

**MINISTRY OF HEALTH OF UKRAINE**  
**ODESSA NATIONAL MEDICAL UNIVERSITY**  
**Department of medical biology and chemistry**

**APPROVED**

Vice-rector for research and educational work,

**Eduard BURYACHKOVSKY**

01 of September, 2024.

**CURRICULUM ON EDUCATIONAL DISCIPLINE**

**«MEDICAL BIOLOGY»**

**Level of higher education:** second (master's)

**branch of knowledge:** 22 «Health Care»

**speciality:** 221 «Dentistry»

**educational and professional program:** Dentistry

The curriculum is composed on the base of the educational and professional program «Dentistry» for training specialists of the second (master's) level of higher education standard of in speciality 221 «Dentistry» branch of knowledge 22 «Health care», approved by the Academic Council of ONMedU (minutes № 10 from 27 of June, 2024).

Developers:

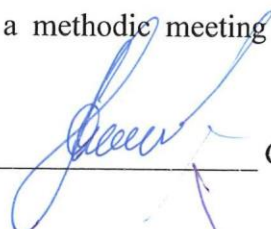
Phd of Medical Sciences, Associate Professor Alla SHEVELENKOVA,

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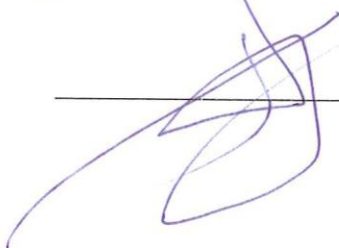
Curriculum was discussed and approved at a methodic meeting of the Department of Medical Biology and Chemistry.

Minutes № 1, 26.08.2024.

Head of the department

  
\_\_\_\_\_ Gennady STEPANOV


Agreed with the guarantor of EPP

  
\_\_\_\_\_ Anatoly GULYUK

Curriculum was approved on the meeting of the subject-cycle methodological commission for medical and biological disciplines ONMedU.

Minutes № 1, 27.08.2024.

Head of the committee for the medical and biological disciplines

  
\_\_\_\_\_ Leonid GODLEVSKY

## 1. Description of the discipline:

Name of indicators	Branch of knowledge, specialty, specialization, level of higher education	Characteristics of the discipline	
The total number of: Credits – 5 Hours – 150 Content modules – 8	branch of knowledge 22 «Health care»	<i>Full-time education</i>	
		<i>Compulsory discipline</i>	
	specialty 221 «Dentistry»  level of higher education second (master's)	<i>Year of study</i>	<i>1</i>
		<i>Semester</i>	<i>I</i>
		<i>Lectures</i>	<i>16 hours</i>
		<i>Practical classes</i>	<i>64 hours</i>
		<i>Independent work</i>	<i>70 hours</i>
		<i>Individual tasks</i>	<i>0</i>
<i>Forms of final control</i>	<i>Exam</i>		

### 1. The purpose and tasks of the discipline

**The purpose** is formation of knowledge and practical skills in human biology for further assimilation by students of the block of disciplines that provide natural-scientific and professional-practical training.

#### **The main tasks are:**

1. To explain the regularities of of manifestations of vital activity of the human body at the molecular-biological, cellular and organismal levels..
2. Explain the etiology of hereditary human diseases.
3. To determine the biological essence and mechanisms of the development of diseases arising as a result of the action of environmental factors.
4. To make preliminary conclusions about the presence of parasitic infestations of humans and to determine measures for the prevention of diseases.

**The process of studying the discipline is aimed at forming elements of the following competencies:**

#### ***Integral competencies of magister:***

Ability to solve complex problems and problems in the field of health care in the specialty "Stomatology" in professional activity or in the learning process, which involves research and/or innovation providing and is characterized by complexity and uncertainty of conditions and requirements

#### **General competencies:**

- GC1. Ability to abstract thinking, analysis and synthesis.
- GC2. Knowledge and understanding of the subject area. and understanding of professional activity.
- GC 3. Ability to apply knowledge in practice.
- GC 4. Ability to communicate in the state language both orally and in writing.
- GC 5. Ability to communicate in English.
- GC 6. Skills in the use of information and communication technologies.
- GC 7. Ability to search, process and analyze information from various sources.
- GC 8. Ability to adapt and act in a new situation.
- GC 9. Ability to identify, pose and solve problems.
- GC 10. Ability to be critical and self-critical.
- GC 11. Ability to work in a team.
- GC 12. The desire to preserve the environment.
- GC 13. Ability to act socially responsibly and consciously.

