8.6. The sufficiency of the width of the sanitary protection zone should be confirmed by calculations of the dispersion in the atmospheric air of harmful substances contained in the emissions of industrial enterprises.

The minimum landscaping area of sanitary protection zones should be taken in accordance with (table 4).

Table 4

Minimum landscaping area of sanitary protection zones, %

Zone width	%
Up to 300 m	60
300-1000m	50
1000-3000 m	40
More than 3000	20

8.9 In the territories of communal storage zones, enterprises of the food (food-tasting, meat and dairy) industry, general (food and non-food), specialized warehouses (refrigerators, potato, vegetable, fruit storage), municipal, transport and consumer services enterprises of the city population should be located.

8.16 Zones of transport and engineering infrastructure should be provided for the placement of structures and communications of railway, road transport, communications, engineering equipment.

8.17 In order to prevent adverse impacts during the operation of transport, communications, engineering communications facilities, sanitary protection zones are established from these facilities to the borders of residential, public-business and recreational areas.

8.21 Motorways of the general network of categories I–III should be designed to bypass settlements.

8.22 Airfields and heliports should be located at a distance from the borders of residential, public-business and recreational zones, ensuring flight safety and the permissible levels of aviation noise and the permissible concentration of pollutants in the atmospheric air and the permissible level of electromagnetic radiation established for these territorial zones from transmitting radio equipment installed at the aerodrome.

9. Recreational areas.

Zones of specially protected territories

9.1. Recreational zones include territories occupied by urban forests, squares, parks, urban gardens, ponds, lakes, reservoirs, beaches, as well as other territories used and intended for recreation, tourism, physical culture and sports. Within the boundaries of urban and rural settlements, zones of specially protected territories are allocated, which include land plots of special environmental, scientific, historical and cultural, recreational and health-improving significance.

9.2. On the territory of recreational zones and zones of specially protected territories, it is not allowed to build new and expand existing industrial, utility, warehouse and other facilities that are not directly related to the operation of recreational, recreational and environmental facilities.

9.3 In urban and rural settlements, it is necessary to provide for a continuous system of green areas of common use and other open spaces. The time of accessibility of city and district parks by public transport should be no more than: 30min. – for urban and 20min. – for district parks.

9.7 The placement of objects of mass short-term recreation of the population located in recreational areas should be provided, taking into account the availability of these zones for no more than 1.5 hours by public transport. The size of the territory of recreation areas should be taken at the rate of at least 500 m2 per visitor.

9.8. The area of green areas of common use – parks, gardens, squares, boulevards located on the territory of urban and rural settlements should be taken according to table 5.

Table 5

Green areas of common use	The area of green areas of common use, m2 per person			
	The largest cities, sized cities, and large cities	Medium-sized cities	Small towns	Rural settlements
Citywide	10	7	8(10)*	12
Residential areas	6	6	-	-

9.23. The resort area should be located in areas with natural healing factors, the most favorable microclimatic, landscape and sanitary conditions. Within its limits, sanatorium-resort and health-improving institutions, recreation and tourism institutions, institutions and service enterprises for patients and vacationers should be located.

9.24. When designing resort areas, it should be provided for: the placement of sanatorium-resort institutions for long-term recreation in areas with permissible noise levels, children's sanatorium-resort and health-improving institutions isolated from adult institutions with their separation by a strip of green spaces with a width of at least 100 m; the removal of industrial and communal storage facilities, residential buildings and public buildings, not related to the service of patients and vacationers; restriction of traffic and complete exclusion of transit traffic flows.

10.1. Institutions, organizations and service enterprises should be located on the territory of urban and rural settlements, bringing

them closer to their places of residence and work, providing for the formation of public centers in conjunction with the public passenger transport network, with ensuring their accessibility for MGN.

11.4 The road network of settlements should be designed as a continuous system taking into account the functional purpose of streets and roads, the intensity of transport, cycling and pedestrian traffic.

THEME 14
THE INFLUENCE OF NATURAL AND ENVIRONMENTALFACTORSON HUMAN HEALTH

Motivational statement

Ecology and human health in the modern world are closely interrelated. Numerous works of scientists have shown that pollution and denaturation of the environment has a negative impact on the functional state of various body systems, physical endurance, human performance, accompanied by an increase in the prevalence of acute and chronic nonspecific morbidity of the population. And in the end, it leads to a decrease in the birth rate and an increase in mortality, what influences demographic processes and the security of the state. The natural environment affects a person – through dependence on natural factors of existence, on the abundance or lack of food, that is, game, fish, plant resources.

According to many authors, environmental factors (pollution) determine the state of health in 18-20% and are in second place after lifestyle.

Objective: to get acquainted with the possible influence of the environment on humans and methods of improving the quality of the environment.

Questions for discussion

1. Natural focality, the concept.

2. Name the natural focal diseases affecting the human population in history.

3. Methods of combating natural focal diseases.

4. The environment artificially created by man, which includes.

5. Factors influencing the occurrence of human diseases in an artificially created environment.

Independent work of a student

Participation in a business game on the topic: "Sustainable development of the Russian Federation".

Organization of work:

1. The study group of students is divided into 4 teams

- an initiative group of residents dissatisfied with the environmental situation;

-representatives of the Rospotrebnadzor service in the field of public health protection;

- representatives of the administration of the settlement

- and representatives of the Green Party.

The teacher acts as a moderator. Students are given a task based on a preliminary acquaintance with the project of sustainable development of Russia to formulate proposals for improving the environmental situation in the region of residence, based on belonging to a specific group (20 minutes). Then, one representative from each group presents their projects within 5 minutes and, under the guidance of a teacher, A regulated discussion is organized to discuss the results of each group's work (25 minutes).

Reference material

Initially, Homo sapiens lived in the natural environment, like all the consults of the ecosystem, and was practically unprotected from

the action of its limiting environmental factors. Primitive man was subject to the same factors of regulation and self-regulation of the ecosystem as the whole animal world, his life expectancy was short, and the population density was very low. The main limiting factors were hyperdynamics and malnutrition. Among the causes of mortality, pathogenic effects of a natural nature were in the first place. Of particular importance among them were infectious diseases, characterized, as a rule, by natural foci.

Natural focal diseases are closely associated with a certain territory, with a particular type of landscape, and therefore with its climatic features, for example, they differ in seasonality of manifestation. Natural focal diseases were the main cause of death of people until the beginning of the XX century. The most terrible of such diseases was the plague, the mortality from which many times exceeded the death of people in the endless wars of the Middle Ages and later.

Diseases associated with the natural environment surrounding a person still exist today, although they are constantly being fought. Their existence is explained, in particular, by the reasons of a purely ecological nature, for example, resistance (development of resistance to various factors of influence) of carriers of pathogens and the pathogens themselves. A typical example of these processes is the fight against malaria. More and more attention is being paid to integrated, environmentally sound methods of combating malaria – methods of "managing the living environment". These include drainage of wetlands, reduction of water salinity, etc. The following groups of methods are biological – the use of other organisms to reduce the danger of mosquitoes; in 40 countries, at least 265 species of larvivorous fish are used for this, as well as microbes that cause diseases and death of mosquitoes.

Plague and other infectious diseases (cholera, malaria, anthrax, tularemia, dysentery, diphtheria, scarlet fever, etc.) destroyed people of various ages, including reproductive. This caused a rather slow

population growth ~ the first billion inhabitants on Earth appeared in 1860. But the discoveries of Pasteur and other scientists at the end of the XIX century, which gave a powerful impetus to the development of preventive medicine of the XX century. in the treatment of very serious diseases, a sharp improvement in sanitary and hygienic living conditions, culture and education of mankind as a whole, led to a sharp decrease in the incidence of natural focal diseases, and some of them practically disappeared in the XX century.

However, in order to combat the effects of natural factors regulating the ecosystem, man had to use natural resources, including irreplaceable ones, and create an artificial environment for his survival. The artificial environment also requires adaptation to itself, which occurs through diseases. The main role in the occurrence of diseases in this case is played by the following factors: physical inactivity, overeating, information abundance, psychoemotional stress. In this regard, there is a constant increase in the "diseases of the century": cardiovascular, oncological, allergic diseases, mental disorders, AIDS and others.

THEME 15
HUMANS AND THE ENVIRONMENT

Motivational statement

Humans are integral part of the environment. A person from the standpoint of ecology has a dual role. On the one hand, a person is a biological species and its relationship with the biological environment is determined by biological laws (stability, variability, adaptation, etc.). On the other hand, a person is a powerful acting factor. To meet their ever-increasing needs, man changes natural ecosystems and even

destroys them, and builds artificial anthropogenic ecosystems. As a result of human activity, significant changes occur in the environment. Knowledge about anthropogenic impacts on the environment and the environmental consequences of these impacts are necessary for the competent solution of environmental protection problems.

The objective: to form an idea of the quality of the environment as an ecological factor that has been formed as a result of human activity and can have a negative impact on biological organisms, including human health; to get acquainted with the methods of assessing anthropogenic impact on the environment.

