

PROGRAMME
ENTRANCE EXAMINATIONS FOR MASTER'S DEGREE
PROGRAM "BIOLOGY"

1. General Biology

Algology and mycology. The group "lower plants". General features of structure. Thallus. Algae: general characteristics, structure of cell and thallus. Fungi and pseudofungi. Lichens. Slime molds.

Higher plants. Life cycle of higher plants. General principles of body organization of higher plants. Concept of tissue. Mosses and vascular plants. Division Spermatophyta (seed plants). Gymnosperms. Covered seeded plants. Ecological groups of plants in relation to water, light substrate.

Zoology of invertebrates. Systematics of Eukaryota. Main groups of protozoa. Role of archaea and eubacteria in the origin of eukaryotes. Lower multicellular organisms. Sponges. Cnidarians. Sponges. Corals. The three-layer Bilateria. The integument and its functions. Symmetrical and segmental body structure. Ringed worms. Molluscs. Cephalopods. Flatworms. Life cycles and medical significance of parasitic worms. Supratype Moulting. Structure and functions of the hemocoelium. Arthropods. Chilopoda. Spiders. Crustaceans. Sixlegs (Hexapoda). Type roundworms. Nematodes. Supra-terrestrials. Echinoderms.

Vertebrate zoology. Chordate type system. Lanceolates. Obolonia. Salps and appendiculariae. Armored mandibles. Roundworms: hagfish and lampreys. Jawbreakers. Cartilaginous fishes. Bony fishes. Amphibians. Pulmonary and gill respiration. Circulatory systems. Anamniotes and amniotes. Reptiles. Birds. Thermoregulation. Mammals. Features of reproduction. Basics of anthropology.

References:

1. Belyakova G.A., Diakov U.T., Tarasov K.L. Algae and fungi: textbook for students of higher education / Botany: in 4 vols. M.: Publishing Center "Academy", 2006. T. 1. 320 p.

2. Lotova L.I. Botany. Morphology and anatomy of higher plants. Textbook. Ed. 3rd revised edition. M.: ComKniga, 2007. 512 p.

Timonin A.K. Higher plants: textbook for students of higher educational institutions.

/ M.: Publishing Center "Academia", 2007. T. 3. 352 p.

Systematics of higher plants: a textbook for students of higher educational institutions in 2 volumes / ed. Timonin A.K., Filin V.R. Botany: in 4 volumes of Moscow: Academia Publishing Center, 2009. T. 4. 1. 320 p.

5. Timonin A.K., Sokolov D.D., Shipunov A.B. Systematics of higher plants: textbook for students of higher educational institutions in 2 vols / ed. by A.K. Timonin Botany: in 4 vols. T. 4. In: 3 vol. 2. 352 p.

6. Zoology of invertebrates In two volumes / Ed. by V. Westheide and R. Rieger. Translation from German, ed. by A.V. Chesunov. Moscow: The Association of Scientific Editions KMK, 2008.

7. Edward E. Rupert, Richard S. Fox, Robert D. Barnes. Zoology of invertebrates (in 4 vols.) Moscow: Academia Publishing Center, 2008.

8. Levushkin S.I., Shilov I.A. General Zoology. Moscow: Higher School, 2004.

9. Dzerzhinsky F.Y., Vasiliev B.D., Malakhov V.V. Zoology of vertebrates. Moscow: Academy, 2012.
10. Kartashev N.N., Sokolov V.E., Shilov I.A. Practicum on zoology of vertebrates. Ed. 3. In the series "Classical university textbook". Moscow: Aspect Press, 2005.
11. V.A. Bakholdina, M.A. Negasheva. Evolution and morphology of man. Moscow: Moscow State University Press, 2014.

2. Theory of Evolution and Fundamentals of Ecology

History of evolutionary biology. Creationism, Transformationism, and Evolutionism. Darwinism. Synthetic theory of evolution. Factors of evolution. Genetic variability. Mutational variability. Mobile elements of genome. Sexual reproduction. Recombination. Horizontal transfer of genes. Phenotypic variability. Norm response. Genetic background, epistasis. Environmental factors. Concept of epigenetic landscape. Genetic assimilation.

