

MINISTRY OF HEALTH OF UKRAINE  
ODESSA STATE MEDICAL UNIVERSITY



APPROVED  
Rector of ONMedU  
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«*[Signature]*» 2024

**PROGRAM**

(in a distance format )

OF AN ENTRANCE EXAMINATION IN THE BIOLOGY  
FOR FOREIGNERS AND STATELESS PERSONS

Odesa

2024

## Explanatory note

The main purpose of the entrance exam in distant format is an objective and impartial assessment of the level of academic achievement of persons who graduated general educational institution and desire to enter the Odessa National Medical University.

The biology entrance exam program is composed on the basis of current biology curricula for students in grades 6-11 of secondary schools (standard level). The material of the program is divided into three sections: "Introduction. Chemical composition, structure and functioning of cells. Realization of hereditary information", "Regularities of heredity and variation", "Principles of ecology and evolutionary theory".

An entrance exam in distant format biology takes place orally. Total number of questions - 5.

The program was discussed and approved by the Admissions Committee of Odessa National Medical University (Minutes № 4 of "24" 04 2024)

The program was approved by the order of the rector of Odessa National Medical University № 106-0 from "24" 04 2024)

## EVALUATION CRITERIA

The entrance exam in distant format consists of 5 questions, each of which is rated at 40 points.

Competitive score based on the results of entrance examinations in the form of an oral interview is determined by the formula:  $(Q1 + Q2 + Q3 + Q4 + Q5)$ . Thus, the maximum number of points that an entrant can receive in an individual oral interview in biology is 200 points.

### CRITERIA FOR EVALUATION OF TASKS ON BIOLOGY

General requirements (recommendations) for the tasks:

- to show a certain level of awareness of the topic being discussed;
- reflect the main idea, differentiating the material into primary and secondary;
- to present the material logically, consistently;
- argue the views expressed;

**Biology tasks are evaluated according to the criteria set out in the table.**

Answer to the question is the correct, reasonable and complete.	40
The answer to the question is complete, but 1-2 insignificant mistakes were made, which the applicant corrects himself. Some of the key points are not grounded enough. For a complete answer applicant need additional questions that he is able to answer.	30
The applicant reproduces most of the theoretical material, shows knowledge and understanding of the basic principles. Some of the key points are insufficiently substantiated or not substantiated. With the help of the examiner, the applicant is able to analyze the educational material, correct mistakes, among which there is a number of significant ones.	20
The answer may be partially incorrect or incomplete (only part of the task is explained correctly). There are no some stages in explaining theoretical issues. The key points of the explanation are not substantiated.	10
There are only a few steps in the explanations. The key points of the question are not substantiated. The answer has significant mistakes.	5
The applicant doesn't answer or the answer is completely incorrect.	0

## BASIC REQUIREMENTS FOR THE APPLICANTS

The questions test the following knowledge and skills of applicants:

- to characterize the basic biological concepts, laws, regularities and theories, biological phenomena and processes, the structure of biological objects;
- use modern biological terminology and symbols; compare the processes of life at different levels of the organization (molecular, cellular, organism, population-species, ecosystem, biosphere) and identify the relationships between them;
- to establish causal, functional, structural interactions and regularities in animate nature,
- classify objects; apply biological knowledge to analyze situations that arise in various spheres of life (ground the rules of behavior in the environment, disease prevention measures, ways to provide medical home care);
- perform calculations in solving biological problems using a mathematical apparatus.

## GENERAL DESCRIPTION OF THE MAIN COMPONENTS OF THE INTERVIEW IN BIOLOGY

The entrance exam in distant format on biology includes five theoretical questions from mentioned above sections of the discipline. The answers require knowledge of biology to the extent determined by the program of secondary school.