Questions for discussion

1. Environment: concept, groups of environmental factors.
2. Anthropogenic impacts on the atmosphere: the main sources of pollution, the main pollutants.
3. Anthropogenic impacts on the hydrosphere: the main types of water pollution; the main sources of pollution of surface and groundwater.
4. Ecological consequences of pollution of the hydrosphere.
5. The main types of anthropogenic impact on the soil.
6. Anthropogenic impacts on plant communities; ecological consequences of human impact on the plant world.
7. Anthropogenic impacts on the animal world; ecological consequences of human impact on the animal world.
8. The impact of the state of the environment on human health.
8. The main indicators for assessing the quality of the environment.

Independent work students

1. Watching the documentary film "Garbage". Regulated discussion is a discussion of the elements of environmental behavior in a person's daily life that will reduce environmental pollution by production and consumption waste.
2. Practical work:

2.1. Determination of anthropogenic pollutants entering the environment as a result of the operation of vehicles.

Materials and equipment are needed to perform the work: watches, pens, a notebook, a calculator.

Task

2.1. Determine the number of vehicles passing along the selected section of the highway (100 m.) for 30 or 60 minutes. Enter the data in table 1.

Table 1

Average number of registered cars

Type of vehicle	In just 30 minutes	In just 1 hour
Passenger cars		
Trucks		
The buses		
Diesel trucks		

2.2. Determine the amount of emissions of harmful substances coming from vehicles into the atmosphere by the calculation method (Appendix 1).

1. Calculate the total distance traveled by a set number of cars of each type in 1 hour (La, km) using the formula:

$$La = Na \times L,$$

where - Na is the number of cars of each type;

- L is the length of the section, km;
- a is the designation of the type of car.

Common path:

2.3. Calculate the amount of fuel of different types (Qa) burned by the engines of cars, according to the formula:

$$Qa = Ya \times La,$$

where Y – is the specific fuel consumption (l/km); L is the length of the section, km; a is the designation of the type of car (appendix 1)

Enter the result in table 2.

Table 2

Total amount of fuel burned

Vehicle type	Qa	
	Gasoline	Diesel fuel
Passenger cars		
trucks		
the buses		
diesel trucks		
Total (ΣQ)		

2.4. Calculate the volume of pollutants released in liters for each type of fuel (multiplying the corresponding values of ΣQ and empirical coefficients K), enter the results in table 3.

Table 3

Volume of pollutants released

Types of fuel	Amount of harmful substances, l		
Gasoline	Carbon Monoxide	Hydrocarbons	Nitrogen dioxide
Diesel fuel			
Total (V)			

Calculate the mass of released harmful substances (m, g) by the formula:

$$m = V \times M / 22.4,$$

where M is the molecular weight (for CO – 28, for NO2 – 46, the average molecular weight for hydrocarbons – 43).

M is the molecular weight (for CO – 28, for NO2 – 46, the average molecular weight for hydrocarbons – 43).

2.5. Determine the average daily concentration of harmful substances (Ccc, mg / m3) in the atmospheric air of the area, compare the data obtained with the MPCC for each of the harmful substances and make a conclusion (Appendix 1).Fill in table 4.

Table 4

Types of fuel	Average daily concentration of harmful substances (Ccc, mg/m3)	Maximum permissible concentration of harmful substances (MPCC, mg/m3)
Carbon monoxide		
Hydrocarbons		
Nitrogen dioxide		

At the end of the work, formulate a general conclusion and write it down in the protocol of independent work.

Appendix 1

Introduction

Internal combustion engines of cars are the main source of atmospheric pollution in cities and densely populated regions. In particular, on the scale of our country, the share of transport in total emissions of pollutants into the atmosphere from all sources reaches 45%, in greenhouse gas emissions – about 10%, in discharges of harmful substances with wastewater – about 3%.

The main harmful impurities contained in engine exhaust gases are: carbon monoxide, nitrogen oxides, various hydrocarbons, including carcinogenic 3,4-benz(a)pyrene, aldehydes, sulfur dioxide.

Gasoline engines, in addition, emit products containing lead, chlorine, bromine, and sometimes phosphorus, and diesel engines – significant amounts of soot and soot particles of ultramicroscopic sizes. Each car with a gasoline engine that has traveled 15 thousand km consumes 4350 kg of oxygen and emits 530 kg of CO, 93 kg of hydrocarbons, 27 kg of nitrogen oxide. 75% of the lead contained in high-octane gasoline passes into the atmosphere, that is, each car annually emits up to 1 kg of lead into the air. In general, the exhaust gases of internal combustion engines contain more than 200 harmful substances and names.

The practical part

On various sections of the highway (according to the teacher's instructions) with a length of about 100 m. determine the number of units of passing vehicles for 30 or 60 minutes. At the same time, take into account how many cars of a certain type (cars, trucks, buses, diesel trucks) drove through the selected section. In the event that the observation took 30 minutes, multiply the result by 2.

Calculate the average number of registered vehicles for each type of vehicle, depending on the number of selected sections of the route, (enter data in table 1 of the protocol).

The amount of emissions of harmful substances coming from vehicles into the atmosphere can be estimated by the calculation method. The initial data for calculating the amount of emissions are:

- the number of units of vehicles passing along a designated road section per unit of time;
- fuel consumption rates by motor transport.

The average fuel consumption rates when driving in urban conditions are shown in table 5.

Table 5

Average fuel consumption rates

Vehicle type	Average fuel consumption rates (liters per 100 km)	Specific fuel consumption Ya (l per 1 km)
Passenger cars	11-13	0.11-0.13
Trucks	29-33	0,29-0,33
Buses	41-44	0,41-0,44
Diesel trucks	31-34	0.31-0.34

The values of the empirical coefficients (K) determining the emission of pollutants from vehicles, depending on the type of fuel, are given in table 6.

Table 6

Values of empirical coefficients

Fuel types	Coefficient value (K)		
Gasoline	Carbon monoxide	Hydrocarbons	Nitrogen dioxide
Diesel fuel	0,6	0,1	0,4
	0,1	0,03	0,04

The coefficient K is numerically equal to the amount of harmful emissions of the corresponding component when the amount of fuel equal to the specific consumption (l/km) is burned in the car engine.

Processing of the results:

Calculate the total distance traveled by a set number of cars of each type in 1 hour (La, km) using the formula:

$$La = Na \times L,$$

where Na is the number of cars of each type; L is the length of the section, km; a is the designation of the type of car.

Calculate the amount of fuel of different types (Qa) burned at the same time by the engines of cars, according to the formula:

$$Qa = Ya \times La,$$

where Y is the specific fuel consumption (l/km); L is the length of the section, km; a is the designation of the type of car.

Determine the total amount of burned fuel of each type (enter the data in table 2 of the protocol).

Calculate the volume of pollutants released in liters for each type of fuel by multiplying the corresponding values of ΣQ and empirical coefficients K (enter the data in table 3 of the protocol).

Calculate the mass of released harmful substances (m, g) by the formula:

$$m = V \times M / 22.4,$$

where M is the molecular weight (for CO – 28, for NO2 – 46, the average molecular weight for hydrocarbons – 43).

Determine the average daily concentration of harmful substances (Ccc, mg/ m3) in the atmospheric air of the area, taking into account that the volume of air used near a 100-meter-long road section is approximately 20,000 m3. It should also take into account the high intensity of traffic in the daytime.

Reference material

Environmental factors have different nature and specificity of action and are divided into abiotic (factors of inanimate nature); biotic and anthropogenic.

Types of impact of environmental factors on organisms

Environmental factors have different kinds of effects on living organisms. They can be:

- stimuli that contribute to the appearance of adaptive (adaptive) physiological and biochemical changes (hibernation, photoperiodism);
- limiters that change the geographical distribution of organisms due to the impossibility of existence in these conditions;
- modifiers that cause morphological and anatomical changes in organisms;
- signals indicating changes in other environmental factors.

Environmental pollution is the introduction of components or structural changes that are not peculiar to the ecological system, interrupting the circulation of substances, their assimilation, the flow of energy, as a result of which this system is destroyed or its productivity decreases.

A pollutant is any physical agent, chemical substance and biological species entering the environment or arising in it in quantities beyond their usual concentration, the limit of natural fluctuations of the average natural background at the time under consideration.

Chemical pollution is a change in the natural chemical properties of the medium, as a result of which the average annual amount of any

substances increases or decreases over the period under consideration, or the penetration into the medium of substances normally absent in it or in concentrations exceeding the MPC;

light pollution is a violation of the natural illumination of the area as a result of exposure to artificial light sources, leading to anomalies in the life of plants and animals;

noise pollution – is formed as a result of an increase in intensity and noise above the natural level;

electromagnetic pollution – appears as a result of changes in the properties of the environment (from power lines, radio, television, the operation of some industrial installations, etc.), leading to global and local geophysical anomalies and in subtle biological structures;

radioactive pollution – is associated with an increase in the natural level of radioactive substances in the environment.

The direct objects of pollution (acceptors of pollutants) are the main components of the ecotone: atmosphere, water, soil.

Indirect objects of pollution are components of the biocenosis – plants, animals, microorganisms.

Atmospheric air pollution is any change in composition and properties that has a negative impact on human and animal health, the condition of plants and ecosystems.

The degree of atmospheric air pollution depends on:

1. The capacity of industrial production.
2. The quality of the fuel being burned (for example, burning gas in a boiler room will produce less pollution than burning coal).
3. Availability and perfection of treatment facilities that delay the release of chemical pollutants into the atmosphere.
4. The location of the residential area in relation to the industrial enterprise (on the windward side).
5. Climatic and weather conditions.