Struggle for existence and natural selection. Population as an elementary unit of microevolution. The complex of ecological interactions that make up the concept of the "struggle for existence". Forces of natural selection. Directing selection. Stabilizing selection. Purifying selection. Disruptive selection. Balancing selection. Sexual selection. Group selection, kin selection.

Genetic processes in populations. Systems of interbreeding, their impact on gene pool. Genetic drift. Neutral evolution and "molecular clock". Founder and bottle-neck effects. Detection of population genetic processes by nucleotide sequence analysis.

Speciation. Evolution and systematics. Allopatric and sympatric speciation. Phylogeny of taxa. Coevolution and symbiogenesis. Forms of interspecific interactions. Presumed scenarios of life origin. Abiogenesis. Experimental evolution. Examples of experimental confirmation of evolutionary processes.

Subject matter and methods of ecology. Ecological factors. Conditions and resources. Range of measurement of basic chemical and physical parameters in wildlife. The ecological niche models. Population ecology. Statistical characteristics of a population. Spatial and dynamic characteristics of a population. Distribution of mortality by age. Types of survival curves. Types of ecological and cenotic strategies. Population interactions. Trophic relationships and energy flows.

Biogeochemical cycles. Evolution of the biosphere. Anthropogenic impact on biosphere.

References:

1. Severtsov A.S. Theory of Evolution. Moscow: Vldos, 2005.
2. Markov A., Naimark E. Evolution: classical ideas in the light of new discoveries. Moscow: AST, 2014.
3. Nikolaykin N.I., Nikolaykina N.E., Melekhova O.P. Ecology. 7th ed. Moscow: Drofa, 2009. 624 p.
4. Mirkin B.M., Naumova L.G. Short course of general ecology. Part 1: Ecology of Species and Populations. Ufa: Publishing house of BGPU, 2011. 206 c. Part 2: Ecology of ecosystems and biosphere. Ufa: Publishing house of

3. Cell Biology, Histology and General Embryology.

Cell theory and its postulates. Totipotency. Functional systems of cell. Methods of cell biology. Cell culture. Structural and functional characteristics of nucleus. Chromatin. Histones. Karyotype. Chromosomes. Membrane components of cell. Lipids. Membrane proteins. Plasma membrane. Endo- and transcytosis. Cell interactions. Cell adhesion. Structure of ribosomes. Polysomes. Granular EPR. Golgi apparatus. Transport pathways of vacuolar system. Exocytosis. Smooth endoplasmic reticulum. Lysosome. Autophagy. Mitochondria. Chloroplasts. Photosynthesis and respiration. The role of ATP. Components of cytoskeleton. Actin filaments. Myosins. Microtubules. Tubulin. MAP proteins. Kinesins and dyneins. Centriolar cycle. Cilia and flagella.

Mitosis. Phases of mitosis. Mitotic spindle. Kinetochore. Anaphase A and B. Telophase. Cytokinesis. Meiosis. Principles of germ cell formation and maturation. Phases of meiosis. Crossingover. First and second meiotic divisions. Methods for study of cell cycle. Exogenous and endogenous regulation. Cell death. Apoptosis. Autophagic cell death. Necrosis.

Peculiarities of structure and functioning of vegetable and bacterial cells. Cell wall. Plastids. Photosynthetic structures.

General histology. Definitions of the concept of "tissue". Methods of histological study. Factors of differentiation. Origin of tissue. Epithelial tissue. Tissues of the internal environment (blood, lymph, connective tissue). Blood cells. Hemopoiesis. Cellular basis of protective reactions. Innate and adaptive immunity. Inflammation. Fiber connective tissue. Intercellular matrix. Muscle tissue. Smooth and transverse striated muscle tissue. Nerve tissue.

