

PROGRAMME OF ENTRANCE EXAM FOR THE MASTER'S DEGREE IN "BIOLOGY"

Topic 1. General Biology

Algology and mycology. The "lower plants" group. General features of the structure. Tallom. Algae: general characteristics, cell structure and thallus. Mushrooms and pseudogungi. Lichens. Slime molds.

Higher plants. The life cycle of higher plants. General principles of body organization of higher plants. The concept of fabric. Mossy and vascular plants. Department of Spermatophyta (seed plants). Gymnosperms. Angiosperms. Ecological groups of plants in relation to water, light, and substrate.

Zoology of invertebrates. Taxonomy of Eukaryota. The main groups of protozoa. The role of archaea and eubacteria in the origin of eukaryotes. The lower multicellular. Sponges. Armored cars. Shooting. Corals. Three-layer Bilateria. The whole and its functions. Symmetrical and segmental body structure. Annelids. Shellfish. Cephalopods. Flatworms. Life cycles and medical significance of parasitic worms. The supertype is Shedding. The structure and functions of the hemocoel. Arthropods. Chelicerata. Arachnids. Crustaceans. Six-legged (Hexapoda). Type of roundworms. Nematodes. The supertype of secondary larvae. Echinoderms.

Zoology of vertebrates. A chordal type system. The lancelet. Shell makers. Salpae and appendicularia. The carapace is jawless. Round-mouthed: mixins and lampreys. The maxillofacial ones. Cartilaginous fish. Bony fish. Amphibians. Pulmonary and gill respiration. Circulatory system. Anamnias and amniotes. The reptiles. Birds. Thermoregulation. Mammals. Features of reproduction. Fundamentals of anthropology.

References:

1. Belyakova G.A., Dyakov Yu.T., Tarasov K.L. Algae and fungi: a textbook for students. higher. studies. Botany: in 4 volumes. Moscow: Publishing center "Academy", 2006. Vol. 1. 320 p.

2. Lotova L.I. Botany. Morphology and anatomy of higher plants. Textbook. 3rd edition, ispr. Moscow: KomKniga, 2007. 512 p.

3. Timonin A.K. Higher plants: a textbook for students. higher. studies. Botany: in 4 volumes. Moscow: Publishing center "Academy", 2007. Vol. 3. 352 p.

4. Timonin A.K., Filin V.R. Systematics of higher plants: a textbook for students. higher. studies. establishments in 2 books. / edited by A.K. Timonin Botany: in 4 volumes. Moscow: Publishing Center "Academy", 2009. Vol. 4. Book 1. 320 p.

5. Timonin A.K., Sokolov D.D., Shipunov A.B. Systematics of higher plants: a textbook for students. higher. studies. establishments in 2 books. / edited by A.K. Timonin Botany: in 4 volumes. Moscow: Publishing Center "Academy", 2009. Vol . 4. Book 2. 352 p .

6. Zoology of invertebrates In two volumes / Edited by V. Westheide and R. Rieger. Translated from German under the editorship of A.V. Ches

7. Edward E. Rupert, Richard S. Fox, Robert D. Barnes. Zoology of invertebrates (in 4 volumes) M.: Publishing Center "Academy", 2008.

8. Levushkin S.I., Shilov I.A. General zoology. M.: Higher School, 2004.

9. Dzerzhinsky F.Ya., Vasiliev B.D., Malakhov V.V. Zoology of vertebrates. M.: Academy, 2012.

10. Kartashev N.N., Sokolov V.E., Shilov I.A. Practicum on vertebrate zoology. 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: Publishing House of Moscow. University, 2014.

Topic 2. Theory of evolution and fundamentals of ecology

The history of evolutionary biology. Creationism, transformism, and Evolutionism. Darwinism. The synthetic theory of evolution. Factors of evolution. Genetic variability. Mutational variability. Mobile elements of the genome. Sexual reproduction. Recombination. Horizontal gene transfer. Phenotypic variability. The reaction rate. Genetic background, epistasis. Environmental factors. The concept of the epigenetic landscape. Genetic assimilation.

The struggle for existence and natural selection. The population as an elementary unit of microevolution. The complex of ecological interactions that make up the concept of "struggle for existence". Odds of natural selection. Driving selection. Stabilizing selection. Purifying selection. Disruptive selection. Balancing lights out. Sexual selection. Group selection, related selection.

Genetic processes in populations. Crossbreeding systems and their effect on the gene pool. Genetic drift. Neutral evolution and the "molecular clock". Founder and bottleneck effects. Detection of population genetic processes by analyzing nucleotide sequences.