GC 14 The ability to realize one's rights and responsibilities as a member of society, to realize the values of a civil (free democratic) society and the need for its sustainable development, the rule of law, the rights and freedoms of a person and a citizen in Ukraine.

GC 15. Ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, techniques and technologies, use different types and forms physical activity for active recreation and a healthy lifestyle.

#### **Special competencies:**

SC 13. Ability to assess the impact of the environment on the health of the population (individual, family, population).

SC 15. Processing of state, social and medical information.

#### **Programm learning outcomes:**

PLO 2 Collect information about the general condition of the patient, assess the psychomotor and physical development of the patient, the condition of the organs of the maxillofacial area, based on the results of laboratory and instrumental studies to assess information about the diagnosis (list 5).

**Upon completion of the study of the discipline "Medical biology" students must know:**

- structure of a light microscope, rules for working with a microscope;
- levels of living matter organization,
- life forms and fundamental properties;
- structural and functional organization of the eukaryotic cell;
- molecular basis of heredity;
- cell cycle and types of cell division;
- basic patterns of inheritance in mono- and dihybrid cross and linked inheritance,
- inheritance of human blood groups by ABO system and Rh factor;
- inheritance of a sex and sex-linked traits;
- variation, its forms and manifestations;
- methods for the study of human heredity: genealogic, twins, dermatoglyphic, cytogenetic, molecular-genetic, biochemical and population-statistic;
- classification of hereditary diseases, principles of prenatal diagnosis of hereditary diseases;
- forms of reproduction of organisms;
- characterization of gametogenesis, structure of sex cells;
- definition of ontogenesis and its periodization, basic stages of embryonic development, molecular and cellular mechanisms of differentiation;
- classification of congenital defects, teratogenic factors;
- types of regeneration;
- types of transplantation, causes of tissue incompatibility;
- forms of symbiosis, parasitism as a biological phenomenon;
- principles of the classification of parasites and hosts;
- ways of transmission of parasitic diseases; obligatory vector-borne and facultative vector-borne diseases;
- notion of natural-focal diseases; structure of the natural focus;
- the basics of prophylaxis of parasitic diseases;
- causative agents of the most common protozoozosis, trematodosis, cestodiosis, nematodosis;
- principles of laboratory diagnosis of helminthoses
- arthropods - vectors and causative agents of human diseases, the concept of mechanical and specific(biological) vectors;
- poisonous representatives of the Arthropods;
- the concept of a population as an elementary unit of evolution, the population structure of mankind, dems, isolates;
- functional types of people's response to environmental factors ("sprinter", "stayer", "mix");

- the concept of biological rhythms, their medical significance;
- subject of ecology; types of environment, environmental factors;
- human adaptive ecotypes;
- The role of man as an environmental factor.
- examples of poisonous plants and animals for humans;
- Main directions and results of anthropogenic changes of the environment; the main statements of the biosphere and the noosphere doctrine of Academician V.I. Vernadsky;

***be able to:***

- to study microspecimens under a light microscope at low and high magnifications;
- make temporary slides,
- differentiate the components of the animal cell on microphotographs and diagrams;
- identify (schematically) the primary protein structure, the amount of amino acids, the molecular weight of the polypeptide based on the sequence of the nucleotides of the gene;
- predict genotypes and phenotypes of children by the genotypes of parents;
- calculate the probability of birth of a sick child with single gene diseases if genotypes of parents are known:
- exclude paternity by analyzing the blood groups of parents and the child;
- analyze the karyotype of a person and determine the most common chromosomal diseases;
- compose a pedigree and conduct its genealogical analysis;
- calculate the role of heredity and environment in the development of characteristics (based on the results of twins analysis);
- calculate the frequency of genes and genotypes under Hardy-Weinberg equilibrium;
- determine the place of the biological object (agents of parasitic diseases) in the system of life;
- diagnose on gross and micro- specimens agent and vectors of parasitic diseases under study;
- substantiate diagnostic methods and prophylaxis of human parasitic diseases, basing on the biology of the parasite.