## BIOLOGY ENTRANCE EXAM IN DISTANT FORMAT PROGRAM

<b>Section 1. Introduction. Chemical composition, structure and functioning of cells.</b>	
1.1 Chemical composition of cell	Organic and inorganic compounds and their role in the body. Water, its main properties and role in the body. Water as a solvent, hydrophobic and hydrophilic compounds. Biopolymers: the concept of their structure and conformation. Carbohydrates: monosaccharides (ribose, deoxyribose, glucose, fructose), oligosaccharides (sucrose, lactose), polysaccharides (starch, cellulose, chitin, glycogen). Basic properties and functions of carbohydrates in organisms. Lipids (fats, waxes, steroids, phospholipids). Basic properties and functions of lipids in organisms. Proteins. Amino acids as protein monomers. Levels of structural organization of proteins. Denaturation and renaturation of proteins. Basic

	biological functions of proteins. Enzymes, their properties and principles of functioning. Nucleic acids. Nucleotide structure. Structure and functions of DNA. The principle of complementarity. Nucleotide sequence and the concept of gene. Properties of DNA. RNA and its types (mRNA, rRNA, tRNA). ATP. The role of ATP in energy supply..
1.2. Structure and functioning of eukaryotic cells	The cell as an elementary unit of life. Cell membranes: chemical composition, structure, properties and basic functions. Transport of substances across cell membranes. Cytoplasm, its components: cytoskeleton, organelles and inclusions. Single-membrane organelles: endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles. Double-membrane organelles: mitochondria, plastids (chloro-, leuko - and chromoplast). Mitochondria: structure, functional role. Chloroplasts: structure, functional role of chloroplasts. Autonomy of mitochondria and chloroplasts in the cell. Non-membranous organelles. Ribosomes: structure, functional role. Centrioles. Locomotory organelles (flagella, cilia). Nucleus: structure, functional role. Chromosomes: chemical composition, structure, functional role. Haploid and diploid sets of chromosomes. Homologous chromosomes. The main states of chromosomes: interphase non-compact and overcompact in the process of cell division. Chromosome doubling due to DNA replication. Morphology of supercompact / mitotic / chromosomes. The concept of karyotype. Nucleolus, its functional role.
1.3. Cell metabolism	Metabolism, its general characteristics. The unity of the processes of synthesis and breakdown of substances in the body. Autotrophic and heterotrophic types of nutrition. Mixotrophic organisms. Breakdown of substances in the body (anaerobic, aerobic). The concept of glycolysis, fermentation. The concept of cellular respiration. Mitochondria as the energy station of the cell. Photosynthesis. The main processes occurring in light-dependent and light-independent reactions / light and dark phases /of photosynthesis. The role of chlorophyll in light-dependent reactions of photosynthesis. Importance of photosynthesis for the existence of the biosphere. The concept of chemosynthesis.
1.4. Storage and realization of hereditary information	Genes, their structure and functional role. Mosaic structure of the eukaryotic gene (exons and introns). The concept of the genome. Transcription: template synthesis of RNA molecules. The concept of transcription regulation. Protein biosynthesis (translation). Genetic code and its main properties. The role of mRNA, tRNA and ribosomes in protein biosynthesis. DNA replication: a semi-conservative principle. The concept of DNA repair. DNA replication and cell cycle. Interphase and cell division. The number of DNA molecules and chromosomes at different stages of the cell cycle. Mitosis, the main processes that occur during mitosis. Meiosis and its peculiarities in comparison with mitosis. Functional role of meiosis. The concept of DNA recombination during meiosis. Crossingover. Sexual reproduction. Gametogenesis. Fertilization. The main forms of asexual reproduction of organisms (mitosis, budding, spore reproduction, vegetative reproduction). Individual development of the organism (ontogenesis). Embryonic development. The main stages of embryonic development in chordates (cleavage, gastrulation, organogenesis). The phenomenon of embryonic induction. The concept of cell differentiation during embryonic development. Stem cells. Post-embryonic development in animals and its main types (indirect and direct).
<b>Section 2. Realization of hereditary information</b>	
2.1. Genetics - the science of heredity and variation of organisms	Classical methods of genetic research. Basic concepts of genetics. Basic regularities of gene functioning in prokaryotes and eukaryotes.
2.2. Regularities of heredity of organisms	Laws of heredity established by G. Mendel. Method of checking the genotype of hybrid individuals (test cross). Multiple alleles. Inheritance of ABO and Rh

