

**Entrance exam program
in training of highly qualified personnel
(Ph.D. programme)
1.5 "BIOLOGICAL SCIENCES"**

Entrance exam program for the postgraduate Ph.D. programme in training of highly qualified personnel 1.5 "BIOLOGICAL SCIENCES" includes the following sections:

"Biochemistry"

Biochemistry in the system of biological disciplines. Relationship of biological chemistry with adjacent disciplines - biophysics, bioorganic chemistry, cytology, microbiology, genetics, physiology. The place of biochemistry in the system of sciences related to physical and chemical biology. Main stages in the development of biochemistry. Molecular biology and genetics and their relationship to biochemistry. Practical applications of biochemistry; biochemistry as a fundamental basis of biotechnology. Directions and prospects for the development of biochemistry. Physical and chemical characteristics of water as a universal solvent in biological systems. Water and its role in living organisms. Basic concepts of electrochemistry of aqueous solutions. The law of effective masses, dissociation constants of acids and bases, hydrogen index (pH), buffer solutions. Basic physicochemical methods used in biochemistry. Structure and physicochemical properties of low molecular weight compounds included in biological objects. Natural amino acids. Different ways of classifying amino acids. General and specific reactions of functional groups of amino acids. Ionization of amino acids. Methods for separation of amino acids and peptides. Natural oligopeptides. Glutathione and its importance in metabolism. Vitamins, coenzymes and other biologically active compounds. Role of vitamins in animal and human nutrition. Mineral composition of cells. Micronutrients. Methods of analytical bioinorganic chemistry. Structure and properties of biopolymers. Specific role of protein substances in life phenomena. Principles of isolation, purification and quantitative determination of proteins. Peptide bonding, its properties and influence on polypeptide conformation. Theory of protein molecule structure. Metabolism of substances and energy in living systems. Circulation of substances in biosphere. Biological objects as stationary systems. Coupling of biochemical reactions. Metabolic chains, networks and cycles. Reversibility of biochemical processes. Catabolic and anabolic processes. Unity of basic metabolic pathways in all living systems. Storage and utilization of genetic information. Notions of gene and operon. Cell cycle. Active and inactive chromatin. Structure

of chromosomes. Role of nucleic acids in protein biosynthesis. Nucleic acid biosynthesis and DNA polymerase. Interconnection and regulation of metabolic processes in the body. Unity of metabolic processes. The relationship between the processes of catabolism and anabolism, energetic and constructive processes. Energetics of metabolism. The relationship between the metabolism of proteins, carbohydrates, fats and lipids. Key enzymes. Ways to regulate metabolism. Regulation of gene expression. Hereditary diseases.

Reference List:

1. Basics of Lehninger biochemistry/ Nelson, D. : in 3 vols. T. 2 : bioenergetics and metabolism / D. Nelson, M. Cox ; translated from English by T. P. Mosolova and [others] ; edited by T. P. Bogdanov, S. N. Kochetkov. - Moscow : BINOM. Lab. knowledge, 2014.
2. biochemistry [Electronic resource] / ed. E. C. Severin. - 5-th edition, revised and extended - Moscow : GEOTAR-Media, 2014. - 768 p.
3. Principles and methods of biochemistry and molecular biology [Text] : transl. from English / ed. K. Wilson, J. Walker ; translated from English by T. P. Mosolova, E. Yu. Bozelek Reshetnyak ; edited by A. V. Levashov, V. I. Tishkov. - Moscow : BINOM. Lab. knowledge, 2012. - Ed. Principles and Techniques of Biochemistry and Molecular Biology / ed. by K. Wilson and J. Walker. - 6th ed. (Cambridge Univ. Press).

"Botany"

General regularities of plant structure and development. Symmetry, polarity, correlation. Analogy and homology. Convergence, reduction, atavism, abortion. Cell as the basic unit of plant body. Features of its structure and multifunctionality. Vegetative organs. Systematics: definition, tasks and significance in biology and in the activity of human society. The special role of systematics as a synthetic science. Diagnosis and taxonomy. Archaeogonial plants. Covergrown, or flowering plants. Fundamentals of botanical geography. Local and specific flora. Types of habitats. Endemism. Relicts and refugia. Problems of disjunctive ranges and major botanical and geographic disjunctions, vicarious biogeography. Concepts of equatorial pump, phytospreading. Algal systems. Scope of the concept of algae. General principles of algal classification. "Convenience" of using morphological traits and "danger" of new approaches. Life cycles of algae. Basics of algal ecology. Ecological groups of algae as understood by different authors. Evolution of algae.