There are weather and climatic conditions that contribute to the concentration of atmospheric pollution:

1. *Calm* – weather characterized by absolute calm, that is, when the air velocity is zero. In such weather, all substances released into the air are collected in the same place, reaching high concentrations.

2. *Foggy weather*, in which toxic fog is formed.

Fog is a high content of water vapor in the air (high humidity), which is formed by sudden fluctuations in temperature. When the air temperature decreases, small water droplets form. These small droplets of water adsorb on their surface all substances in a suspended state, which in such a situation do not disperse in space, but concentrate in large quantities.

3. *Temperature inversion*. According to the laws of physics, when climbing to a height, the air temperature decreases by an average of 0.65- 1 ° C for every 100 meters. The resulting vertical temperature difference in the air leads to its constant mixing. The chemical pollutants contained below rise up in air streams, and in general the air becomes cleaner. There are weather conditions in which, when climbing to a height, there is no decrease in air temperature, and, therefore, there is no mixing of it. In humid, windless weather, this gradient can change, then the warm air remains at on the surface of the earth, vertical convection air flows are weakening. Toxic emissions from enterprises are concentrated in the surface air layer.

4. *Photochemical fog or smog* – a type of critical weather is observed in the spring-summer period of the year, in places of heavy automobile traffic. As a result of fuel combustion, toxic substances are released into the air. As a result of the action of ultraviolet radiation on them, new chemicals are formed in the air, which are called photo-oxidants (ozone, organic peroxides, aldehydes, nitrogen and sulfur oxides, numerous organic compounds of peroxide nature, ketones and other chemicals). Photochemical smog occurs as a result

of photochemical reactions under certain conditions: the presence in the atmosphere of a high concentration of nitrogen oxides, hydrocarbons and other pollutants, intense solar radiation and windlessness or very weak air exchange in the surface layer.

Photo–oxidants have an irritating effect: they irritate the mucous membrane of the upper respiratory tract and eyes (eye pain, cough, sometimes pulmonary edema.

5. *The greenhouse effect* is an increase in the temperature of the lower layers of the planet's atmosphere compared to the effective temperature, that is, the temperature of the planet's thermal radiation observed from space. The main greenhouse gas is carbon dioxide: its contribution to the greenhouse effect, according to various sources, ranges from 50 to 65%. Other greenhouse gases include methane (about 20%), nitrogen oxides (about 5%), ozone, freons (chlorofluorocarbons) and other gases (about 10-25% of the greenhouse effect). In total, about 30 greenhouse gases are known, their warming effect depends not only on the amount in the atmosphere, but also on the relative activity of the action per molecule.

6. *Acid rain* – all types of meteorological precipitation – rain, snow, hail, fog, rain with snow, in which there is a decrease in the pH of precipitation due to air pollution with acid oxides (usually sulfur oxides, nitrogen oxides)

Pollution of reservoirs is a decrease in their biospheric functions and ecological significance as a result of the entry of harmful substances into them.

The main types of pollution of reservoirs

Chemical pollution is the most widespread, persistent and far–reaching. This type of pollution can be organic (phenols, pesticides) and inorganic (salts, acids, alkalis), toxic (arsenic, mercury compounds, lead, etc.) and non-toxic. The most common: oil and petroleum products, synthetic surfactants, pesticides, heavy metals, dioxins.

Physical:

- *radioactive substances* (dangerous even at very low concentrations, the most harmful are "long-lived" radioactive elements), heat, etc.

-*thermal pollution* – an increase in water temperature as a result of mixing with more heated or technological waters. With an increase in temperature, the gas and chemical composition of the waters changes, which leads to the proliferation of anaerobic bacteria, an increase in the number of hydrobionts and the release of toxic gases (hydrogen sulfide, mtana), at the same time there is a "flowering" of water, accelerated development of microflora and microfauna.

Biological pollution is the introduction into ecosystems as a result of anthropogenic impact of uncharacteristic species of living organisms (bacteria, viruses) that worsen the conditions of existence of natural biological communities or negatively affect human health.

Mechanical contamination is the result of various mechanical impurities (sand, sludge, silt, etc.) entering the water. Mechanical impurities significantly impair the organoleptic properties of water.

The main types of anthropogenic impact on soils:

- *erosion*
- pollution
-secondary salinization and waterlogging,
- desertification
-alienation of land for industrial and municipal construction

The quality of the environment is the degree to which its characteristics meet the needs of people and technological requirements.

The principle of environmental quality regulation is the establishment of standards (indicators) of the maximum permissible human impacts on the environment.

The MPC of a chemical compound in the external environment is such a concentration, when exposed to the human body periodically

or throughout life, directly or indirectly through ecological systems, as well as through possible environmental damage, there are no somatic or mental diseases or health changes that go beyond the adaptive physiological reactions detected by modern methods immediately or in the long term the life span of the present and subsequent generations (I.V. Sanotsky)

Maximum-one-time maximum permissible concentration (MPC M.R.)- such a concentration of a harmful substance in the air that should not cause reflex reactions in the human body when inhaling it for 30 minutes (a sense of smell, a change in the light sensitivity of the eyes, etc.)

The average daily maximum permissible concentration (MPC ss) is such a concentration of a harmful substance in the air that should not have a direct or indirect harmful effect on a person impacts with indefinitely long (years) exposure.

The maximum permissible concentration of a harmful substance in the soil (MPC, mg/kg) is the maximum concentration that cannot cause a direct or indirect impact on the environment, disrupt the self–cleaning ability of the soil and have a negative impact on human health.

The maximum permissible concentration of a harmful substance for the aquatic environment (MPC, mg/l) is such a concentration of substances in water above which it becomes unsuitable for one or more types of use.

MPCs of pollutants are set separately for drinking water and fishery reservoirs.

The maximum permissible level of radiation exposure to the environment is a level that does not pose a danger to human health, the condition of animals, plants, and their genetic fund.

The *maximum permissible levels of noise, vibration, magnetic fields* and other harmful physical effects have also been established.

The maximum permissible emission (MPV) or maximum permissible reset (PDS) is the maximum amount of pollutants that

a given enterprise is allowed to emit into the atmosphere or dump into a reservoir per unit of time, without causing them to exceed the maximum permissible concentrations of pollutants or adverse environmental changes.

THEME 16
ECOLOGY OF NUTRITION. XENOBIOTICS IN FOOD

Motivational statement of theme

Anthropogenic redistribution of chemical elements in natural environments is accompanied by negative environmental consequences, including pollution of the air environment, fresh water sources, deterioration of biological and physico–chemical parameters of soils, and, as a consequence, a decrease in the safety of raw materials and food for human health. Therefore, the food industry faces the most important strategic task – meeting the needs of the population not only in biologically complete, but also environmentally safe food products.

Taking into account the negative impact on the health of substandard food products and food additives, priorities were identified to improve the nutritional structure of the population. Based on these priorities, the "Concept of state policy in the field of healthy nutrition of the population of the Russian Federation" has been developed. The objectives of the state policy in the field of healthy nutrition are to preserve and strengthen the health of the population, prevent diseases caused by inadequate and unbalanced nutrition.

The main priorities in the policy of healthy nutrition are: production of food raw materials and food products in the necessary volumes; availability of food products for all segments of the

population; high quality and safety of food products; teaching the population the principles of rational and healthy nutrition; constant monitoring of the state of nutrition. The focus of the ecology of nutrition should be the problem of assessing and ensuring the quality and safety of food products.

The objective: to form students' understanding of nutrition as an environmental factor and its impact on humans. To form an idea about the monitoring of xenobiotics in food products of plant and animal origin and measures to prevent toxic effects in the conditions of the modern ecological situation

Questions for discussion

1. The effect of chemicals on the human body. Ways of chemical substances entering the body.
2. Xenobiotics: definition, classification.
3. Prevention of the negative impact of xenobiotics on human health.

List of knowledge and practical skills

Independent work of students

1. Solving a situational professionally-oriented task.
2. Hearing and discussion of abstracts

Reference material

Food products – products in natural or processed form, consumed by humans for food (including baby food, dietary food), bottled drinking water, alcoholic beverages (including beer), soft drinks, chewing gum, as well as food raw materials, food additives and biologically active additives.

Xenobiotics are substances that are foreign to the body. The word xenobiotics comes from Greek. "xenos" is alien, "bios" is life, that is, these are substances alien to the natural environment surrounding living organisms.

Xenobiotics are divided into three groups:

1) chemical (elements, substances and compounds);

2) physical (noise, vibration, radiation, radiation, etc.);

3) biological (bacteria, viruses, helminths, protozoa, etc.).

Chemicals, in turn, can be represented by:

1) products of human economic activity (industry, agriculture, transport),

2) household chemicals (detergents, substances for combating parasites, perfumes),

3) medicines.

The main ways of xenobiotics entering the human body: with food and water through the mouth, with inhaled air through the lungs and through the skin.

Food safety assessment

When assessing the safety of food products, the basic regulations are the maximum permissible concentration (MPC), the permissible daily dose (DSD), the permissible daily intake (DSP) of substances contained in food.

The MPC of xenobiotics in food is measured in milligrams per kilogram of product (mg/kg) and indicates that its higher concentration is dangerous for the human body.

