

**Entrance exam program  
for the postgraduate Ph.D. programme  
in BIOLOGICAL SCIENCE  
(Subject code: 06.06.01)**

**Biochemistry**

---

Biochemistry in the System of Biological Disciplines. Link between Biological Chemistry and Related Disciplines: Biophysics, Bioorganic Chemistry, Cytology, Microbiology, Genetics, Physiology. Place of Biochemistry in the System of Sciences related to Physical & Chemical Biology. Main Stages of Development of Biochemistry. Molecular Biology and Genetics and their Link with Biochemistry. Practical Biochemistry Applications; Biochemistry as the Fundamental Basis of Biotechnology. Biochemistry Disciplines and Prospects. Physical and Chemical Characteristics of Water as a Universal Solvent in Biological Systems. Water and its Role in Living Organisms. Basic Concepts of Aqueous Solution Electrochemistry. Mass Action Law, Acid and Base Dissociation Constants, pH, Buffer Solutions. Main Physical and Chemical Methods used in Biochemistry. Structure and Physical and Chemical Properties of Low-Molecular-Weight Compounds Making up Biological Objects. Natural Amino Acids. Classification of Amino Acids. General and Specific Reactions of Amino Acid Functional Groups. Ionization of Amino Acids. Methods for the 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. Cell Mineral Composition. Trace Elements. Methods of Analytical Bioorganic Chemistry. Structure and Properties of Biopolymers. Specific Role of Protein Substances in Life Phenomena. Protein Isolation, Purification and Quantification Principles. Peptide Bond, its Properties and Effect on Polypeptide Conformation. Protein Molecule Structure Theory. Metabolism and Energy in Living Systems. Circulation of Substances in the 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 Main Metabolic Pathways in all Living Systems. Storage and Use of Genetic Information. Gene and Operon Concept. Cell Cycle. Active and Inactive Chromatin. Structure of Chromosomes. Role of Nucleic Acids in Protein Biosynthesis. Biosynthesis of Nucleic Acids and DNA Polymerase. Interrelation and Regulation of Metabolic Processes in the Body. Metabolic Process Unity. Relationship between Catabolism and Anabolism Processes, Energy and Constructive Processes. Metabolism Energetics. Relationship between Protein, Carbohydrate, Fat and Lipid Metabolisms. Key Enzymes. Metabolism Regulation Methods. Gene Expression Regulation. Hereditary Diseases.

**Recommended literature:**

1. Fundamentals of Biochemistry Lehninger / Nelson, D.: in 3 vol. Vol. 2: Bioenergetics and Metabolism / D. Nelson, M. Cox; translated from English. Vol. P. Mosolova and [others]; ed. by T. Bogdanov, S. Kochetkov. - Moscow: BINOM. Laboratoriya Znaniy, 2014.
2. Biochemistry [Electronic Resource] / ed. by E. Severin. - 5th ed., rev. and add. - Moscow: GEOTAR-Media, 2014. - 768 p.: il.
3. Principles and Methods of Biochemistry and Molecular Biology [Text]: Translated from English / ed.: K. Wilson, J. Walker; Translated from English Vol. P. Mosolova, E. Bozelek-Reshetnyak; ed. by A. Levashova, V. Tishkova. - Moscow: BINOM. Laboratoriya Znaniy, 2012. -

translated from: 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. The Cell as the Basic Unit of the Plant Body. Features of its Structure and Multifunctionality. Vegetative Organs. Systematics: Definition, Objectives and Importance in Biology and in Human Society. Special Role of Taxonomy as a Synthetic Science. Diagnostics and Taxonomy. Archegonial Plants. Angiosperms, or Flowering Plants. Fundamentals of Botanical Geography. Local and Specific Flora. Types of Habitats. Endemism. Relics and Refugia. Problems of Disjunctive Areas and Main Botanical & Geographical Disjunctions, Variational Biogeography. Concepts of Equatorial Pump, Phyto-Spreading. Algae Systems. Scope of the "Algae" Concept. General Principles of Classification of Algae. "Convenience" of using Morphological Features and the "Danger" of New Approaches. Algae Life Cycles. Fundamentals of Algae Ecology. Ecological Groups of Algae as Understood by Different Authors. Evolution of Algae.