Reference List:

Pautov A.A. Morphology and anatomy of vegetative organs of plants St. Petersburg, St. Petersburg State University. 2014. 336 p.

Internet

resources:

http://eknigi.org/nauka_i_ucheba/88871-botanicheskaya-nomenklatura.html

http://www.botanik_learn.ru/ <http://www.biolab.vologda.ru> <http://bio.1september.ru>

<http://ngo.burnet.ru.redbook> www.forest.ru

"Microbiology"

The world of microbes, nomenclature, classification. Structure and functions of the bacterial cell. Growth and reproduction of bacteria. Basic principles of cultivation of bacteria. Types of interaction between virus and cell. Stages of viral reproduction. Bacteriophages. Normal microflora of the human body and its functions. Dysbiosis. Dysbacteriosis. Effects of physical and chemical factors on microorganisms. Concept of sterilization, disinfection, asepsis and antisepsis. Bacterial genome. The concept of genotype and phenotype. Types of variability. Movable genetic elements, their role in bacterial evolution. Mechanisms of transfer of genetic material in bacteria. Bacterial plasmids, their functions and properties. The use of plasmids in genetic engineering. Microbiological basis of chemotherapy. Natural and synthetic antibiotics. History of discovery of natural antibiotics. Complications of antibiotic therapy, their prevention. Mechanisms of drug resistance of infectious disease agents. Principles of rational antibiotic therapy. Pathogenicity and virulence of bacteria. Pathogenicity factors. Toxins of bacteria, their nature, properties, production. Factors of innate immunity. Complement, its structure, functions, ways of activation, role in immunity. Interferons, nature. Immunoglobulins, structure and functions. Antigens: definition, basic properties. Antigens of the bacterial cell. Jal and Coombs classification of hypersensitivity. Anaphylactic shock and serum sickness. Causes of onset. Mechanism. Their prevention. Features of antiviral, antibacterial, antifungal, antitumor, antihelminthic, transplant immunity. Human immune status and factors affecting it. Evaluation of immune status: basic indicators and methods of their determination. Immunobiological preparations. Vaccines. Modern classification of vaccines. Requirements for vaccine preparations. Vaccine therapy. Complications. Immune sera. Antitoxic sera and immunoglobulin preparations. Classification of immunomodulators. Immunotherapy and immunoprophylaxis of infectious diseases. Methods of microbiological diagnosis of infectious diseases. The causative agents of typhoid fever and paratyphoid fever. The causative agents of escherichiosis. Pathogens of intestinal yersinosis. Pathogens of shigellosis. Pathogens of salmonellosis. Pathogens of cholera.

Taxonomy. Staphylococci. Taxonomy. Streptococci. Meningococci. Tularemia pathogen. Anthrax. Brucellosis pathogen. Plague pathogen. Features of microbiological diagnosis in quarantine infections. Pathogens of anaerobic gas infection. The pathogen of botulism. The pathogen of tetanus. The pathogen of diphtheria. Pathogens of whooping cough and paracocupuncture. Pathogen of tuberculosis. The causative agent of leprosy. Actinomycetes. The causative agent of typhus. Pathogen of Q fever. Chlamydia pathogen. Legionella pathogen. Pathogen of syphilis. Cause of leptospirosis. The pathogen of borreliosis. Mycoplasmas. Pseudomonas bacillus. Non-pore forming anaerobes. Classification of fungi. Malaria pathogens. The causative agent of toxoplasmosis. The causative agent of leishmaniasis. The causative agent of amoebiasis. Pathogens of acute respiratory infections. Pathogen of influenza. Pathogen of polio. Pathogens of hepatitis A and E. Arboviruses. Tick-borne encephalitis pathogen. Pathogen of rabies. Pathogen of smallpox. The pathogen of rubella. Measles virus. Herpes infection: taxonomy, characterization of the causative agents. Laboratory diagnosis. Specific prevention and treatment. Pathogens of hepatitis B, C, D, G. HIV infection. Classification and characterization of oncogenic viruses. Slow viral infections and prion diseases. Pathogens of opportunistic infections.

