

**MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS**  
Educational Institution  
**BELARUSIAN STATE MEDICAL UNIVERSITY**

**APPROVED**

by Rector of the Educational  
Institution «Belarusian State  
Medical University»

S.P.Rubnikovich



*24.06.2023*

Reg. # UD-099-032/2324/edu.

**Контрольный  
экземпляр**

**BIOLOGY**

**Curriculum of the educational institution  
in the academic discipline for the specialty**

**7-07-0912-01 «Pharmacy»**

Curriculum is based on the educational program «Biology», approved 27.06.2023, registration # УД-091-032/2324/уч.; on the educational plan in the specialty 7-07-0912-01 «Pharmacy», approved 17.05.2023, registration # 7-07-0912-01/2324/mf.

**COMPILERS:**

V.V.Davydov, the Head of the Department of Biology of the Educational Institution «Belarusian State Medical University», PhD, Associate Professor;

Ye.I.Karasyova, Assistant Professor of the Department of Biology of the Educational Institution «Belarusian State Medical University», PhD, Associate Professor

V.V.Grigorovich, Senior teacher of the Department of Biology of the Educational Institution «Belarusian State Medical University»;

**RECOMMENDED FOR APPROVAL:**

by the Department (name) of the educational institution «Belarusian State Medical University»

(protocol # 11 of 05.06.2023)

by the Scientific and Methodological Council of the educational institution «Belarusian State Medical University»

(protocol # 6 of 27.06.2023)

## EXPLANATORY NOTE

«Biology» – the academic discipline of the natural science module, which contains systematized scientific knowledge about the structural and functional organization of living matter and about human being as its integral part in the aspect of the needs of modern medicine.

The aim of the discipline «Biology» is the formation of basic professional competencies performing the tasks of interpersonal and professional interaction and solve the problems of professional activity.

The objectives of the discipline «Biology» are to form students' scientific knowledge about:

- basic concepts of cytology, molecular and cell biology, genetic engineering, genetics, developmental biology and evolutionary theory, parasitology and biosphere science;

- the molecular and genetic basis of storage and realization of genetic information;

- the principles of inheritance and diagnosis of human hereditary pathology;

- poisonous mushrooms, plants and animals as a source of farmaceutical raw materials;

- skills and abilities necessary for the competent performance of professional activities of the pharmacist.

Knowledge, skills, and abilities acquired in the study of the discipline «Biology» are necessary for the successful study of the following academic disciplines: «Human Anatomy and Physiology», «Pharmaceutical Botany», «Pharmacognosy», «Pharmaceutical Ecology», «Biological Chemistry» and «Pharmaceutical Biotechnology».

A student who has mastered the content of the study material of the discipline should have the following basic professional competencies: Apply knowledge of basic physical, chemical and biological laws for quality control of drugs and medicinal plant raw materials.

As a result of studying the discipline «Biology» the student should

**know:**

- general biological processes occurring at different organization levels of life;

- the taxonomy of human, the characteristics of human as a biological and social being, the relationship of human with the nature;

- the mechanisms allowing substance, energy and information pass through the cell;

- basic mechanisms that regulate gene expression in prokaryotes and eukaryotes; methods of transgenesis, genome editing and gene therapy;

- patterns of inheritance of normal and pathological traits in humans;

- main types of variability and their manifestations in humans;

- influence of genetic factors on human health;

- methods used for diagnosis of hereditary disorders;

- peculiarities of human reproduction and ethical problems associated with it;

peculiarities of human prenatal and postnatal ontogenesis; mechanisms of ageing and biological nature of death;

biological and medical peculiarities of human ecology and valeology;

forms of biotic relationships in nature; relationship of the parasite and the host at the organism and population levels;

the main groups of poisonous organisms;

characteristics of mycotoxins, phytotoxins, and zootoxins and their use in pharmacy and medicine;

**be able to:**

solve the problems in molecular biology, genetics; analyze pedigrees, calculate the degree of genetic determination;

calculate the frequencies of genes and genotypes in human populations using the Hardy-Weinberg law formula;

analyze the influence of human molecular-genetic features on the action of drugs: their effectiveness and safety;

use the acquired knowledge in the study of pharmaceutical disciplines and in professional activities;

**master:**

skills of working with magnifying glass and light microscope;

skills of drawing pedigree charts and their analysis, calculating the chance to give birth to a sick child;

skills in using statistical methods to study modification variability;

skills in identifying poisonous organisms.