DSD xenobiotics is the maximum dose (in mg per 1 kg of human weight) of xenobiotics, the daily oral intake of which is harmless throughout life, i.e. does not adversely affect the vital activity, health of present and future generations.

DSP xenobiotics – the maximum possible amount of xenobiotic for consumption for a particular person per day (in mg per day). It is determined by multiplying the permissible daily dose by the weight of a person in kilograms. Therefore, the xenobiotic chipboard is individual for each individual, and it is obvious that this indicator is much lower for children than for adults.

The most common **classification of pollutants in food raw materials and food products** in modern science is reduced to the following groups:

1) chemical elements (mercury, lead, cadmium, etc.);

2) radionuclides;

3) pesticides;

4) nitrates, nitrites and nitros compounds;

5) substances used in animal husbandry;

6) polycyclic aromatic and chlorine-containing hydrocarbons;

7) dioxins and dioxin-like substances;

8) metabolites of microorganisms.

Food additives are used to extend the shelf life of products, to give them a marketable appearance.

Food additives are natural or artificial substances and their compounds specially introduced into food products during their manufacture in order to impart certain properties to food products and (or) preserve the quality of food products.

Experts identify the E index with both the word "Europe" and the words "essbag/Edible", which means "edible" in Russian, respectively, from German and English. The E index in combination with a three-digit number is part of the complex name of a specific chemical that is a food additive. Assigning a specific substance, the status of a food additive and a three-digit identification number with the index "E» implying that:

– this particular substance has been tested for safety;

– the substance can be used (recommended) within the framework of its established safety and technological necessity, provided that the use of this substance does not mislead the consumer about the type and composition of the food product in which it is introduced;

– for this substance, the purity criteria necessary to achieve a certain level of food quality have been established.

Therefore, permitted food additives having an E index and a three-digit number have a certain quality.

The quality of food additives is a set of characteristics that determine the technological properties and safety of food additives.

The presence of food additives in products must be indicated on the label, while it can be designated as an individual substance or as a functional name (functional class, technological function) in combination with the E code. For example: preservative E211, or sodium benzoate.

According to the proposed system of digital codification of food additives, their classification, in accordance with the purpose, is as follows (main groups):

E100 – E182 – dyes;

E200 and further – preservatives;

EZOO and further – antioxidants (antioxidants);

E400 and further – consistency stabilizers;

E450 and further – emulsifiers;

E500 and further – acidity regulators, baking powder;

E600 and beyond – flavor and aroma enhancers;

E700 – E800 – spare indexes for other possible information;

E900 and further – glazing agents, bread improvers;

E1000 – emulsifiers.

Many food additives have complex technological functions that manifest themselves depending on the characteristics of the food system. For example, the additive E339 (sodium phosphates) may exhibit the properties of an acidity regulator, an emulsifier, a stabilizer, a complexing agent and a water-retaining agent.

The permissible daily dose of natural preservatives is 5 mg per 1 kg of human body weight, synthetic – from 0.05 (diphenyl E230) to 0.15 mg (urotropin E239). Of the many E-additives, in fact, only two additives can be considered harmless, but even doctors do not recommend using them for children under 5 years old:

E363 – succinic acid (acidifier), is found in desserts, soups, broths, dry drinks.

E504 – magnesium carbonate (baking powder), may be contained in cheese, chewing gum, salt.

The codes of dangerous food additives that should be avoided are listed below:

1) Prohibited especially dangerous additives: E102-105, E110-111, E120-124, E127-129, E130-133, E142, E151-155, E173-175, E180, E210-211, E213-217, E219, E221-227, E230-231, E233, E236-240, E249, E252, E296, E320-322, E330, E338-341, E405, E407, E447, E461-462, E465-466, E620-621, E627, E631, E635, E924 a-b, E926, E951-952, E954, E957.

2) Very dangerous additives: E510, E513, E527.

3) Dangerous: E201, E220, E228, E242, E270, E400-404, E501-503, E636-637.

4) Suspicious: E100, E141, E150, E171, E241, E477.

The effect of food additives on the human body:

Crustaceans: E102, E103, E105, E110, E121, E123, E125-126, E130-131, E142, E152-153, E210-217, E219, E230, E240, E249, U252, E280-283, E330, E447, E954.

Causing disorders of the gastrointestinal tract: E154, E220-226, E320-322, E338-341, E343, E405, E407, E450-454, E461-466, E626-635.

Cause liver and kidney disorders: E171-173, E220, E302, E320-322, E510, E518.

Harmful to the skin: E230-233, E239, E151, E160, E951, E1105.

Causing pressure disturbance: E154, E250, E251.

Provoking the appearance of rashes: E310-312, E907.

Cholesterol-raising: E320, E321.

Allergens: E216-217, E230-232, E239, E311-131.

An additive that interferes with the absorption of vitamin B12: E200.

Dietary supplements that have not yet been fully studied, therefore are not officially allowed:

E103, E107, E125, E127, E128, E140, E153-155, E160, E166, E173-175, E180, E182, E209, E213-219, E225-228, E230-233, E237-238, E241, E263-264, E282-283, E302-303, E305, E308-314, E317-318, E323-325, E328-329, E343-345, E349-352, E355-357, E359, E365-368, E370, E375, E381, E384, E387-390, E399, E408-409, E418-419, E429-436, E441-444, E446, E462-463, E465, E467, E474, E476-480, E 482-489, E491-496, E505, E512, E519, E521-523, E535, E537-538, E541-542, E550, E554-557, E559-560, E574, E576-577, E580, E622-625, E628-629, E632-635, E640-641, E906, E908-911, E913, E916-919, E922-926, E929, E943-946, E957, E959, E1000-1001, E1105, E1503, E1521.

Table 1

Food additives with various technological functions

The purpose of the introduction	is to regulate taste	and improve the appearance	Consistency control and texture formation	Increase shelf life
Functional classes of flavoring additives	Flavoring additives Sweetening substances Acids and acidity regulators	Dyes Bleachers Color Stabilizers	Thickeners Gel-forming bodies Stabalizato-ry Emulsifiers Diluents Foaming agents	Preservatives Antioxidant Moisture-retaining agents Film imagers

Table 2

Functional classes, definitions and technological functions of food additives

Functional classes (for labeling purposes)	Subclasses (technological functions)	Definitions
	Acid-forming agents	Increase the acidity and/or give a sour taste to food
Acidity regulators	Acids, alkalis, bases, buffers, pH regulators	Change or regulate the acidity or alkalinity of a food product
Substances that prevent caking and clumping	Additives that prevent hardening; in-va reducing stickiness, drying additives, powders, separating substances	Reduce the tendency of food product particles to stick to each other
Defoamers	Defoamers	Prevent or reduce the formation of foam
Antioxidants	Antioxidants, synergists antioxidants, complexing agents	Increase the shelf life of food products, protecting against spoilage caused by oxidation, for example, rancid fats or discoloration
Fillers	Fillers	Substances other than water or air, which increase the volume of the product without noticeably affecting its energy value
Dyes	Dyes	Enhance or restore the color of the product
Substances that contribute to the preservation of color	color fixators, color stabilizers	Stabilize, preserve or enhance the color of the product

Continuation of the table 2

Functional classes (for labeling purposes)	Subclasses (technological functions)	Definitions
Emulsifiers	Emulsifiers softeners, dispersing additives, surfactants, wetting agents	Form or maintain a homogeneous mixture of two or more immiscible phases, for example, oil and water in food products
Emulsifying salts	Melting salts, complexing agents	interact with cheese proteins in order to prevent the separation of fat in the manufacture of processed cheeses
Seals (plant tissues)	Seals (plant tissues)	Make or keep so many fruits and vegetables dense and fresh, interact with gelling agents – to form or strengthen the gel
Taste and smell enhancers	Flavor enhancers, flavor enhancers, flavor modifiers, additives that promote digestion	Enhance the natural taste and/or smell of food products
Foaming agents	Whipping additives, aerating additives	Create conditions for uniform diffusion of the gaseous phase into liquid and solid food products
Gelling agents	Gelling agents	Texture food by forming a gel
Glaziers	film-forming agents, polishing substances	Substances, which, when they lubricate the outer surface of the product, give a shiny appearance or form a protective layer
Moisture-retaining agents	Additives that retain moisture/water; wetting additives	Protect food from drying out by neutralizing the influence of atmospheric air with low humidity

End of the table 2

Functional classes (for labeling purposes)	Subclasses (technological functions)	Definitions
Preservatives	Antimicrobial and antifungal additives, additives to combat bacteriophages, chemical sterilizing additives during wine maturation, disinfectants	Increase the shelf life of the product, protecting against spoilage caused by microorganisms
Propellants	Propellants	Gas or other air pushing the product out of the container
Baking powder	Baking powder, substances that contribute to the vital activity of yeast	or mixtures of substances that release gas and thus increase the volume of the dough
Stabilizers	, Binders, seals, moisture- and water-retaining substances, foam stabilizers	Allow you to maintain a homogeneous mixture of two or more immiscible substances in a food product or finished food
Sweeteners	Sweeteners, artificial sweeteners	Substances of a non-sugar nature that give foods and prepared foods a sweet taste
Thickeners	Thickeners texturators	Increase the viscosity of food products

Laboratory control of the content of foreign chemicals in food products

Fresh and freshly frozen vegetables, dried vegetables, potatoes, fruits, berries and mushrooms, juices, beverages and concentrates of vegetables, fruit, berries, salted and pickled vegetables, salted and pickled mushrooms are subject to hygienic examination.