Embryology. Formation of primary germ cells in various groups of animals. Distant and contact interactions of gametes. General characteristics of the process of fragmentation. Moments of inclusion of maternal and Paternal genes. Sachs-Gertwig rules. Spiral fragmentation. Blastulation. Gastrulation. Methods of laying the mesoderm. Parthenogenesis. Gynogenesis. Androgenesis. Formation of extra germ organs and membranes in amniotes. Features of the early development of mammals. Characteristics of stages from fertilization to implantation. Formation of vertebrate organs. Morphogenetic interactions between parts of the embryo. Classification of placentas in mammals.

References:

1. Chentsov Y.S. Cytology with elements of cellular pathology. Textbook. Moscow: Medical Information Agency, 2010.
2. Alberts B. et al. Molecular biology of the cell. M.-Izhevsk: SIC. "Regular and Chaotic Dynamics", Institute for Computer Research, 2012. 2000 p.
3. Bykov V.L. Cytology and general histology. Saint Petersburg: SOTIS, 2003.
4. Bykov V.L. Private histology of man. SPb: SOTIS, 2002.
5. Belousov L.V. Fundamentals of General Embryology. Moscow: Moscow State University Press, 2005.
6. Gilbert Scott F. Developmental Biology. 7th ed. St. Petersburg: Polytechnica,

4. Human and Animal Physiology

Structure and properties of the membrane of excitable cells. Resting potential. Action potential. Ionic mechanisms. Controlled ion channels. Transverse striated muscles. Contractile proteins. Neuron as a structural and functional unit of the nervous system. Axon transport. Synapses. Basic types of mediators and their interaction with receptors. Reflex and reflex arc. Excitatory and inhibitory connections between neurons. Learning and memory. Sensory systems. Ways of flow of afferent information into the brain.

The somatic system. The spinal cord. Motor neurons. Motor reflexes. Autonomic nervous system, its role in homeostasis regulation. Organization and relations between sympathetic and parasympathetic sections. Mediators of autonomic nervous system.

Endocrine system. Mechanisms of targeting. Chemical nature of the main groups of hormones and their interaction with receptors. The main glands of internal secretion. Functional role of various hormones. Connection of nervous and humoral mechanisms of regulation.

Non-specific and specific defense mechanisms. Blood coagulation. Phagocytosis. Immune system. Humoral and cellular immunity. Blood types.

Functions of the circulatory system. Features of blood circulation in various classes of vertebrates. Structure of warm-blooded heart. Cardiac cycle. Conductive system of the heart. Electrocardiogram. Regulation of cardiac activity.

Structure of the lungs. Mechanism of pulmonary respiration. The respiratory center and regulation of breathing. Functions of erythrocytes and hemoglobin in gas exchange.

General structure of the digestive tract. Features of digestion in various departments. Nervous and humoral mechanisms of regulation. Mechanisms of absorption. The role of the liver.

The excretory system. Structure of the nephron. Renal circulation. Reabsorption and secretion. The counterflow-return system. Osmotic pressure of blood plasma.

Physiology of higher nervous activity. I. P. Pavlov's reflex theory of behavior. Instrumental learning. The concept of behaviorism. Ethology. Instincts. Imprinting. Cognitive aspects of learning. Biological motivations. Needs. Emotions. Physiological mechanisms of memory. Forms of memory. Memory disorders. Sleep and wakefulness. Electroencephalogram. Localization of functions in the brain. Speech function. Visual function. Analyzers. Second signal system. Communicative abilities of animals. Stages of speech formation in a child. Formation of abstract-logical type of thinking in humans.

References:

1. Kamkin A.G., Kamensky A.A. Fundamental and clinical physiology. edited by Kamkin A.G., Kamensky A.A. - M.: Academia, 2004. 1073 p.
2. Guyton A.G., Hall J.E. Medical physiology. - Moscow: Logosphere, 2008. -

1273 p.

Shulgovsky V.V. Physiology of higher nervous activity. - Moscow: Academy, 2014. 384 p.

5. Genetics

Aims, principles and methods of genetic analysis. Heritable traits: qualitative, quantitative, elementary, complex. Monohybrid and polyhybrid crossing. Alleles and types of their interaction. Statistical nature of cleavage. Mendelian laws of inheritance. Complementarity, epistasis, polymery of genes.