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

The subject and methods of ecology. Environmental factors.

Conditions and resources. The range of measurement of basic chemical and physical parameters in wildlife. A model of an ecological niche. Population ecology. Statistical characteristics of the population. Spatial and dynamic characteristics of the population. The distribution of mortality by age. Types of survival curves. Types of ecological and cenotic strategies. Interaction of populations. Trophic relations and energy flows. Biogeochemical cycles. Evolution of the biosphere. Anthropogenic impact on the biosphere.

References:

1. Severtsov A.S. Theory of evolution. Moscow: Vladivostok, 2005.
2. A. Markov., Naimark E. Evolution: classical ideas in the light of new discoveries. Moscow: AST, 2014.
3. Nikolkin N.I., Nikolkina N.E., Melekhova O.P. Ecology. 7th ed. Moscow: Bustard, 2009. 624 p.
4. Mirkin B.M., Naumova L.G. A short course in general ecology. Part 1: Ecology of species and populations. Ufa: Publishing House of BSPU, 2011. 206 p. Part 2: ecology of ecosystems and biosphere. Ufa: Publishing House of BSPU, 2011. 180 P.

Topic 3. Cell biology, histology and general embryology.

Cellular theory and its postulates. Totipotency. Functional systems of the cell. Methods of cell biology. Cell culture. Structural and functional characteristics of the core. Chromatin. Histones. Karyotype. Chromosomes. Membrane components of the cell. Lipids. Membrane proteins. The plasma membrane. Endo- and transcytosis. Cellular interactions. Cellular adhesion. The structure of ribosomes. Polysomes. Granular EPR. The Golgi apparatus. Transport routes of the vacuolar system. Exocytosis. Smooth endoplasmic reticulum. The lysosome. Autophagy. Mitochondria. Chloroplasts. Photosynthesis and respiration. The role of ATP. Components of the cytoskeleton. Actin filaments. Myosins. Microtubules. Tubulin. MAR-squirrels. Kinesins and dyneins. The centriolar cycle. Cilia and flagella.

Mitosis. Phases of mitosis. The mitotic spindle. Kinetochore. Anaphase A and B. Telophase. Cytokinesis. Meiosis. Principles of germ cell formation and maturation. Phases of meiosis. Crossingover. The first and second meiotic divisions. Methods of studying the cell cycle. Exogenous and endogenous regulation. Cell death. Apoptosis. Autophagic cell death. Necrosis.

Features of the structure and functioning of plant and bacterial cells. The cell wall. Plastids. Photosynthetic structures.

General histology. Definitions of the concept of "fabric". Methods of histological research. Differentiation factors. Origin of the tissues. Epithelial tissue. Tissues of the internal environment (blood, lymph, connective tissue). Blood cells. Hematopoiesis. Cellular bases of defense reactions. Innate and adaptive immunity. Inflammation. Fibrous connective tissue. The intercellular matrix. Muscle tissue. Smooth and striated muscle tissue. Nervous tissue.

Embryology. Formation of primary germ cells in different groups of animals. Distant and contact interactions of gametes. General characteristics of the crushing process. The moments of inclusion of maternal and paternal genes. The Sachs-Hertwig Rules. Spiral crushing. Blastulation. Gastrulation. Methods of laying the mesoderm. Parthenogenesis. Gynogenesis. Androgenesis. Formation of extra-embryonic organs and membranes in amniotes. Features of early mammalian development. Characteristics of the stages from fertilization to implantation. Formation of vertebrate organs. Morphogenetic interactions between parts of the embryo. Classification of placentas in mammals.

References:

- 1.Chentsov Yu.S. Cytology with elements of cellular pathology. Textbook. Moscow: Medical Information Agency, 2010.
- 2.Alberts B. et al. Molecular Biology of the cell. Moscow-Izhevsk: Scientific Research Center "Regular and Chaotic dynamics", Institute of Computer Research, 2012. 2000 p.
3. Bykov V.L. Cytology and general histology. St. Petersburg: SOTIS, 2003.
4. Bykov V.L. Private human histology. St. Petersburg: SOTIS, 2002.
5. Belousov L.V. Fundamentals of general embryology. Moscow: Publishing House of Moscow State University, 2005.
6. Gilbert Scott F. Developmental biology. 7th ed. St. Petersburg: Polytechnic, 2010.

Topic 4. Human and animal physiology

Structure and properties of the membrane of excitable cells. The potential of rest. The potential for action. Ionic mechanisms. Controlled ion channels. Striated muscles. Contractile proteins. A neuron is a structural and functional unit of the nervous system. Axonal transport. Synapses. The main 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 afferent information entering the brain.