The content of *nitrates* is determined in fresh vegetables, fruits and berries, which is one of the important indicators characterizing

the environmental and hygienic safety of plant-based food products. The reason for the increase in the content of nitrates in these products is, as a rule, the excessive use of nitrogen fertilizers in agriculture, as a result of which the level of nitrate content in soil, surface and groundwater increases, from where they enter food and feed agricultural products. In addition, nitrates are used as food additives, for example, in sausage production, where their overdose is possible. It is also known about the possibility of using nitrates for the purpose of food adulteration, since they contribute to accelerating the maturation, in particular, of melons (watermelons, melons, etc.), A significant accumulation of nitrates in water and food products can cause methemoglobinemia in children and a number of diseases in farm animals. Nitrates can combine with amines and amides to form carcinogenic nitrosamines and nitrosamides. The accumulation of nitrates in plant products occurs with varying intensity. So, with the same content of them in the soil – 80 mg / kg, they can be contained in melons in quantities of 100-140 mg / kg, tomatoes – 115 mg / kg, cucumbers – 120 mg / kg, potatoes – 220 mg / kg, cabbage – 280 mg/ kg, beets – 420 mg/kg.

*Pesticides a*re the collective name of chemical compounds used to destroy bacteria, viruses, spores, fungi, insects, rodents, plants that harm agricultural crops and animals, as well as for various technological purposes. The industrial classification is based on the purpose of pesticides, the purpose and direction of their use: insecticides, fungicides, herbicides, difoliants, desiccants, etc.

Based on the chemical structure, organochlorine, organophosphate, mercury-containing, arsenic-containing, carbamic acid derivatives, etc. are distinguished.

When pesticides enter the body, depending on the dose, acute, subacute and chronic intoxication may develop.

Children, adolescents, sick and weakened persons are highly sensitive to pesticides. Contact with pesticides during pregnancy and

during the feeding period of the child is particularly dangerous. Pesticides, entering the body, penetrate the placental barrier and can adversely affect the development of the fetus, have an embryotoxic and teratogenic effect, During lactation, pesticides can enter the baby's body with mother's milk and cause intoxication. A number of pesticides have gonadotoxic, mutagenic, carcinogenic effects, as well as allergenic properties.

Heavy metals are also dangerous for the human body. From the standpoint of sanitary toxicology, lead, mercury, cadmium, fluorine, arsenic, aluminum, nickel, tin, copper, zinc have priority among heavy metals.

These substances have high toxicity, are able to accumulate in the body during prolonged intake with food and have mutagenic and carcinogenic effects.

Special attention should be paid to food raw materials received from regions with a high level of anthropotechnogenic load, grown near major highways, in industrial zones, with intensive use of mineral fertilizers. Lead accumulates in vegetables (potatoes, carrots, beets), mercury in seafood and fish, cadmium in mushrooms, cereals.

Heavy metals can enter products when storage is disrupted and packaging material is damaged, when tinned, glazed ceramic and enameled dishes, cans are used. Thus, numerous lead poisoning was observed during the storage of acidic products of liquid consistency (yogurt, homemade wine, beer, apple juice, etc.) in ceramic dishes.

Mycotoxins are compounds that accumulate as a result of the vital activity of mold fungi, for example, aflatoxins and natulin. As a rule, fungi develop on the surface of food products, and the products of their metabolism can also penetrate inside.

Measures to prevent the ingestion of xenobiotics with food

The World Health Organization (WHO) is considering the monitoring of xenobiotics in food (MCP) as the most important

subsystem of ecological and hygienic monitoring, since from 30 to 80% of harmful chemicals enter the human body with food. The greatest attention is paid to monitoring the most toxic, highly cumulative and stable xenobiotics, which are called indicators. The indicators include long-lived radionuclides, heavy metals (Hg, Pb, Cd, Ni, Al, Co), arsenic, fluorine, nitrates and nitrites, pesticides, carcinogens (benz (a) pyrene, nitros compounds), polychlorinated biphenyls, mycotoxins, and in some cases a complex of food additives.

The evaluation criteria for the degree of contamination of xenobiotic products are its MPC in food products and the background content known from the literature in them. To assess the actual load on the human body, data on the content of xenobiotics in the diet are compared with DSP (permissible daily intake in milligrams) and DSD (permissible daily dose in milligrams per 1 kg of body weight). If the diet contains several xenobiotics, then the proportion of each to its chipboard is calculated: the sum of the ratios should not exceed one.

Xenobiotics monitoring is particularly widely used in human biological media: blood, urine, breast milk, saliva, hair, teeth, placenta, adipose tissue, nails, feces, exhaled air, and during autopsy – in the liver, kidneys, etc. The degree of risk is judged by comparing the data obtained in the process of biomonitoring with the already available toxicological information about the permissible parameters of the content of xenobiotics in biological media. Thus, the level of mercury in the urine exceeding 10 mcg / l signals danger, and more than 50 mcg / l indicates the onset of intoxication.

Taking into account the possibility of mutagenic and oncogenic action of xenobiotics, in recent years, attention has been paid to the use of screening tests of genetic monitoring, which allow assessing the integral load of a person (population) with mutagens. The use of these tests makes it possible to assess the dynamics of the load of a

certain contingent of people with mutagens (carcinogens) contained in food, as well as to identify regions and groups of people at increased risk. The final stage of monitoring food xenobiotics is a general conclusion about the contamination of food with xenobiotics.

Examples of situational professionally oriented tasks for practical training

Task 1. The following food additives were found in the batch of baby food: E 101 – vitamin B2, E 160a – carotene, E 240 – formaldehyde, E 300 – vitamin C, E 440 – pectin, E 918 – nitric oxide, E 1420 – starch.

Task:

1. Evaluate the suitability of this product for baby nutrition.
2. Regulatory and legal issues of the use of food additives.
3. Describe the likely health risks to adults and children from unauthorized use of dietary supplements.

Task 2. A man, 50 years old, treated a garden plot with a mixture of insecticides consisting of fufanon and pyrethrum. However, he soon felt a deterioration in his health. The patient was taken to the clinic in a serious condition, complaining of headache, dizziness, fear, abdominal pain. There were vomiting and loose stools several times during the day.

The examination revealed the following symptoms: hyperemia of the skin, sharp constriction of the pupils, tachycardia, muffled heart tones, increased blood pressure, difficulty breathing, muscle twitching, hallucinations.

Task:

1. What is the cause of these symptoms of poisoning?
2. Indicate the routes of entry of toxic substances into the human body and possible health consequences.
3. What preventive measures should be applied in this case?

THEME 17
CHARACTERISTICS OF DIETARY SUPPLEMENTS, ANALYSIS OF INDIVIDUAL DIETARY SUPPLEMENT INGREDIENTS, SAFETY DETERMINATION AND APPLICATION

Motivational statement

Nutrition is one of the main factors of living conditions that shape human health and quality of life. Recently, a new field of knowledge has emerged – pharmaconutritionology, which is the borderline between nutrition science and pharmacology. The outstanding Russian scientist academician A.A. Pokrovsky noted that "... food should be considered not only as a source of energy and plastic substances, but also as a very complex pharmacological complex."

Studies of nutrition, energy consumption and population health, conducted in many countries of the world, have shown a significant change in the structure of human nutrition over the past 100 years. At the same time, the consumption of essential nutrients, especially micronutrients and biologically active food components, decreased.

The diet is usually characterized by excessive consumption of animal fats and easily digestible carbohydrates, and at the same time, for the majority of the population, the diet is significantly deficient in the content of polyunsaturated fatty acids (omega-3 and omega-6); soluble and insoluble dietary fiber (pectin, gums, mucus, cellulose, etc.); vitamins; a wide range of vitamin-like substances of natural origin (L – carnitine, ubiquinone, choline, lipoic acid, etc.); macronutrients (calcium, etc.); trace elements (iodine, iron, selenium, zinc, etc.).

The search for alternative solutions to this crucial problem has led scientists to the idea of the need to develop technologies for obtaining complexes of dietary supplements from natural sources in essentially chemically pure form.

Dietary supplements are compositions of natural or identical to natural biologically active substances intended for intake with food or for introduction into food products to enrich the diet with food or biologically active substances and their complexes.

Taking into account all the above, it should be noted that the mass introduction of dietary supplements to food allows us to solve the problem of providing the population with the scarcest nutrients that will help increase the resistance of the human body to adverse environmental conditions, improve the quality of life of patients, reduce the risk of the most common diseases, and as a result significantly improve the health indicators of the nation in as a whole.

The objective: to form students' understanding of nutrition as an environmental factor and its impact on humans. To familiarize students with the concept of dietary supplements, classification, functions, role for the human body, with the basic regulatory framework governing the circulation of dietary supplements.

Questions for discussion

1. General characteristics of dietary supplements.
2. Classification of dietary supplements.
3. The role of dietary supplements in human nutrition.
4. Differences between dietary supplements and medications.
5. Functional role of nutraceuticals.
6. Physiological significance of parapharmaceuticals.
7. Functional role of eubiotics.
8. Regulatory issues of turnover of dietary supplements, their safety.
9. Features of the sale of dietary supplements in Russia.
10. Procedure for establishing the safety of food additives.