**Total number** of hours for the study of the discipline is 90 academic hours. Classroom hours according to the types of studies: lectures - 12 hours, laboratory studies - 28 hours, student independent work (self-study) - 50 hours.

Current assessment is carried out according to the syllabus of the specialty in the form of examination (1<sup>st</sup> semester).

Form of higher education -- full-time.

**ALLOCATION OF ACADEMIC TIME  
ACCORDING TO SEMESTERS OF STUDY**

| Code, name of the specialty | semester | Number of academic hours |          |           |                    |                           | Form of intermediate assessment |
|-----------------------------|----------|--------------------------|----------|-----------|--------------------|---------------------------|---------------------------------|
|                             |          | total                    | in-class | including |                    | out-of-class self-studies |                                 |
|                             |          |                          |          | lectures  | laboratory studies |                           |                                 |
| 7-07-0912-01<br>«Pharmacy»  | 1        | 90                       | 40       | 12        | 28                 | 50                        | Examination                     |

## THEMATIC PLAN

| Section (topic) name   | Number of class hours |            |
|--|-----------------------|------------|
|  | lectures              | laboratory |
| <b>1. Molecular and Cell Biology</b>   | <b>8</b>              | <b>16</b>  |
| 1.1. Medical biology as a science, its role in the training of a physician. Subject matter, objectives and methods of cytology | -                     | 2          |
| 1.2. Structural and functional organization of the cell  | 1                     | 2          |
| 1.3. Structurally functional organization of the genome  | -                     | 2          |
| 1.4. Cell cycle  | -                     | 2          |
| 1.5. Mechanism of gene expression  | 1                     | 2          |
| 1.6. Regulation of gene expression   | 2                     | 2          |
| 1.7. Genomics. DNA analysis methods  | -                     | 2          |
| 1.8. Genetic engineering   | 2                     | 2          |
| 1.9. Postgenomic medicine  | 2                     | -          |
| <b>2. General and Medical Genetics</b>   | <b>2</b>              | <b>10</b>  |
| 2.1. The mechanisms of heredity  | -                     | 2          |
| 2.2. Genetic linkage. Biology and genetics of sex  | -                     | 2          |
| 2.3. Variability. Mutagenesis. DNA repair  | 1                     | 2          |
| 2.4. Population genetics   | -                     | 2          |
| 2.5. Human genetics  | 1                     | 2          |
| <b>3. Developmental biology. Reproduction of living matter</b>   | <b>1</b>              | <b>2</b>   |
| <b>4. Medical parasitology</b>   | <b>1</b>              | <b>-</b>   |
| <b>Total hours</b>   | <b>12</b>             | <b>28</b>  |

### CONTENT OF THE EDUCATIONAL MATERIAL

#### 1. MOLECULAR AND CELL BIOLOGY

##### 1.1. Medical biology as a science, its role in the training of a physician. Subject matter, objectives and methods of cytology

The nature of life, the role of proteins and nucleic acids in the organization of living systems. Organization levels of living matter. Human as a biological and social being. The role of biology in medical education.

Cytology. Methods of cytology (light microscopy, fluorescence microscopy, electron microscopy and histochemistry and immunohistochemistry, differential centrifugation, autoradiography, morphometry, etc.).

The method of light microscopy. The structure of light microscope. The instructions for working with a microscope.

Cell as the least structural and functional unit of life. General characteristics of viruses, prokaryotes and eukaryotes.

## **1.2. Structural and functional organization of the cell**

Models of plasma membrane. The structure, properties and functions of plasma membrane. Transport across the membrane: passive transport (simple diffusion, facilitated diffusion, osmosis), active transport (ion channels, their functions), endocytosis, exocytosis.

Cytosol. Cytoskeleton: microtubules, intermediate filaments, microfilaments. Vesicular transport. Nuclear localization signal.

Assimilation and dissimilation. Ribosomes. Endomembrane system (nucleus, endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes, endosomes, vesicles).

Photosynthesis and chemosynthesis, fermentation and respiration. Stages of catabolism, mitochondria, enzymes of mitochondria.

Disorders caused by impairments of cellular activities (mitochondrial diseases, lysosomal storage diseases, peroxisomal disorders and prion diseases).

## **1.3. Structurally functional organization of the genome**

Organization of hereditary material in viruses, prokaryotes and eukaryotes. Organization levels of genetic material in eukaryotes (gene, chromosome and genome levels).