Definition of sex. Inheritance of sex-linked traits. Clutch groups. Crossingover. Coincidence. The role of T. Morgan in the chromosomal theory of heredity. Nonchromosomal inheritance. Maternal effect. Plastid and mitochondrial inheritance. Viruses and non-nuclear inheritance. Plasmid inheritance.

Interaction of genotype and environment. Modification variability. Normality of response. Penetrance and expressivity. Combinative variability, its role in evolution. Euploidy, polyploidy, aneuploidy. Auto- and allopoliploids. Interspecific hybridization. Chromosomal rearrangements. Gene mutations. Spontaneous and induced mutagenesis. Repair. Mobile genetic elements. Genetic recombination.

Tasks and methodology of genetic engineering. Key enzymes of genetic engineering. Gene isolation and synthesis. Vectors. Recombinant DNA molecules. Cloning. Expression of foreign genes. Transgenic organisms. Genetic engineering of plants and animals.

References:

1. Inge-Vechtomov S.G. Genetics with the basics of breeding. SPb: N.-L., 2015. 720 p.
2. Zhimulev I.F. General and molecular genetics. Novosibirsk: Siberian University Publishing House, 2007. 420 p.

6. Molecular Biology and Biochemistry

Structures and physicochemical properties of monomeric natural compounds: amino acids, carbohydrates, lipophilic compounds. pH and buffer solutions. Nitrogenous bases. Vitamins and coenzymes. Structure and properties of biopolymers. Proteins. Peptide bonds. Levels of structural organization of proteins. Intra- and intermolecular interactions. Posttranslational modifications of proteins. Nucleic acids. Chemical structure of DNA and RNA. Gene, genome and transcriptome. DNA amplification and sequencing. Biological membranes. Micelles and liposomes. Membrane channels. pores, transporters.

Enzymatic catalysis. Reaction equilibrium constant, energy barrier. Inhibitors and activators of enzymatic reactions. Isoenzymes. International classification of enzymes. Basics of bioenergetics. Compounds with high group transfer potential. ATP. Structure of mitochondria and localization of mammalian respiratory chain components. Regulation of phosphoryl potential.

Photosynthesis. Structure of chloroplasts and proteins involved.

Carbohydrate metabolism. Glycolysis and glycogenolysis. Krebs cycle. Chemical structures of substances involved, characteristics of enzymes, reaction stoichiometry. The reversibility of glycolysis and glyconeogenesis. Glycogen synthesis. Lipid metabolism. Role of carnitine in transport of fatty acids. Oxidative decomposition of fatty acids. Synthesis of fatty acids. Metabolism of amino acids and other nitrogenous compounds. Irreplaceable amino acids. Transamination. Decarboxylation. Keto acids. Urea synthesis. Metabolic regulation. Catabolic and anabolic chains. Hormone receptors and G-proteins. Insulin, adrenaline glucagon (metabolic action). Secondary mediators of signal transduction and cell signaling circuits.

Evidence for genetic function of DNA. DNA structure, principles of complementarity and antiparallelism. DNA synthesis direction. Superspiralization. Topoisomerases. DNA replication. Accuracy of DNA replication. Enzymes of replicative complex and bacterial DNA polymerases. Replication fork. Peculiarities of DNA replication.

Eukaryotes. DNA repair. Types of damage. Direct repair. Excisional repair.

Transcription in prokaryotes. Features of RNA polymerase, sigma factors. Concept of operon. Negative and positive regulation of transcription. DNA recognition by proteins in prokaryotes. Lactose operon of *E. Coli*. *ATS* protein. Attenuation of transcription. Transcription in eukaryotes. Basal transcription, transcription factors. Enhancers and silencers. TATA-box. Protein domains that recognize DNA sequences. Leucine zippers and zinc fingers. Homeodomain and selector genes. Extracellular signals activating gene transcription and their transmission. DNA methylation, role in gene regulation. Reverse transcription.