Independent work of students

1. Situational problems. Reference material, tables and recommended literature may be used.

The situational problems should be reported in writing.

2. Discussion report prepared by the students on an individual task of a teacher.

Task 1. Fill out the table with information about dietary supplements available in retail (obtain from your teacher). Analyze the relationship between the functional purpose of dietary supplements and micronutrients (minors) contained in them. Compare daily dose micronutrients and minors (recommended by manufacturers) with adequate standards their consumption, using MP 2.3.1.1915-04 “RECOMMENDED LEVELS CONSUMPTION OF FOOD AND BIOLOGICALLY ACTIVE SUBSTANCES" https://ohranatruda.ru/upload/iblock/5e9/4293846547.pdf.

Table 1

Trading brand (Name)	Dietary supplement Manufacturer	Terms and conditions storage, number SGR	Functional new appointment dietary supplement, contraindication	Daily dosage	Content micronutrients (minor) in daily allowance dosage

Conclusion and recommendations:

_____
_____
_____
_____
_____
_____
_____
_____
_____

An example of a table to fill out based on information from labels and annotations of dietary supplements

Trading Brand (Name)	Dietary supplement Manufacturer	Terms and conditions storage, number SGR	Functional New appointment dietary supplement, contraindication	Daily dosage	Content micronutrients (minor) in daily allowance dosage
Allicor	INAT-PHARMA	At a temperature not above +30°C in dry place, guaranteed shelf life 24 months from the date manufacturing, SGR 77.99.10.916. B.00371.08.03	Maintenance functions cordially-vascular systems, normalization lipid exchange	2 tablets 150 mg	Allicin, 5 mg

Task 2. Solving situational professionally oriented problem №.____

Task 3. Test tasks. Answer the test questions. Select one or more answer options.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Reference material

Dietary supplements are natural (identical to natural) biologically active substances intended for consumption along with food or for inclusion in food products.

Adequate level of consumption – the level of daily consumption of food and biologically active substances, established on the basis of calculated or experimentally determined values, or estimates of consumption of food and biologically active substances by a group/ groups of practically healthy people (using epidemiological methods), for which this consumption (with taking into account health indicators) is considered adequate (used in cases where the recommended amount (norm) of consumption of food and biologically active substances cannot be determined).

Dietary supplements are used as an additional source of food and biologically active substances to optimize carbohydrate, fat, protein, vitamin and other types of metabolism in various functional states, to normalize and/or improve the functional state of organs and systems of the human body, incl. products that have restorative, mild diuretic, tonic, sedative and other types of effects in various functional

conditions, to reduce the risk of diseases, as well as to normalize the microflora of the gastrointestinal tract, as enterosorbents.

Dietary supplements must meet the quality requirements established by regulatory documents in terms of organoleptic, physicochemical, microbiological, radiological and other indicators for the permissible content of chemical, radiological, biological objects, prohibited components and their compounds, microorganisms and other biological agents that pose a danger to human health.

In biologically active food additives, the content of the main active ingredients is regulated. However, unlike medicines, Russia does not provide for mandatory certification or declaration (quality testing by independent laboratories) of each batch of dietary supplements. The quality of dietary supplements is checked almost only during production, which is often taken advantage of by unscrupulous manufacturers, violating technology and recipes. In addition, clinical studies of the use and effect of dietary supplements are not mandatory. All of the above, together with unreliable (and often aggressive) advertising, creates fertile ground for fraud and deception in the production and sales of dietary supplements.

In the Russian Federation, examination of documentation, medical and biological assessment, sanitary-chemical, microbiological and other necessary studies of dietary supplements, as well as, if necessary, making a decision on their clinical testing, are entrusted to the Center for Hygienic Certification of Food Products of the Department of Sanitary and Epidemiological Surveillance of the Ministry of Health of the Russian Federation, which is located on the basis of the Institute of Nutrition of the Russian Academy of Medical Sciences. In some cases, this work is carried out jointly with other authorized institutions.

Dietary supplements are included in the "List of products subject to state registration with the Federal Service for Surveillance on Consumer Rights Protection and Human Welfare."

The right to produce, use, sell dietary supplements on the territory of the Russian Federation, as well as import dietary supplements, is given by the Certificate of State Registration (SGR).

For dietary supplements that have passed state registration in accordance with the Resolution of the Chief State Doctor of the Russian Federation "On state registration of biologically active food additives" No. 21 dated September 15, 1997, a federal register of biologically active additives (BAA) is maintained. Information about dietary supplements, agreed with Rospotrebnadzor, is open and is kept up to date on its Search server on the official website of Rospotrebnadzor http://fp.crc.ru.

The registration certificate contains information about the name of the dietary supplement, the manufacturer and recipient of the certificate for the dietary supplement, their addresses, the certificate number and the date of its issue, the scope of the dietary supplement, the composition and hygienic characteristics of the dietary supplement.

The production, circulation and sale of dietary supplements in the Russian Federation is regulated by SanPiN 2.3.2.1290-03 "Hygienic requirements for the organization of production and circulation of biologically active food additives (BAA)".

The SGR is valid for the entire period of production of dietary supplements, i.e. is actually an indefinite document.

Before the introduction of the state registration procedure, dietary supplements underwent a sanitary and epidemiological examination, the results of which were included in the sanitary and epidemiological report (SEZ) or registration certificate (RU). These documents were valid for 3-5 years, after which a re-examination was necessary. All SEZ and RU, the terms of which have not yet expired, continue to be valid together with the SGR for newer dietary supplements. Information about the majority of existing SEZs and RUs is also included in the database of the Rospotrebnadzor Search Server.

Information on the packaging of dietary supplements should contain:

- names of dietary supplements, and in particular:
- manufacturer's trademark (if available);
- designations of regulatory or technical documentation, the mandatory requirements of which must be met by dietary supplements (for dietary supplements of domestic production and CIS countries);
- composition of dietary supplements, indicating the ingredient composition in order corresponding to their decrease in weight or percentage terms;
- information about the main consumer properties of dietary supplements;
- information on the weight or volume of dietary supplements in a unit of consumer packaging and the weight or volume of a unit of product;
- information about contraindications for use in certain types of diseases;
- indication that the dietary supplement is not a medicine;
- date of manufacture, warranty expiration date or deadline for the sale of products;
- storage conditions;
- information on state registration of dietary supplements indicating the number and date;
- location, name of the manufacturer (seller) and location and telephone number of the organization authorized by the manufacturer (seller) to accept claims from consumers.

Retail trade in dietary supplements is carried out through pharmacies (pharmacies, pharmacy stores, pharmacy kiosks, etc.), specialized stores selling dietary products, food stores (special departments, sections, kiosks).

The sale of biologically active additives is not allowed:

1) Who have not passed state registration;

2) Do not have documents confirming their safety;

3) Expired;

4) In the absence of appropriate conditions for implementation;

5) Without label;

6) In the case when the information on the label does not correspond to the information agreed upon during state registration;

7) In the absence of information on the label, applied in accordance with the requirements of current legislation;

8) Without packaging or if its integrity is damaged;

9) With obvious signs of poor quality.

To extend the shelf life of products and give them a marketable appearance, food additives are used.

In accordance with SanPiN 2.3.2.1290-03 "Hygienic requirements for the organization of production and circulation of biologically active food additives (BAA)", retail trade of dietary supplements can only be carried out through pharmacies (pharmacies, pharmacy stores, pharmacy kiosks and others), specialized stores sale of dietary products, food stores (special departments, sections, kiosks).

Classification of dietary supplements

There are various classifications of dietary supplements depending on their composition, functional activity, effects, etc.

Based on their composition, dietary supplements are divided into the following groups: **nutraceuticals, parapharmaceuticals and eubiotics**.

Nutraceuticals are biologically active food additives used to correct the chemical composition of human food.

Nutraceuticals are essential nutrients or their close precursors. This group of dietary supplements can rightfully be classified as food, since in most cases it is represented by well-studied natural

components, the physiological need and biological role of which have been established.

Nutraceuticals include: vitamins, provitamins, macro-microelements, polyunsaturated fatty acids, amino acids, carbohydrates, dietary fiber.

Sources of amino acids: are produced in most cases in the form of easily digestible, ready-made dry carbohydrate-protein-fat-mineral-vitamin mixtures, which contain a high amount of milk, egg, and soy proteins with a digestibility of 97%. Their main function is to additionally enrich the traditional diet with essential amino acids (methionine, lysine). They are often used by athletes to accelerate the growth of muscle mass, and are used for diseases of the liver and blood vessels.

Sources of fatty acids, fat-soluble vitamins and lipids: The Russian population is deficient in linolenic and eicosapentaenoic acids (polyunsaturated fatty acids), and their role in the body is extremely high. For example, in the construction of cell membranes. Natural sources of such acids are soybean and flaxseed oil. To compensate for their deficiency, various supplements are also produced. Supplements containing phospholipids are produced to increase the activity of antioxidant systems. In the prevention of cardiovascular diseases, it is recommended to use supplements containing fat-soluble vitamins.