Gene organization level of hereditary material. The main functions of gene. Properties of genes. Structure of deoxyribonucleic acid (DNA). Watson and Crick postulates. Evidence for the role of DNA in the transmission of hereditary information (transformation and transduction). Ribonucleic acid (RNA) and its types.

Genome organization level of hereditary material. Chromosome organization level of hereditary material. DNA condensation in eukaryotes. Chromatin remodeling. Euchromatin and heterochromatin.

The structure and functions of nucleus.

Types of chromosomes. Rules of chromosomes. Karyotype and idiogram. Nomenclatures of human chromosomes.

Nuclear genes and cytoplasmic genes. Cytoplasmic inheritance.

## **1.4. Cell cycle**

The flow of genetic information in the cell. Semi-conservative mechanism of DNA replication. Replicon.

Cell cycle. Interphase. Types and types of cell division: binary fission of bacteria, amitosis, mitosis, endomitosis, polyteny.

Mitosis: characteristics of phases, distribution of genetic material, biological significance.

Meiosis: characteristics of phases, distribution of genetic material, biological significance.

Cell cycle regulators (cyclins and cyclin-dependent kinases). Cell proliferation and cell death. Necrosis and apoptosis. Caspases.

## **1.5. Mechanisms of gene expression**

The Central Dogma of Molecular Biology.

Genetic code and its properties.

Transcription. Transcription factors. Eukaryotic mRNA synthesis: primary transcript, pro-mRNA processing, splicing. Alternative splicing. Transcriptome. Reverse transcription.

Aminoacyl-tRNA synthetases. Translation: initiation, elongation and termination. Proteome. Metabolome.

Posttranslational modifications of proteins. Protein folding. Chaperones. Utilization of proteins in cell. Proteasomes. Ubiquitin.

### **1.6. Regulation of gene expression**

Housekeeping and tissue-specific genes. Human genome: protein-coding genes, RNA genes, non-coding sequences (repeats, introns, junk DNA). DNA transposons and retrotransposons.

Lac and trp operons. Polycistronic RNA.

Regulation of transcription in eukaryotes: preinitiation complex. Enhancers, silencers.

Epigenetic mechanisms of controlling gene expression: histone modifications, cytosine methylation, CpG-islands, regulatory systems of non-coding RNA.

International human genome research projects: Human genome, ENCODE, Roadmap.

### **1.7. Genomics. DNA analysis methods**

Analysis of genetic material. Methods of DNA analysis: gel electrophoresis, restriction analysis, hybridization of nucleic acids, DNA microarrays.

Polymerase chain reaction (PCR), reaction components, stages of the method. PCR variants: qPCR, RT-PCR (reverse transcription), nested PCR, multiplex PCR, methylation-sensitive PCR.

DNA sequencing: Sanger sequencing, next generation sequencing (NGS): pyrosequencing, nanopore sequencing, bisulfite sequencing.

### **1.8. Genetic engineering**

Aims, objectives and stages of genetic engineering. Methods allowing to obtain genes for transgenesis. Recombinant DNA. Construction of vectors, their types: plasmids, cosmids, viral and phage vectors, phasmids, shuttle vectors.

Medical applications of genetic engineering: production of protein products, monoclonal and polyclonal antibodies, recombinant antigens. DNA probes.

Introduction of recombinant DNA into a recipient cell. Selection of transformed cells. Selective and reporter genes.

Biotechnology and its significance in medicine. Genetically modified organisms (GMO). Food products containing GMOs.

### **1.9. Postgenomic medicine**

Genome editing tools: CRISPR/Cas 9, TALEN. Perspectives for medicine and bioethical problems of genomic editing.

Personalized medicine. Pharmacogenetics. Gene therapy. Molecular genetic markers for tumors. Cancer genetic diagnostics.

Methods used for diagnosis of genetic disorders: direct sequencing, PCR, restriction fragment length polymorphism (RFLP) analysis, single-strand conformation polymorphism (SSCP) analysis, DNA-microarrays.

## **2. GENERAL AND MEDICAL GENETICS**

### **2.1. The mechanisms of heredity**

Genetics. The subject, methods and tasks of Genetics. Hybridological analysis. Monohybrid crossing. Hypothesis of Purity of Gametes. Test cross. Backcrossing.

Polyhybrid cross. Limitations of Mendel's laws. Pleiotropy.