### **Recommended literature:**

Pautov 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://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>

<http://www.forest.ru>

## **Microbiology**

---

Microbial World, Nomenclature, Classification. Bacterial Cell Structure and Functions. Bacteria Growth and Reproduction. Basic Principles of Bacteria Cultivation. Types of Virus-Cell Interaction. Virus Reproduction Stages. Bacteriophages. Normal Microflora of the Human Body and its Functions. Dysbiosis. Dysbacterioses. Effect of Physical and Chemical Factors on Microorganisms. Concept of Sterilization, Disinfection, Asepsis and Antisepsis. Bacteria Genome. Genotype and Phenotype Concept Types of Variability. Mobile Genetic Elements, their Role in Bacteria Evolution. Genetic Material Transmission Mechanisms in Bacteria. Bacteria Plasmids, their Functions and Properties. Use of Plasmids in Genetic Engineering. Microbiological Basis of Chemotherapy. Natural and Synthetic Antibiotics. History of the Discovery of Natural Antibiotics. Antibiotic Therapy Complications, their Prevention. Drug Resistance Mechanisms of Pathogens of Infectious Diseases. Principles of Rational Antibiotic Therapy. Pathogenicity and Virulence of Bacteria. Pathogenicity Factors. Bacteria Toxins, their Nature, Properties, Production. Congenital Immunity Factors. Complement, its Structure, Functions, Activation Methods, Role in Immunity. Interferons, Nature. Immunoglobulins, Structure and Functions. Antigens: Definition, Basic Properties. Bacterial Cell Antigens. Gell and

Coombs Classification of Hypersensitivity Anaphylactic Shock and Serum Sickness. Causes of Occurrence. Mechanism. Their Prevention. Features of Antiviral, Antibacterial, Antifungal, Antitumor, Anthelmintic, Transplantation Immunity. Human Immune Status and Affecting Factors. Immune Status Assessment: Key Indicators and their Determination Methods. Immunobiological Preparations. Vaccines. Modern Classification of Vaccines. Requirements Applicable to Vaccine Formulations. Vaccinotherapy. Complications. Immune Sera. Antitoxic Sera and Immunoglobulin Preparations. Classification of Immunomodulators. Immunotherapy and Immunoprophylaxis of Infectious Diseases. Methods of Microbiological Diagnostics of Infectious Diseases. Typhoid and Paratyphoid Pathogens. Colibacillosis Pathogens. Enteric Yersiniosis Pathogens. Shigellosis Pathogens. Salmonellosis Pathogens. Cholera Pathogens. Taxonomy. Staphylococci. Taxonomy. Streptococci. Meningococci. Tularemia Pathogens. Anthrax Pathogens. Brucellosis Pathogens. Plague Pathogens. Features of Microbiological Diagnostics of Quarantine Infections. Anaerobic Gas Infection Pathogens. Botulism Pathogens. Tetanus Pathogens. Diphtheria Pathogens. Whooping Cough and Pertussis Pathogens. Tuberculosis Pathogens. Leprosy Pathogens. Actinomycetes. Typhus Pathogens. Q Fever Pathogens. Chlamydia Pathogens. Legionellosis Pathogens. Syphilis Pathogens. Leptospirosis Pathogens. Borreliosis Pathogens. Mycoplasma. Pseudomonas Aeruginosa. Non-Sporogenous Anaerobes. Classification of Fungi. Malaria Pathogens. Toxoplasmosis Pathogens. Leishmaniasis Pathogens. Amebiasis Pathogens. SARS Pathogens. Influenza Pathogens. Polio Pathogens. Hepatitis A and E Pathogens. Arboviruses. Tick-Borne Encephalitis Pathogens. Rabies Pathogens. Smallpox Pathogens. Rubella Pathogens. Measles Virus. Herpes Infection: Taxonomy, Characterization of Pathogens. Laboratory Diagnostics. Specific Prophylaxis and Treatment. Hepatitis B, C, D, G Pathogens. HIV Infection. Classification and Characterization of Oncogenic Viruses. Slow Viral Infections and Prion Diseases. Pathogens of Opportunistic Infections.

### **Recommended literature:**

1. Netrusov A., Kotova I. Microbiology: Textbook for Higher Vocational Education - M.: Academy, 2012. -384 p.
2. Microbiology / ed. by V. Zvereva, M. Boychenko. M.: GEOTAR-Media, 2012.
3. Gosmanov R. Galiullin K. Microbiology: \* / Moscow: Lan, 2012 – 496 p.