Sources of carbohydrates: used mainly by patients with diabetes. Such dietary supplements contain fructose, inulin, xylitol and other sweeteners. They enhance metabolism, improve glucose tolerance and insulin sensitivity. Currently, various supplements containing inulin based on the juice of vegetables, fruits and berries have been developed.

Sources of fiber: these include pectin, bran, vegetable fiber, cellulose. Available in the form of mixtures. The gel-forming properties of pectin make it possible to use it as an enveloping agent

in the treatment of gastrointestinal diseases. It is obtained from: citrus fruits, apples, beets, sunflowers, watermelon, pumpkin, grapes, cotton, etc. Sources of water-soluble vitamins: The most effective forms of these vitamins are powdered vitamin drinks.

Sources of minerals: in recent years, complex supplements containing macro- and microelements with anti-carcinogenic effects have been developed. At the same time, they try to make them as easily and quickly digestible as possible.

Parapharmaceuticals are biologically active food additives used for prevention, auxiliary therapy and support within the physiological boundaries of the functional activity of organs and systems.

These are, as a rule, products containing minor food components – bioflavonoids, organic acids, glycosides, biogenic amines, regulatory oligopeptides, polysaccharides, oligosugars, etc.

Eubiotics (probiotics) are biologically active food additives, which contain live microorganisms and (or) their metabolites, which have a normalizing effect on the composition and biological activity of the microflora of the digestive tract.

In turn, they are divided into 3 groups: probiotics, synbiotics, prebiotics.

Probiotics are drugs of microbial origin, while prebiotics are non-bacterial in nature.

Synbiotics are drugs obtained by rationally combining pro- and prebiotics.

The most common probiotics are bifidobacteria and lactobacilli. They are used to prepare various food products such as yogurt, kefir, bifidoc, ice cream or even candy. Probiotics are used to prevent microbial imbalance in the body, as well as for intestinal inflammation, gastritis, acute intestinal infections, etc.

Prebiotics include various carbohydrates. For example, inulin, lactosulu, galacto-, fructo-, oligosaccharides. Despite the fact that prebiotics are not digested or absorbed in the upper parts of the

digestive tract, they are capable of causing active growth and reproduction of bifidobacteria and lactobacilli.

The difference between dietary supplements and medications

It should be especially noted that the mechanisms for implementing the therapeutic and prophylactic effects of pharmacological drugs and dietary supplements are significantly different. The only exception is, perhaps, the treatment with dietary supplements of classical deficiency conditions, such as scurvy or beriberi. In other cases, the main principles of the treatment and prophylactic action of dietary supplements and pharmacological drugs differ significantly.

Dietary supplements	**Medicines**
Specificity of action	
Regulation of a very wide range of biochemical reactions and physiological functions. A specific action is always accompanied by nonspecific effects, reactions that are beneficial to health.	Strictly selective and highly specific action. Nonspecific effects most often manifest themselves as toxic or side effects.
Physiological action	
The therapeutic effect is realized through physiological evolutionarily fixed mechanisms.	The therapeutic effect in most cases is realized through non-physiological and evolutionarily uncharacteristic mechanisms.
Toxicity and adverse reactions	
For most micronutrients there is no toxic dose because they have been are natural components of food.	Many medications are characterized by toxic reactions and complications due to the very narrow interval between therapeutic and toxic doses.

Speed of achieving effect	
Achieving a positive and sustainable effect is usually slow.	The effect is quick but short-lived.
Interaction with other drugs	
Interaction with other micronutrients in most cases is characterized by synergy and complementarity of beneficial effects and the elimination of possible undesirable reactions.	Interactions with other pharmaceuticals are often characterized by antagonism, neutralization of the therapeutic effect, or aggravation of toxic reactions.

Principles of using dietary supplements

The use of additives is based on some principles:

1. The principle of functionality and consistency. That is, the impact must be complex, since the functioning of organs in the body is directly related to nutrition.

2. The principle of phasing. At different stages of the disease, it is advisable to select different supplements. For example, in the first stages it is necessary to urgently eliminate the symptoms of the disease, and at the end of treatment, eliminate the toxic effect of taking medications.

3. The principle of adequacy. It is necessary to prescribe dietary supplements, taking into account the nature of the disease and the characteristics of its course.

4. Syndromic principle. The prescription of biological additives should be made taking into account those symptoms that are pronounced. The principle of optimality. When treating or preventing diseases, the dosage must be selected individually.

5. Combination principle. Dietary supplements can be combined with food and other medications.

Analyzing all the principles, we can say about dietary supplements that this is a product that must be used in combination with other therapy during illness. It is impossible to cure with supplements alone.

There are a number of recommendations for the use of dietary supplements:

✓ it is better to start using the supplement in small quantities in order to assess the body's response to this product;

✓ for best absorption of the supplement, manufacturers recommend taking it with food. However, dietary supplements that contain potassium must be consumed between meals to avoid a decrease in the concentration of hydrochloric acid in the stomach;

✓ in the first half of the day they take supplements that increase the tone of the body so that excessive activity does not interfere with falling asleep;

✓ eubiotics containing live microorganisms are stored strictly in the refrigerator so that bacteria do not have the opportunity to rapidly grow and reproduce, which leads to spoilage of the additive;

✓ you should not independently increase the portions of dietary supplements consumed, except in cases where this is recommended by a doctor;

✓ taking several dietary supplements at once without consulting a doctor can lead to negative consequences; Dietary supplements are stored in a dark, dry place, protected from direct sunlight.

Situational professionally oriented problem

Problem № 1. A 45-year-old woman purchased a widely advertised dietary supplement that promotes weight loss in one of the city pharmacies to correct her figure. The instructions for the dietary supplement did not contain information about contraindications for use in certain types of diseases that this woman has. Also, the packaging of this product lacked a special protective layer, which led to a significant shortening of shelf life. A week after starting to take this dietary supplement, the woman felt significantly worse; an exacerbation of a chronic disease occurred, which resulted in urgent hospitalization and expensive treatment.

Questions for the problem:

1. What violations were revealed during the inspection?

2. What information should be on the packaging of dietary supplements?

Problem № 2. The dietary supplement was purchased in powder form at the pharmacy. The client filed a complaint because... This product has become damp and has stopped spilling out of the packaging.

Questions for the problem:

1. Explain what happened.

Problem № 3. The drug Digoxin was purchased at the pharmacy with a doctor's prescription. The client complained about ineffective therapy. After a conversation with the client, it was established that in addition to Digoxin, he also took a dietary supplement containing the herb St. John's wort.

Questions for the problem:

1. Explain what happened.

Problem № 4. The patient purchased dietary supplements through distributors to improve immunity and performance. A week later, he developed red, dotted rashes on his upper torso and arms, which were itchy and growing in size. The patient consulted a doctor, who diagnosed an allergic reaction and prescribed antihistamines. When collecting anamnesis, the patient said that he had not recently consumed new food products, household chemicals or cosmetics, but had started taking dietary supplements on his own. The patient took the capsules daily, several times a day, 2-3 capsules. Having examined the packaging, the doctor drew the patient’s attention to the fact that the packaging lacks information: about the manufacturer (manufacturer’s address), only a cell phone number is indicated; There is no state registration number and information about contraindications for the drug. The doctor recommended giving up dietary supplements.

Questions for the problem:

1. Indicate what information should be included on the packaging of dietary supplements?

2. Conditions for the production of dietary supplements.

3. Give a classification of modern dietary supplements.

Problem № 5. The mother of a 5-year-old child noted that the child began to gain weight, often asks for an extra portion of food, and loves sweets and sandwiches. To improve the child's health, the woman bought a dietary supplement at the pharmacy to reduce appetite, without consulting a doctor. A few days later, kindergarten teachers noted changes in the child's behavior, a sharp change in mood, tearfulness and apathy. With these complaints, the parents brought the child for a consultation with a neurologist. When collecting anamnesis, the mother said that she gives the child dietary supplements to reduce appetite. The doctor recommended urgently stopping taking dietary supplements. He explained that dietary supplements should be prescribed to children strictly in accordance with the recommendations, including age and the presence of contraindications. In addition, children under 7 years of age can be prescribed dietary supplements only on the recommendation of a doctor and in accordance with hygienic requirements. Allowed drugs include vitamins and mineral salts, dietary fiber, pro- and prebiotics.

Questions for the problem:

1. Specify the reason for the deterioration of the child's condition.

2. What preventive measures are needed in this case?

3. Specify the documents regulating the trade turnover of dietary supplements.

Problem № 6. An advertisement for the dietary supplement "Fulflex" was placed on television. The advertiser recommended treatment for gout. FAS (Federal Antimonopoly Service) banned the broadcast of the video and fined the producing company.

Questions for the problem:

1. What inconsistencies of the Federal Law "On Advertising" were identified in this case?

2. What additional inscriptions should be on the screen when advertising dietary supplements?

Problem № 7. During an inspection by Rospotrebnadzor at the pharmacy, it was revealed that the vitamin and mineral complex "Alphabet", which is a dietary supplement, and the vitamin and mineral complex "Supradin", which is a medicinal product, were stored in the same metabox. At the same time, there was no inscription on the packaging of the dietary supplement: "Not a medicine." To this remark, the pharmacist replied that they have the same storage conditions and are similar in scope.