Intra-allelic interaction (complete and incomplete dominance, superdominance, codominance and allelic exclusion). Multiple alleles. Inheritance of blood groups (ABO, MN, Rh).

Inter-allelic interaction (complementary gene action, inhibitory gene action, polymeric gene interaction and position effect). Bombay blood group.

### **2.2. Genetic linkage. Biology and genetics of sex**

T. Morgan's experiments. Complete and partial genetic linkage. Crossing over and recombination of traits. Autosomal and gonosomal linkage groups. Basic provisions of chromosomal theory of heredity. Genetic and cytological chromosome maps.

Sex as a biological trait. Sex-limited, sex-influenced, sex-linked and holandric inheritance.

Determination and development of sex in ontogenesis. Peculiarities of sex determination in humans: physical, intermediate and socio-psychological determinants. Genetic mechanisms of gonadogenesis in humans. Barr body, Mary Lyon's hypothesis of X chromosome inactivation.

Disruption of sex formation in humans. Ethical aspects associated with sex, disorders of sex development, sex change and transsexualism.

### **2.3. Variability. Mutagenesis. DNA repair**

Variability. Types of variability. Phenotypic plasticity. Morphosis. Phenocopies. Medical aspects of phenotypic plasticity.

Genotypic variability. Combinative variability and its mechanisms. Genetic variation caused by mutations. Causes of mutations: Replication errors, unequal crossing over, mutagens. Mechanisms of mutagenesis. Genocopies. Physical, chemical and biological mutagens. Supermutagens. Genetic hazards of environmental pollution with mutagens. Classification of mutations.

Genome stability and DNA repair. Types of DNA repair: excision repair, double-strand break repair, direct reversal repair. Antimutagens. Medical aspects of DNA repair.

Carcinogenesis. Oncogenes and tumor suppressor genes.

### **2.4. Population genetics**

Population. Ecological and genetic characteristics of populations. Gene pool. Ideal population. Hardy-Weinberg equilibrium. Factors disturbing Hardy-Weinberg equilibrium. Natural selection. Mutations. Migration. Genetic drift, founder effect, bottleneck effect. Non-random mating, inbreeding, assortative mating, inbreeding coefficient.

Population structure of humanity. Large populations, demes and isolates. Peculiarities of gene pool of isolates. Effects of elementary evolutionary factors on human populations.



Human genetic polymorphism, its biological, medical and social aspects. Genetic burden, its biological essence and medical significance.

### **2.5. Human genetics**

Current tasks of human genetics. Human being as a specific object of genetic analysis.

The main methods human genetics: pedigree analysis, twin study, cytogenetic techniques, the methods of population genetics, biochemical diagnostic techniques, the methods of molecular genetics.

Methods used for diagnosis of numerical and structural chromosomal abnormalities: karyotyping, SKY, FISH and SNP array-based karyotyping.

Rapid diagnostic tests: Guthrie bacterial inhibition assay, detection of sex chromatin.

Neonatal screening of monogenic disorders. Screening programs in the Republic of Belarus.

Methods of prenatal diagnosis. Genetic counselling.

### **3. DEVELOPMENTAL BIOLOGY. REPRODUCTION OF LIVING MATTER**

Reproduction – universal property of living things. Evolution of reproduction types. Asexual reproduction, its forms and biological roles. Sexual reproduction, its forms and biological roles. Lateral gene transfer. Hermaphroditism.

Ovogenesis and spermatogenesis in humans. Regulation of gametogenesis. Characteristics of human gametes. Insemination. Peculiarities of fertilization in humans. Fertilization, its phases and biological role. Monospermy and polyspermy. Development of dioeciousness and sexual dimorphism in the course of evolution.

Assisted reproductive technologies (ART) in overcoming infertility in humans.

### **4. MEDICAL PARASITOLOGY**

Parasitism as an antagonistic form of symbiosis. Parasitocoenosis. Microbiome. Medical parasitology, its goals and objectives. Classification of parasites. Classification of hosts.

Characteristics of the parasite-host system. Transmission routes of parasites. Pathogenic action and specificity of parasites. Morphophysiological and biological adaptations of parasites. Responses of the host organism to the invasion of parasites. Parasitic system.

General characteristics of parasitic diseases (infections, invasions, anthroponoses, zoonoses, vector-borne and natural-focal diseases). The study of Pavlovsky about natural-focal diseases.