The somatic system. The spinal cord. Motor neurons. Motor reflexes. The autonomic nervous system, its role in the regulation of homeostasis. The organization and relationship of the sympathetic and parasympathetic divisions. Mediators of the autonomic nervous system.

The endocrine system. Mechanisms of impact orientation. The chemical nature of the main groups of hormones and their interaction with receptors. The main endocrine glands. The functional role of various hormones. The relationship between nervous and humoral regulation mechanisms.

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

Functions of the circulatory system. Features of blood circulation in different classes of vertebrates. The structure of the warm-blooded heart. The cardiac cycle. The conduction system of the heart. Electrocardiogram. Regulation of cardiac activity.

The structure of the lungs. The mechanism of pulmonary respiration. The respiratory center and respiratory regulation. The functions of erythrocytes and hemoglobin in gas exchange.

The general structure of the digestive tract. Peculiarities of digestion in various departments. Nervous and humoral mechanisms of regulation. Mechanisms of suction. The role of the liver.

The excretory system. The structure of the nephron. Renal blood circulation. Reabsorption and secretion. Countercurrent rotary system. Osmotic pressure of blood plasma.

Physiology of higher nervous activity. I.P. Pavlov's reflex theory of behavior. Instrumental training. 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. The second alarm system. Communication skills of animals. Stages of speech formation in a child. Formation of abstract-logical type of thinking in humans.

References:

1. Fundamental and clinical physiology. / Ed . Kamkina A.G., Kamensky A.A. – M.: Akademiya, 2004. 1073 p.
2. Gaiton A.G., Hall J. E. Medical physiology. Moscow: Logosphere, 2008. 1273 p.
3. Shulgovsky V.V. Physiology of higher nervous activity. Moscow: Akademiya Publ., 2014. 384 P.

Topic 5. Genetics.

Objectives, principles and methods of genetic analysis. Hereditary traits: qualitative, quantitative, elementary, complex. Monohybrid and polyhybrid hybridization. Alleles and types of their interaction. The statistical nature of the split. Mendelian patterns of inheritance. Complementarity, epistasis, polymerization of genes.

Sex determination. Inheritance of gender-related traits. Coupling groups. Crossingover. Coincidence. The role of T. Morgan in the chromosomal theory of heredity. Non-chromosomal inheritance. Maternal effect. Plastid and mitochondrial heredity.

The interaction of the genotype and the environment. Modification variability. The reaction rate. Penetrance and expressiveness. Combinative variability, its role in evolution. Euploidy, polyploidy, aneuploidy. Auto- and allopolyploids. Interspecific hybridization. Chromosomal rearrangements. Gene mutations. Spontaneous and induced mutagenesis. The reparation. Mobile genetic elements. Genetic recombination.

Tasks and methodology of genetic engineering. Key enzymes of genetic engineering. Isolation and synthesis of genes. 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. St. Petersburg: N.-L., 2015. 720 p.
2. Zhimulev I.F. General and molecular genetics. Novosibirsk: Siberian University Publishing House, 2007. 420 p.

Topic 6. Molecular Biology and Biochemistry

Structures and physico-chemical properties of monomeric natural compounds: amino acids, carbohydrates, lipophilic compounds. pH and buffer solutions. Nitrogenous bases. Vitamins and coenzymes. Structure and properties of biopolymers. Squirrels. The peptide bond. Levels of structural organization of proteins. Intra- and intermolecular interactions. Posttranslational modifications of proteins. Nucleic acids. The chemical structure of DNA and RNA. The gene, the genome, and the transcriptome. DNA amplification and sequencing. Biological membranes. Micelles and liposomes. Membrane channels. pores, carriers.

Enzymatic catalysis. Reaction equilibrium constant, energy barrier. Inhibitors and activators of enzymatic reactions. Isoenzymes. International classification of enzymes. Fundamentals of bioenergetics. Compounds with high group transfer potential. ATP. The structure of mitochondria and localization of components of the mammalian respiratory chain. Regulation of phosphory potential. Photosynthesis.

The structure of chloroplasts and the involved proteins.

Carbohydrate metabolism. Glycolysis and glycogenolysis. The Krebs cycle. Chemical structures of the substances involved, characteristics of enzymes, reaction stoichiometry. Reversibility of glycolysis and glycogenesis. Glycogen synthesis. Lipid metabolism. The role of carnitine in the transport of fatty acids. Oxidative degradation of fatty acids. Synthesis of fatty acids. The exchange of amino acids and other nitrogenous compounds. Essential amino acids. Transamination. Decarboxylation. Ketoacids. Synthesis of urea. Regulation of metabolism. Catabolic and anabolic chains. Hormone receptors and G-proteins. Insulin, adrenaline, glucagon (metabolic action). Secondary intermediaries of signal transmission and signaling circuits of the cell.