General principles of rRNA structure. RNA processing. Introns, splicing. Editing of RNA. Small RNA. Genetic code. Transport RNA. Aminoacylation of tRNA. Ribosomes in prokaryotes and eukaryotes. Ribosomal RNA, its importance. Working cycle of ribosome. Elongation and its factors. Transpeptidation. Translocation. Role of GTP hydrolysis. Regulation. Action of toxins. Initiation of translation in prokaryotes. Start and stop codons. Protein factors. Regulation of translation in eukaryotes. Peculiarities of eukaryotic mRNA. General mechanisms of translation regulation in eukaryotes.

References:

1. D. Nelson, M. Cox. Fundamentals of Leninger biochemistry. In three volumes. M.:Binom. Laboratory of Knowledge, 2012.
2. I. Strayer. Yuiiochemistry. In three volumes. M.:Mir, 1987.
3. Spirin A.S. Molecular biology. Ribosomes and protein biosynthesis. Moscow: Academia, 2011. 513 p.
4. Razin S.V., Bystritsky A.A. Chromatin: a packed genome. Moscow: Finom, 2012. 176 p.

7. Microbiology and Virology

Systematics of microorganisms. The main groups and methods of classification of prokaryotes. Principles and methods of identification of microorganisms. Structure and development of microorganisms. Morphology of cell walls. Peculiarities of the structure of archaea. Methods of movement of microorganisms. Cabs. Methods of reproduction in prokaryotes. Role of plasmids. Life cycles of microorganisms. Spores and cysts.

Genetics of prokaryotes. Recombination processes. Conjugation, transformation and transduction. Hereditary and nonheritable variability. Mutagenesis. Bacteriophages. Genetically modified bacteria. Producer bacteria in biotechnology.

Culturing of microorganisms. Pure culture. Unculturable microorganisms. Antimicrobials and antibiotics. General principles of culture work: types of media, concept of sterility of work, contamination, general principles of biosafety. Classification of pathogenicity of microorganisms.

Metabolism of bacteria. Types of nutrition. Aerobes and anaerobes. Auto- and heterotrophs. Chemotrophs. Ways of transporting nutrients into cell. Ways of ATP synthesis in prokaryotes. Microbial bioluminescence. Methylophiles. Photosynthesis and chlorophyll-free photosynthesis in bacteria. Extremophiles. Growth strategies. Symbiosis in bacteria and eukaryotes.

Classification of viruses by structure of genetic material. DNA- and RNA-containing viruses. RNA genomes with positive and negative polarity. Forms of the viral genome. Segmented and separated genomes. General principles of virion organization. Types of symmetry. Structural and non-structural proteins. Capsid, capsomer and nucleocapsid. Lipid membrane and surface proteins and their role. Glycoproteins.

Interaction of viruses with cell. Stages of infection. Ways of penetration of viral genomes into bacteria, plant and animal cells. Localization of synthesis of viral components in cells. Packaging of nucleic acids into virion. Types of viral infections: lytic, lysogenic, transforming. Viral replication. Types and characteristics of viral polymerases. Scheme of retrovirus replication using HIV as an example. Role of reverse transcription.

Basic characteristics and structure of some viruses and bacteriophages: influenza virus type A, hepatitis A virus, hepatitis C virus, hepatitis B virus, HIV, bacteriophage T4, bacteriophage T7, bacteriophage lambda.

References:

1. Netrusov A.I., Kotovs I.B. Microbiology. University Course. 4th edition revised and enlarged. Textbook for Universities. Moscow: Academy of Sciences, 2012.
- Ecology of Microorganisms. Textbook for Bachelors. 2nd ed. edited by A.I. Netrusov M.: Yurite, 2013.
3. Kartova O.V., Gradova N.B. Fundamentals of Virology for Biotechnologists. Moscow: DeLee Plus, 2012.
4. Pinevich AV, Sirotkin AK, Gavrilova OV, Potekhin AA Virology. St. Petersburg: St. Petersburg University Press, 2013.