## ACADEMIC DISCIPLINE CURRICULAR CHART

| Section, topic # | Section (topic) name  | number of hours |           | Self-studies | Form of control  |
|------------------|---|-----------------|-----------|--------------|--|
|                  |   | lectures        | practical |              |  |
| <b>1.</b>        | <b>Molecular and Cell Biology</b>   | <b>8</b>        | <b>16</b> | <b>20</b>    |  |
| 1.1.             | Medical biology as a science, its role in the training of a physician. Subject matter, objectives and methods of cytology | -               | 2         | 2            | Interview, units of classroom practical exercises with oral defense, electronic test, electronic workshop  |
| 1.2.             | The flow of substance and energy in the cell  | 1               | -         | 1            | Reports, electronic tests  |
| 1.2.             | Structural and functional organization of the cell  | -               | 2         | 1            | Interview, units of classroom practical exercises with oral defense, accounts of home practical exercises with oral defense, electronic test, electronic workshop                            |
| 1.3.             | Structurally functional organization of the genome  | -               | 2         | 2            | Interview, test, units of classroom practical exercises with oral defense, accounts of home practical exercises with oral defense, electronic test, electronic workshop                      |
| 1.4.             | Cell cycle  | -               | 2         | 2            | Interview, test, units of classroom practical exercises with oral defense, accounts of home practical exercises with oral defense, electronic test, electronic workshop, control questioning |
| 1.5.             | Mechanism of gene expression  | 1               | -         | 1            | Reports, electronic tests  |
| 1.5.             | Mechanism of gene expression  | -               | 2         | 1            | Interview, test, units of classroom practical exercises with oral defense, accounts of home practical exercises with oral defense, electronic test, electronic workshop                      |
| 1.6.             | Gene expression. Epigenetics  | 2               | -         | 1            | Reports, electronic tests  |
| 1.6.             | Regulation of gene expression in prokaryotes and eukaryotes   | -               | 2         | 1            | Interview, test, units of classroom practical exercises with oral defense, accounts of home practical exercises with oral defense, electronic test, electronic workshop                      |

|           |  |           |           |           |   |
|-----------|--|-----------|-----------|-----------|---|
| 1.7.      | Genomics. DNA analysis methods                         | -         | 2         | 3         | Interview, test, unts of classroom practical exercises with oral defense, accounts of home practical exercises with oral defense, electronic test, electronic workshop          |
| 1.8.      | Genetic engineering                                    | 2         | -         | 1         | Reports, electronic tests   |
| 1.8.      | Genetic engineering                                    | -         | 2         | 2         | Interview, test, unts of classroom practical exercises with oral defense, accounts of home practical exercises with oral defense, electronic test, electronic workshop, reports |
| 1.9       | Postgenomic medicine                                   | 2         | -         | 2         | Reports, electronic tests   |
| <b>2.</b> | <b>General and medical Genetics</b>                    | <b>3</b>  | <b>10</b> | <b>14</b> |   |
| 2.1.      | The mechanisms of heredity. Gene interactions          | -         | 2         | 3         | Interview, solving the problems, electronic test, electronic workshop   |
| 2.2.      | Genetic linkage. Biology and genetics of sex           | -         | 2         | 3         | Interview, solving the problems, electronic test, electronic workshop   |
| 2.3.      | Mutagenesis. DNA repair                                | 1         | -         | 1         | Reports, electronic tests   |
| 2.3.      | Variability  | -         | 2         | 2         | Interview, solving the problems   |
| 2.4.      | Population genetics                                    | -         | 2         | 3         | Interview, solving the problems, electronic test, electronic workshop   |
| 2.5.      | Human genetics   | 1         |           | 1         | Reports, electronic tests   |
| 2.5.      | Human genetics   | -         | 2         | 1         | Interview, solving the problems   |
| <b>3.</b> | <b>Developmental biology</b>                           | <b>1</b>  | <b>2</b>  | <b>7</b>  |   |
| 3.1.      | Human reproduction. Methods for overcoming infertility | 1         | -         | 2         | Reports, electronic tests   |
| 3.1.      | Reproduction of living matter                          | -         | 2         | 2         | Interview, test, unts of classroom practical exercises with oral defense, accounts of home practical exercises with oral defense, electronic test, electronic workshop          |
| <b>4.</b> | <b>Medical parasitology</b>                            | <b>1</b>  | <b>-</b>  | <b>9</b>  | <b>Reports, electronic tests, examination</b>   |
|           | <b>Total number of hours</b>                           | <b>12</b> | <b>28</b> | <b>50</b> |   |

## INFORMATION AND INSTRUCTIONAL UNIT

### LITERATURE

#### Basic (relevant):

1. Биология для иностранных студентов по специальности «Фармация» = Biology for international students studying «Pharmacy»: учеб.-метод пособие/ В. Э. Бутвиловский [и др.] – Минск : БГМУ, 2017. – 128 с.
2. Биология для иностранных студентов по специальности «Фармация» = Biology for international students studying «Pharmacy»: курс лекций/ В. Э. Бутвиловский [и др.] – Минск : БГМУ, 2017. – 68 с.