Reference List:

1. Netrusov A.I., Kotova I.B. Microbiology: textbook for higher professional education - Moscow: Academy, 2012. -384 p.
2. Microbiology / Edited by V.V. Zverev, M.N. Boychenko. Moscow: GEOTAR-Media, 2012.
3. Gosmanov R. G. Galiullin A. K. Microbiology: * / Moscow: Lan', 2012 - 496 p.

"Human and Animal Physiology"

Reobase, chronaxie and their importance in clinical practice. Chronoximetry. Receptors: concepts, classification, basic properties and features of excitation. Fatigue of an isolated muscle, neuromuscular preparation and neuro-motor unit under conditions of the whole organism. Theories of fatigue. Features of mental work. Overwork. Prevention of fatigue. Active and passive rest. Dermal and tendon reflexes of man and their clinical significance. Sensory and motor disorders in full and partial crossing of the spinal cord (spinal shock, Brown-Sekar syndrome). Electroencephalography. EEG rhythms and their characteristics. Sleep, its physiological significance. Phases of sleep, theories of sleep. Characteristics of human electroencephalogram in conditions of natural sleep and wakefulness. Protein metabolism. Protein optimum and minimum. Nitrogen balance, its types. Protein starvation.

Physiological norms of nutrients in the daily diet. Nutrition regimes. Modern approaches to rational nutrition. Physiological basis of hunger and satiety. Analysis of typical gastric secretion curves for bread, meat and milk. Adaptive nature of gastric secretion to different types of food. Methods for studying the secretory and motor functions of the human stomach. The inflammatory (appetite) juice and its importance. The metabolism of carbohydrates. Normo-, hypo- and hyperglycemia. The mechanism of maintaining a constant level of glucose in the blood. Endocrine function of the pancreas and its role in the regulation of metabolism. Endocrine function of the thyroid gland and its role in metabolism. Endocrine function of the adrenal glands. Endocrine function of sex glands. Hypothalamic-pituitary system and its role in regulation of organism's functions. Regulation of calcium level in blood. The role of thyroid and parathyroid glands. Minute respiratory volume, its definition. "Dead space" and ventilation of alveoli, its efficiency depending on the frequency and depth of breathing. Pressure in pleural cavity, its change in different phases of respiratory cycle and its role in the mechanism of external respiration. Pneumothorax. Partial pressure of gases O₂ and CO₂ in alveolar air and their tension in blood. Gas exchange in lungs. Physiological basis of artificial respiration. Effects of 96% O₂ and 4% CO₂ mixture. Physiological mechanisms of diving and caisson illnesses. Breathing in altered environmental conditions. Mountain (altitude) sickness, diving and caisson sickness, their physiological mechanisms. Functions of respiratory tract. Protective respiratory reflexes. Role of irritant and juxtacapillary receptors in respiratory regulation. Acid-base balance of blood and mechanisms ensuring its constancy. Erythrocyte sedimentation rate, factors affecting its value. Clinical significance of sedimentation rate. Rules for blood transfusion. Blood substitute solutions. Classification and indications for use. Physiological basis of immunity. T- and B-lymphocytes. Nervous and humoral regulation of hematopoiesis. Concept of hematopoietic. Changes in excitability of cardiac muscle in different phases of cardiac cycle. Extrasystole. Biophysical basis of electrocardiography. Basic ECG leads. Clinical significance. Cardiac tones and their origin. Components of the first and second tone. Phonocardiography. Physiological mechanisms of regulation of transplanted heart activity. Arterial pulse, its main indices. Sphygmogram. Physiological basis of hypertension. Peculiarities of the pulmonary circulation. Features of coronary circulation. Peculiarities of the cerebral circulation. Peculiarities of the renal blood flow. The role of hydrostatic blood pressure in ultrafiltration. Renin-angiotensin-aldosterone system and its role in the regulation of blood pressure. Biological significance of pain. Types of pain. Modern concepts of pain reception. Physiological basis of analgesia and anesthesia.

Reference List:

1. Normal Physiology. Textbook. Ed. by K.V. Sudakov. Approved by the Ministry of Education and Science of the Russian Federation. Moscow: Geotar-Media publishing house, 2012. 875 p.
2. Alipov N.N. Fundamentals of medical physiology [Text]: [Textbook for medical universities]. - 2nd ed. amended and supplemented - Moscow : Practice, 2013. - 496 p.