Questions for the problem:

1. Name the storage conditions for dietary supplements and justify your answer.

2. What documents confirm the quality of the goods received at the pharmacy?

3. What are the requirements for the dietary supplement label?

4. What requirements were violated during the acceptance control of Alphabet?

5. What is the difference between dietary supplements and medications?

Task 3. Answer the test questions. Select one or more answer options:

1. Dietary supplements mostly come from:

1. Alternative medicine.
2. Western medicine of the 19th century.
3. Modern Western medicine.

2. Dietary supplements:

1. Have international non-proprietary names.
2. They do not have international non-proprietary names.

3. Do not have international non-proprietary names if developed before 1970.

3. What are the key differences between dietary supplements and medications:

1. The dietary supplement has one key active ingredient.
2. Dietary supplements do not have clear pharmacodynamics.
3. Dietary supplements do not have clear pharmacokinetics.
4. The dietary supplement has multiple effects.
5. The dietary supplement has one receptor.

4. All dietary supplements are tested for safety:

1. Chemical.
2. Hygienic and medical.
3. Sanitary and hygienic.
4. Pharmaco-epidemiological.
5. Microbiological.

5. Select from the proposed categories of dietary supplements according to the radar classification:

1. Balms, teas, infusions and mixtures.
2. Proteins, amino acids and their derivatives.
3. Resins and tar.
4. Alcohol tinctures and elixirs.

6. How does dietary supplement affect chemical processes in the body?

1. Blocks metabolic pathways.
2. Replenishes the deficiency of substances.
3. Changes the metabolism of substances.
4. Stimulates receptors.

7. The main point of control of dietary supplements is:

1. Their price.
2. Their safety.
3. Their effectiveness.
4. Their effectiveness and safety.

8. When testing dietary supplements for safety, a special role is played by:

1. Receptor on which the dietary supplement acts.
2. Complexity, multicomponent dietary supplements.
3. Price of dietary supplements.
4. The effectiveness of dietary supplements.

9. From a legal point of view, dietary supplements

1. It is not a medicine.
2. It is a special type of medicine.
3. It is a product of the chemical industry.

10. From a legal point of view, registration of dietary supplements compared to registration of medicines is

1. Longer.
2. More expensive.
3. More simple.
4. More complex.

11. A certificate of state registration of dietary supplements is issued if

1. The dietary supplement has been proven effective.
2. The dietary supplement does not contain prohibited components.
3. The dietary supplement meets other safety conditions of the Customs Union.
4. The dietary supplement contains potent components.

12. The term "dietary supplement" was introduced into circulation:

1. A.V. Strutynsky.
2. V.A. Tutelyan.
3. N.A. Semashko.
4. G.N. Golukhov.

13. What regulates the labeling of dietary supplements?

1. Federal law.
2. Local technical conditions.

3. Regional laws.

4. Standard.

14. The following dietary supplements are represented on the domestic parapharmaceutical market:

1. Plant based.

2. Based on sheep spleen.

3. Based on seafood.

4. Based on pure cultures of microorganisms.

5. Based on vitamins.

15. Organizations selling dietary supplements at retail:

1. Pharmacies.

2. Specialized stores selling health products.

3. Through distributors.

4. Special departments of grocery stores.

5. Pharmacy kiosks

16. Information about dietary supplements must contain:

1. Mandatory indication that this is an "environmentally friendly product"

2. Designations of regulatory or technical documentation, the mandatory requirements of which must be met by dietary supplements (for dietary supplements of domestic production and CIS countries).

3. Composition of dietary supplements, indicating the ingredient composition in order corresponding to their decrease in weight or percentage terms, including indications of the presence of components subjected to genetic modification.

4. Information about the main consumer properties of dietary supplements.

17. Sale of dietary supplements is not allowed:

1. Those that have not passed state registration (or sanitary-epidemiological examination).

2. Without a label, as well as in the case when the information on the label does not correspond to that agreed upon during state registration (or sanitary-epidemiological examination).

3. Not complying with sanitary rules and regulations.

4. If there is no information on the label in accordance with the requirements of current legislation.

5. With a certificate of quality and safety (for each batch of products)

18. Advertising of biologically active food additives should not:

1. Create the impression that they are medicines and (or) have medicinal properties

2. Encourage people to give up healthy eating

3. Contain an expression of gratitude by individuals in connection with the use of such additives

4. Present the object of advertising as a food product

5. Contain links to specific cases of people being cured and their condition improved as a result of the use of such supplements

19. Advertising of dietary supplements is not allowed:

1. Contradictory to the materials agreed upon during registration of dietary supplements.

2. Those who have not passed state registration with the Ministry of Health of the Russian Federation.

3. Dietary supplement as a unique, most effective and safe product in terms of side effects.

4. Creating the impression that the natural origin of the raw materials used in dietary supplements is a guarantee of their safety.

5. As a natural (identical to natural) substance intended for consumption simultaneously with food or inclusion in food products.

Recommended topics for personal reports

1. Boundaries between living and nonliving matter. Phenomena of active and hidden life.
2. The concept of Volterra's laws. Lindemann number and its ecological essence.
3. Examples of parasitism in wildlife: symbionts and endophytes
4. Age structure of populations in plants and animals.
5. Spatial structure of plant and animal populations. Types of distribution of individuals in space, territorial behavior of animals.
6. Population survival strategies. Population growth rate.
7. Regulation of population numbers in biocenoses.
8. Biocenosis and natural environment.
9. The influence of pharmaceutical enterprises on the structure of the biocenosis.
10. Natural ecosystems of the Earth as chorological units of the biosphere
11. Noosphere as a new stage in the evolution of the biosphere
12. Impact of man-made environmental disasters
13. Main types of anthropogenic impacts on the biosphere
14. Population characteristics of a person. Population growth. Age pyramid.
15. Natural resources of the Earth as a limiting factor in human survival.
16. Population structure of humanity.
17. Man as an object of action of evolutionary factors.
18. Urban noise: sources, impact on biological systems and humans, protective measures.

19. The role of green spaces in creating a favorable urban environment. Forest park area of the city. Requirements for the organization.

20. Electromagnetic radiation in the urban environment: sources, impact on biological systems and humans, protective measures.

21. Antibiotics and the environment.

22. Ecological consequences of global air pollution.

23. Anthropogenic impacts on flora, environmental consequences.

24. Human impact on wildlife, environmental consequences.

25. Main directions of protection of biotic communities.

26. Dietary supplements in the diet of adults and children.

27. Dietary supplements are nutraceuticals containing vitamins, HSFAs, macro and microelements.

28. Dietary supplements – parapharmaceuticals containing alkaloids, glycosides, essential oils, organic acids, etc.

29. Establishing the safety of food additives. Regulatory documents and quality control systems for dietary supplements.

List of questions for concludings

General Ecology module

1. Pharmaceutical ecology – definition, place in the system of environmental sciences.
2. Pharmaceutical ecology – definition, subject, goals and objectives.
3. What is the subject of environmental studies?
4. List the levels of biological organization (according to Yu. Odum)
5. "Biosphere" – give a definition, indicate the author of the term.
6. Environment – definition.
7. What is a habitat and what environments are inhabited by living organisms?
8. Environmental factors – list and define.
9. Population and biocenosis – definitions.
10. "Biogeocenosis" – provide a diagram.
11. Ecosystem and biogeocenosis – similarities and differences.
12. Trophic levels
13. How are organisms classified according to the nature of their food sources and ecological functions in biotic communities?
14. What is the essence of the biogenetic law?
15. Methods used in ecology.
16. What are "limiting factors"?
17. Adaptation of living organisms to the action of abiotic environmental factors (list the main directions).
18. Edaphic factors and their role in the life of plants and soil biota.

19. Morphological adaptation to the action of air humidity – give a definition, give examples.

20. of stenobiotic and eurybiotic organisms is a manifestation of adaptation to which environmental factor?

21. “Photoperiodism” and “Phototropism” – give definitions, give examples.

22. The law of the minimum – formulate, indicate the author.

23. The law of tolerance – formulate, indicate the author.

24. The law of independence of factors – formulate, indicate the author.

25. Indicate what specific features are characteristic of the ground-air habitat.

26. Indicate what specific features are characteristic of the aquatic habitat.

27. Large cycle of substances in nature.

28. Biological cycle of substances in nature.

29. Small cycle of substances in nature – what functions in nature it provides.

30. Biogeochemical cycles of which substances are the most vital for the biosphere.

31. Functions of living matter in the biosphere according to V.I. Vernadsky.

32. “Noosphere” – give a definition, indicate the author of the term.

Human Ecology module

1. Adaptive types of people
2. What reflects the biosocial nature of man?
3. What factors limit the growth of the human population.
4. The habitat of modern man (according to N.F. Reims).
5. Anthropogenic factors – definition.
6. Commoner's Laws – list.

7. Concepts of natural, quasi-natural, artificial and social environment

8. What are low intensity factors?

9. Ecological consequences of the influence of environmental factors on human health.

10. What is “urbanization”?

11. The main “+” and “-” of life in urban areas.

12. Measures for urban improvement.

13. The influence of chemicals on public health.

14. Ways of chemicals entering the body.

15. Xenobiotics: definition, classification.

16. System of standardization and quality control of food additives.

17. Routes of entry of xenobiotics into food products.

18. Food additives.

19. Dietary supplement for food.

20. Procedure for establishing the safety of food additives.

Reference

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In English

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