#### Additional:

3. Biology for international students studying «Pharmacy» : practical book/ V.E.Butvilovsky [et al.]. – 3<sup>rd</sup> edition – Minsk : BSMU, 2019 – 106 pages.
4. Medical biology : methodological recommendations for the students studying in the speciality «Pharmacy» V. E. Butvilovsky [et al.]. – Minsk : BSMU, 2018. – 40 pages.
5. Medical biology : textbook / Yu. I. Bazhora, R. Ye. Bulyk, M. M. Chesnokova [et al.]. – Vinnytsia : Nova Knyha, 2018. – 448 pages.

## TOPICS FOR SELF-STUDY

### DEVELOPMENTAL BIOLOGY

#### Ontogenesis in mammals and human

Periodization of ontogenesis. Determination of phenotype by genetic and environmental factors in ontogenesis.

Prezygotic period of ontogenesis. Prenatal period of ontogenesis. Genetic control of prenatal development. Significance of ooplasmic segregation, totipotency of zygote, selective gene expression. Interactions between parts of developing embryo. Embryonic induction, positional information of embryonic cells.

Critical periods of human prenatal ontogenesis, teratogenic factors.

Genomic imprinting. Diseases of genomic imprinting.

Periodization of postnatal ontogenesis in humans. Genetic control of postnatal ontogenesis. The influence of external and internal factors on postnatal ontogenesis. Growth and development of the organism and their regulation. Acceleration. Human constitution and habitus. Critical periods of postnatal ontogenesis.

Molecular and genetic basis of aging. Gerontology and Geriatrics. Clinical and biological death. Resuscitation and its biological aspects. Moral and ethical problems of euthanasia.

### POISONOUS AND VENOMOUS ORGANISMS

#### Poisonous and venomous organisms

Poisonousness and venomousness - universal and widespread phenomenon in living nature.

Poisonous fungi: micro- and macromycetes. Mycotoxins, their characteristics, mechanisms of action. Poisoning by mycotoxins, measures for their prevention.

Poisonous plants, their classification. Phytotoxins, their characteristics, mechanisms of action. The picture of human poisoning poisonous algae, lycopodia, horsetails, ferns, gymnosperms and angiosperms. Prevention of poisoning by poisonous plants. Poisonous plants as a source of medicinal plant raw materials and their protection.

Classification of poisonous animals. Characteristics of zootoxins.

Poisonous animals, representatives of types: Amphipods, Arthropods and Chordates (classes Cartilaginous and Bony Fishes, Amphibians and Reptiles).

Physiological characteristics of toxins of invertebrates (jellyfish, spiders, webworms) and vertebrates (fish, amphibians, reptiles), their effect on humans; first aid and preventive measures for bites and poisoning.

Zootoxins as a source of pharmacological substances. Protection of poisonous animals.

### **BIOSPHERE-AND HUMAN BEING**

The main systems of biosphere-biogeocenotic organization level of life: community, ecosystem (biogeocenosis), biosphere. The main stages of the biosphere's evolution. Noosphere.

Human ecology and its objectives. Ecological differentiation of mankind: adaptive types, their morphophysiological characteristics.

Rational use of renewable and nonrenewable natural resources. Problems of anthropogenic pollution of environment and ways of its prevention.

Valeology. Main factors of health: rational lifestyle, getting rid of bad habits, active lifestyle, full and physiologically balanced nutrition. The role of doctors in preserving health and developing ecological consciousness and thinking of the population.