	blood groups. A trait as a result of the manifestation of many genes. Gene allelic and non allelic genes interaction. Pleiotropy. Linked inheritance. Chromosomal theory of heredity. Genetic basis of sex determination in different groups of organisms. Chromosomal sex determination. Sex-linked inheritance. Chromosomal analysis as a method of diagnosis of hereditary disorders. Examples of chromosomal and single-gene disorders. Notion of multifactorial diseases. Modern molecular genetic methods for human heredity studying.
2.3. Regularities of variation of organisms	Modification (phenotypic) variation, its causes. Norm of reaction rate. Genetic variation and its types: recombinations and mutations. Sources of recombination. Mutations and their properties. Types of mutations (genome, chromosomal, gene; somatic and germ). Mutagenic factors (physical, chemical and biological).
<b>Section 3. Principles of ecology and evolutionary theory</b>	
3.1. Ecological factors. Population	Environmental factors and its classification. The concept of the optimal range of environmental factors. Regularities of influence of ecological factors on living organisms. Adaptation of living organisms. Ecological valence. Ecological niche as a result of adaptation. The concept of population. Structure and characteristics of populations. Population parameters. Waves of life.
3.2. Ecosystem	Components, properties and characteristics of the ecosystem. Biocenosis and biotope. Types of relationships between populations of different species in ecosystems. Symbiosis and its forms. Energy flow in ecosystems. The concept of producers, consumers and reducers. Trophic structure of the ecosystem. Ecological pyramids. Spatial heterogeneity of the biocenosis. Temporal heterogeneity of ecosystems (phenological changes, succession).
3.3. Biosphere as a global ecosystem	The structure and boundaries of the biosphere. Biogeochemical cycles / cycles of matter / as a necessary condition for the existence of the biosphere. V.I. Vernadsky's doctrine of the biosphere and noosphere. Basic ideas about impact on the biosphere. Types of pollution, results for ecosystems and humans. The concept of environmental quality. Modern global environmental problems.
3.4. Fundamentals of evolutionary theory	The concept of evolution. Evolutionary hypothesis J.-B. Lamarck. The main postulates of Darwin's theory of evolution. The combination of Darwin's theory and genetics: a synthetic theory of evolution. Population of organisms as a unit of evolution. The concept of microevolution. Factors that shift the genetic structure of the population (elementary factors of evolution): mutations, isolation, migration, gene drift, natural selection. Patterns of allele distribution in populations. Methods of speciation. The concepts of divergence, convergence and parallelism, analogous and homologous organs, rudiments (vestigial organs) and atavisms (ancestral defects), biological progress and regress.

### Questions on Biology for entrance exam

1. Organic and inorganic compounds and their role in the body. Water, its main properties and function. Water as a solvent, hydrophobic and hydrophilic compounds.
2. Proteins. Amino acids as protein monomers. Levels of structural organization of proteins. Denaturation and renaturation of proteins. Basic biological functions of proteins. Enzymes, their properties and principles of functioning.
3. Nucleic acids. Nucleotide structure. Structure and functions of DNA.
4. RNA and its types (mRNA, rRNA, tRNA). ATP. The role of ATP in energy supply.
5. The concept of prokaryotic and eukaryotic cells. Fundamental differences.

6. Cell membranes: chemical composition, structure, properties and basic functions. Transport of substances across cell membranes.
7. The structure of the eukaryotic cell. Double-membrane organelles: mitochondria, plastids. Structure, functional role.
8. The structure of the eukaryotic cell. Single-membrane organelles: endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes. Structure, functional role.
9. The structure of the eukaryotic cell. Non-membranous organelles: ribosomes, centrosome. Structure, functional role.
10. Nucleus: structure, functional role. Chromosomes: chemical composition, structure, functional role. Characteristics of the human karyotype.
11. Autotrophic and heterotrophic types of nutrition. Photosynthesis. The main processes occurring in light-dependent and light-independent reactions / light and dark phases / of photosynthesis.
12. Breakdown of substances in the body (anaerobic, aerobic). The concept of glycolysis, fermentation. Cell respiration.
13. The concept of gene, genome. Genetic code and its properties.
14. Biosynthesis of proteins: transcription, translation.
15. Cell cycle. Interphase and cell division. The number of DNA molecules and chromosomes at different stages of the cell cycle.
16. Mitosis. The main processes, biological significance.
17. Meiosis, difference from mitosis. Functional role of meiosis. Crossingover.
18. Gametogenesis. Peculiarities of oogenesis and spermatogenesis. Fertilization.
19. Sexual and asexual reproduction of organisms: fundamental differences, basic forms.
20. Individual development of the organism (ontogenesis). Embryonic development. The main stages of embryonic development in chordates (cleavage, gastrulation, organogenesis).
21. Individual development of the organism (ontogenesis). Post-embryonic development in animals and its main types (indirect and direct).
22. Subject and tasks of genetics. Basic concepts of genetics: heredity and variation, allelic genes, homozygotes, heterozygotes. Genotype, phenotype.
23. Monohybrid cross. Law of dominance (first law of Mendel). Mendelian traits.
24. Monohybrid cross. Law of dominance (first law of Mendel). (second law of Mendel). Mendelian traits.
24. Di- and polyhybrid crossing. Law of independent assortment (third law of Mendel).
25. Multiple alleles. Inheritance of AB0 and Rhesus factor human blood groups.
26. Interaction of allelic genes: complete dominance, incomplete dominance, overdominance, codominance.
27. Interaction of non-allelic genes: complementary action, epistasis, polymery.
28. Linked inheritance (Morgan's law). Crossingover.
29. Chromosomal theory of heredity.
30. Genetics of sex. Chromosomal diseases caused by changes in the number of sex chromosomes.
31. Sex-linked inheritance.
32. Variation, its forms, significance in ontogenesis and evolution.
33. Modifications (phenotypic variation), its characteristics. Norm of reaction. Phenocopy.