### **Physiology**

---

Rheobase, Chronaxia and their Importance in Clinical Practice. Chronaximetry. Receptors: Concepts, Classification, Basic Properties and Features of Stimulation. Fatigue of the Isolated Muscle, Neuromuscular Preparation and Neuro - Motor Unit under Conditions of the Whole Body. Theory of Fatigue. Features of Mental Work. Over-Fatigue. Fatigue Prevention. Active and Passive Recreation. Human Skin and Tendon Reflexes and their Clinical Significance. Sensory and Motor Impairment under Whole or Partial Interception of the Spinal Cord (Spinal Shock, Brown-Sequard Syndrome (BSS)). Electroencephalography. EEG Rhythms and their Characteristics. Sleep. Its Physiological Significance. Sleep Stages. Theories of Sleep. Characteristics of Human Electroencephalogram under Conditions of Natural Sleep and Wakefulness. Protein metabolism. Protein Optimum and Minimum. Nitrogen Balance. Types. Protein Starvation. Physiological Nutrient Rates in the Daily Food Ration. Dietary Regimen. Modern Approaches to Balanced Nutrition. Physiological Foundation 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. Fuze (Appetizing) Juice and its Value. Carbohydrate Metabolism. Normo -, Hypo- and Hyperglycemia. Mechanism for Maintaining Blood Glucose Level Constancy. Pancreas Endocrine Function and its Role in Metabolism Regulation. Thyroid Gland Endocrine Function and its Role in Metabolism. Endocrine Function of the Adrenal Glands. Endocrine Function of the Gonads. Hypothalamic-Pituitary System and its Role in the Regulation of Body Functions. Regulation of Blood Calcium Levels. Role of the Thyroid and Parathyroid Glands. Pulmonary Minute Volume. Definition.

"Dead Space" and Alveoli Ventilation, Its Effectiveness Depending on Respiration Frequency and Depth. Pleural Cavity Pressure. Its Change in Different Respiratory-Cycle Phases and Role in External Respiration Mechanism. Pneumothorax. Partial Pressures of O<sub>2</sub> and CO<sub>2</sub> Gases in Alveolar Air and their Blood Tensions. Respiratory Metabolism in the Lungs. Physiological Foundation of Artificial Respiration. Action of 96 % O<sub>2</sub> and 4% CO<sub>2</sub> Mixture. Physiological Mechanisms of Diving and Caisson Disease. Breathing in Altered Environmental Conditions. Mountain (Altitude) Disease, Diving and Caisson Disease, their Physiological Mechanisms. Functions of the Respiratory Tract. Defensive Respiratory Reflexes. Role of Irritant and Juxtacapillary Receptors in Respiration Regulation. Blood Acid-Alkaline Balance and Mechanisms Ensuring its Constancy. Erythrocyte Sedimentation Rate. Factors Affecting its Value. Clinical Significance of ESR (Erythrocyte Sedimentation Rate). Blood Transfusion Rules. Blood-Substituting Solutions. Classification and Indications for Use. Physiological Basis of Immunity. T- and B- Lymphocytes. Nervous and Humoral Regulation of Hematopoiesis. Hematopoietin Concept. Changes in Heart Muscle Stimulation in Different Cardiac Cycle Phases. Extrasystole. Biophysical Principles of Electrocardiography. Basic ECG Leads. Clinical Significance. Heart Tones and their Origins. Components of the First and Second Tone. Phonocardiography. Physiological Regulation Mechanisms for Transplanted Heart Activity. Arterial Pulse, its Main Indicators. Sphygmogram. Physiological Basis of Hypertension. Features of Pulmonary Circulation. Features of Coronary Circulation. Features of Cerebral Circulation. Features of Renal Blood Flow. Role of Blood Hydrostatic 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 Nociceptive Sensory Reception. Physiological Principles of Anesthesia and Narcosis.

### **Recommended literature:**

1. Hominal Physiology. Textbook. Under the editorship of K. Sudakov. Approved by the Ministry of Education and Science of the Russian Federation. M.: Geotar-Media Publishing House, 2012. 875 p.
2. Alipov, N. Fundamentals of Medical Physiology [Text]: [Textbook for Medical Schools]. – 2nd ed., rev. and add. – Moscow: Practice, 2013. – 496 p.: il.