Evidence of the genetic function of DNA. The structure of DNA, the principles of complementarity and antiparallel. The direction of DNA synthesis. Overcoiling. Topoisomerases. DNA replication. DNA reproduction accuracy. Enzymes of the bacterial replication complex and DNA polymerase. Replication fork. Features of eukaryotic DNA replication. DNA repair. Types of damage. Direct reparation. Excision repair

Transcription in prokaryotes. Features of RNA polymerase, sigma factors. The concept of an operon. Negative and positive regulation of transcription. Recognition of DNA by proteins in prokaryotes. The lactose operon of E. Coli. SAR is a 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 that activate gene transcription and transmission. DNA methylation, a role in gene regulation. Reverse transcription.

General principles of the mRNA device. RNA processing. Introns, splicing. RNA editing. Small RNAs. The genetic code. Transport RNA. Aminoacylation of tRNA. Ribosomes in prokaryotes and eukaryotes. Ribosomal RNA, its significance. The working cycle of the ribosome. Elongation and its factors. Transpeptidation. Translocation. The role of GTP hydrolysis. Regulation. The effect of toxins. Initiation of translation in prokaryotes. Start and stop codons. Protein factors. Regulation of translation in eukaryotes. Features of eukaryotic mRNA. General mechanisms of translation regulation in eukaryotes.

References:

1. D. Nelson, M. Cox. Fundamentals of biochemistry of Leningrad. In three volumes. Moscow: Binom. Laboratory of Knowledge, 2012.
2. L. Strayer. Microbiochemistry. In three volumes. Moscow: Mir, 1987.
3. Spirin A.S. Molecular Biology. Ribosomes and protein biosynthesis. Moscow: Akademiya, 2011. 513 p.
4. Razin S.V., Bystritsky A.A. Chromatin: a packaged genome. Moscow: Binom, 2012. 176 p.

Topic 7. Molecular Biology and Biochemistry

Microbiology and Virology Systematics of microorganisms. The main groups and methods of classification of prokaryotes. Principles and methods of identification of microorganisms. The structure and development of microorganisms. Morphology of cell walls. Features of the archaea structure. Methods of movement of microorganisms. Taxonomic groups. Methods of reproduction of prokaryotes. The role of plasmids. Life cycles of microorganisms. Spores and cysts.

Genetics of prokaryotes. Recombination processes. Conjugation, transformation, and transduction. Hereditary and non-hereditary variability. Mutagenesis. Bacteriophages. Genetically modified bacteria. Producing bacteria in biotechnology.

Cultivation of microorganisms. Pure culture. Uncultivated microorganisms. Antimicrobial substances and antibiotics. General principles of cultural work: types of environments, the concept of sterility of work, contamination, general principles of biosafety. Classification of pathogenicity of microorganisms.

Bacterial metabolism. Types of food. Aerobes and anaerobes. Auto- and heterotrophs. Chemotrophs. Methods of nutrient transport into the cell. Methods of ATP synthesis in prokaryotes. Microbial bioluminescence. Methylophilic. Photosynthesis and chlorophyll-free photosynthesis in bacteria. Extremophiles. Growth strategies. Symbiosis in bacteria and eukaryotes.

Classification of viruses according to the structure of the 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, their role. Glycoproteins.

The interaction of viruses with the cell. Stages of infection. Methods of viral genome penetration into cells of bacteria, plants and animals.

Localization of the synthesis of viral components in cells. Packaging of nucleic acids in a virion. Types of viral infections: lytic, lysogenic, and transformative. Viral replication. Types and characteristics of viral polymerases. The scheme of retrovirus replication using HIV as an example. The role of reverse transcription.

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

References:

1. Netrusov A.I., Kotov I.B. Microbiology. University course. 4th ed., revised and expanded. Textbook for universities. Moscow: Akademiya, 2012.
2. Ecology of microorganisms. A textbook for bachelors. 2nd ed. Edited by Netrusova A.I. M.: Yurait, 2013.
3. Kartova O.V., Gradova N.B. Fundamentals of virology for biotechnologists. Moscow: Delhi Plus, 2012.
4. Pinevich A.V., Sirotkin A.K., Gavrilova O.V., Potekhin A.A. Virology. St. Petersburg: Publishing House of St. Petersburg University, 2013.