### **METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF STUDENT INDEPENDENT WORK IN THE ACADEMIC DISCIPLINE**

Main forms of supervised student independent work:  
 preparation and presentation of abstracts;  
 presentation of reports;  
 studying topics and problems that have not been discussed at the lectures;  
 taking notes of original sources (sections of anthologies, collections of documents, monographs, textbooks);  
 computer testing;  
 preparation of tests for the organization of mutual assessment;  
 preparation of didactic materials;  
 participation in active forms of education;

Control of supervised student independent work is carried out in the form of:  
 test paper;  
 discussion of abstracts;  
 defense of educational assignments;

assessment of an oral reply to a question, presentation, report or problem solving;

checking up abstracts, written reports, accounts, prescriptions;  
checking up notes of original sources, monographs and articles;  
individual interview.

#### **LIST OF AVAILABLE DIAGNOSTIC TOOLS**

The following forms are used for competences assessment:

##### **Oral form:**

interviews;  
conference reports.

##### **Written form:**

tests;  
control questioning;  
reports.

##### **Oral-written form:**

accounts of classroom practical exercises with oral defense;  
accounts of home practical exercises with oral defense;  
examinations.

##### **Technical form:**

electronic tests;  
electronic workshops (practicals).

#### **LIST OF AVAILABLE TEACHING METHODS**

Traditional method (lecture, laboratory practicals);

Active (interactive) methods:

- Problem-Based Learning (PBL);
- Team-Based Learning (TBL);
- Research-Based Learning (RBL).

#### **LIST OF PRACTICAL SKILLS**

1. Work with optical instruments (magnifying glass, light microscope).
2. Solution of problems in molecular biology.
3. Solving problems on genetic patterns of inheritance of normal and pathological traits, sex-linked inheritance.
4. Drawing up and analyzing pedigrees: determining the type of disease inheritance, establishing the genotypes of all members of the pedigree.
5. Solving problems to calculate the frequencies of genes and genotypes in human populations according to the formula of the Hardy-Weinberg law.
6. Detection of Barr body.

#### **LIST OF EQUIPMENT USED**

Teaching aids, computers, computer networks, multimedia equipment, TV sets, light microscopes, electronograms, chemical reagents, spatulas, slides and covers, filter paper, magnifying glass, micropreparations, macropreparations.

**LIST OF LECTURES**

1. The flow of substance and energy passing through the cell. Cell structure.
2. Structural organization of the genome.
3. Gene expression. Epigenetics.
4. Genetic engineering.
5. Postgenomic medicine.
6. Mutagenesis. DNA repair.
7. Human genetics.
8. Reproduction of humans. Ways to overcome infertility.
9. Parasitism as a form of ecological relationships in the nature.

**LIST OF LABORATORY (PRACTICAL) STUDIES**

1. Medical biology as a science, its role in the training of a physician.  
Subject matter, objectives and methods of cytology.
2. Structural and functional organization of the cell.
3. Structural and functional organization of the genome.
4. Cell cycle.
5. Mechanism of gene expression.
6. Regulation of gene expression.
7. Genomics. DNA analysis methods.
8. Genetic engineering.
9. The mechanisms of heredity.
10. Genetic linkage. Biology and genetics of sex.
11. Variability.
12. Population genetics.
13. Human genetics.
14. Reproduction of living matter.

**PROTOCOL OF THE CURRICULUM APPROVAL  
BY OTHER DEPARTMENTS**

| Title of the discipline requiring approval | Department   | Amendments to the curriculum in the academic discipline                        | Decision of the department, which designed the curriculum |
|--|--|--|---|
| 1. Biological Chemistry                    | Department of Biological Chemistry                   | No suggestions for changes in the content of the curriculum for the discipline | (protocol # 11 of 05.06.2023);                            |
| 2. Pharmaceutical Botany                   | Department of Organization and Economics of Pharmacy | No suggestions for changes in the content of the curriculum for the discipline | (protocol # 11 of 05.06.2023);                            |

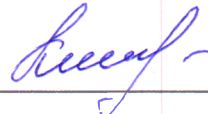


**COMPILERS/AUTHORS:**

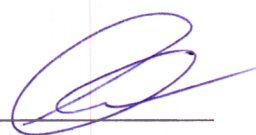
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Senior teacher of the Department of Biology of the Educational Institution «Belarusian State Medical University»

  
V.V. Grigorovich

Curriculum content, composition and the accompanying documents comply with the established requirements.

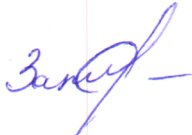
Dean of the Medical Faculty for International Students of the Educational Institution «Belarusian State Medical University»

26.06. 2023

  
O.S. Ishutin

Methodologist of the Educational Institution «Belarusian State Medical University»

26.06. 2023

  
S.V. Zaturanova