34. Genetic variation, its forms.
35. Recombinations. Mechanisms and significance.
36. Mutations. Classification by the level of changes in hereditary information (numerical and structural chromosomal aberrations, gene mutations).
37. Gene mutations, mechanisms. The concept of single gene diseases.
38. Structural chromosomal aberrations. Mechanisms, examples of diseases.
39. Numerical chromosomal aberrations (polyploidy, aneuploidy). Examples of diseases.
40. Mutations in germ and somatic cells, their significance. Mosaicism.
41. Spontaneous and induced mutations. Mutagenic factors, their types.
42. Man as a specific object of genetic analysis. Genealogical method of studying human heredity.
43. Environmental factors and their classification. The concept of tolerance zone. Ecological valence.
44. Ecosystem: components, properties and characteristics of the ecosystem. Biocenosis and biotope. Energy flow in ecosystems. Ecological pyramids.
45. Biotic environmental factors. Symbiosis and its forms.
46. The structure and boundaries of the biosphere. Biogeochemical cycles / cycles of matter / as a necessary condition for the existence of the biosphere.
47. The concept of population. Structure and characteristics of populations. Hardy-Weinberg's equilibrium.
48. The concept of evolution. The main postulates of Darwin's theory of evolution.
49. Synthetic theory of evolution as combination of Darwin's theory and genetics. Elementary evolutionary factors: mutations, isolation, migration, gene drift, natural selection.
50. The concept of macroevolution. Divergence, convergence and parallelism. Biological progress and regress. The results of evolution.

### **LIST OF RECOMMENDED LITERATURE**

1. Biology : textbook / R. J. Brooker; E. P. Widmaier; L. E. Graham; P. D. Stiling. 4th ed. – NY: McGraw-Hill Education – 2021. - P.1438
2. Biology : textbook for Class XI / A. K. Rajput; S. Uppal; A. Chitkara [et al]. – 1st ed., reprinted. – New Delhi: National Council of Educational Research and Training – 2021. - P.356
3. Biology : textbook for Class XII / M. S. Anwar; S. Uppal; A. Chitkara [et al]. – 1st ed., reprinted. – New Delhi: National Council of Educational Research and Training – 2019. – P.296
4. Campbell biology / Lisa Urry, Michael Cain, Steven Wasserman, Peter Minorsky, Jane Reece. – 11th restricted ed. – Hoboken : Pearson Higher Education, 2016.
5. Biological Science 1 & 2: Third Edition /Taylor D. J., Green N. P. O., Stout G. W. , Soper, R. [Ed.] – Cambridge: Cambridge University Press - 2008. – P. 984



6. Essential Cell Biology : textbook / B.M. Alberts, D. Bray, K. Hopkin [et al]. – 4th ed., rev. and upd. – NY : Garland Publishing, Inc., 2019. – 862 p.

The Executive Secretary

of the admission board of ONMedU –

A handwritten signature in blue ink, appearing to be 'H. Stepanov', written in a cursive style.

Henadii STEPANOV