## **2. Contents of the curriculum**

### **Content Module 1. Molecular and cellular levels of living matter organization**

#### **Topic 1. Introduction into the course of medical biology. Optical systems in biological research. Levels of living matter organization.**

Medical biology as a science about biological peculiarities of human vital activity, studies regularities of heredity, variation in human ontogenesis and morphophysiological and social adaptation of humans towards environment according to the biosocial nature of a man.

Modern stage of development of general and medical biology. Role of biology in the system of medical education.

Biological essence of life. Life forms, main properties and strategy of life. Levels of life organization and main biological phenomena on each level. Importance of biological knowledge about level organization for medicine.

Human place in the system of organic world. Correlation of physical, chemical, biological and social phenomena in human activities.

Methods of studying the structure and functioning of the cell. Optical systems in biological research. The structure of a light microscope and the rules for working with it. The technique of manufacturing temporary micropreparations and their study.

#### **Topic 2. Morphology of the eukaryotic cell. Structural components of cytoplasm**

Structural and functional organization of eukaryotic cell

Cytoplasm and cytoskeleton. Cyclosis. Organelles of cytoplasm - membranous and non membranous, tasks and principles of functioning. Inclusions and its functions.

### **Topic 3. Biological membranes. Transport across the cell membrane.**

Cell as an open system. Assimilation and dissimilation.

Cell membrane, its structure and functions. Compartment organization principle. Cells receptors. Transport across the cell membrane.

### **Topic 4. Structural components of nucleus. Chromosomes morphology. Human karyotype.**

Nucleus as the central information apparatus of the cell. Structural components of nucleus: nuclear membrane, karyoplasm, chromosomes, nucleolus..

Morphofunctional characteristics and classification of human chromosomes. Euchromatin and heterochromatin. Rules of the chromosomes. Chromosomes analysis. Nucleolus as a derivative of chromosomes, its role in ribosome production. Ideogram.

### **Topic 5. Molecular basis of heredity. Gene structure in eukariotes.**

Characteristics of the nucleic acids: DNA and RNA, their role in the storage and transmission of the hereditary information, chemical structure and organization, species specificity. DNA replication. Maintenance of the genetic constancy of the cells, DNA-editing and repair of DNA. Organization of information flow in the cell. Molecular basis of heredity. Gene as a unit of the genetic function. Gene structure in prokaryotes and eukaryotes. Genes: structural, regulatory genes, tRNA and rRNA. Exon-intron organization of eukaryotic gene.

### **Topic 6. Organization of information flow in a cell. Stages of protein synthesis.**

Genetic code and its properties. Molecular mechanisms of protein biosynthesis in humans. Transcription. Processing, splicing. Translation: initiation, elongation, termination. Post translation modifications of the proteins.

Regulation of gene expression in eukaryotes and prokaryotes. Molecular mechanisms of variation in humans.

### **Topic 7. Cell life cycle. Cell division. Regulation of mitotic cycle.**

Temporal organization of the cell. Life cycle of the cell (cell cycle). Types of cell division: mitosis, meiosis. Endomitosis, polyteny. Changes of the cell and its structures during the mitotic cycle (interphase and mitosis). Cell growth, growth factors. Concept of the mitotic activity. Mitosis arrest. Somatic mutations. Meiosis and its biological importance. Cultivation of cells beyond the organism. Cloning of the cells.

## **Content Module 2. Biology of individual development.**

### **Topic 8. Biological features of human reproduction. Meiosis. Gametogenesis. Fertilization.**

Peculiarities of human reproduction because of human biosocial essence.

Reproduction as a mechanism for ensuring genetic continuity in a number of generations.

Meiosis. Differences between meiosis and mitosis. The role of meiosis in maintaining of constant number of chromosomes in generations.

Gametogenesis. Features of spermatogenesis and oogenesis. The structure of human germ cells. Fertilization in humans as a restoring the diploid set of chromosomes and increasing the diversity of genes in the offspring.

### **Topic 9. Peculiarities of the prenatal period of ontogenesis and preconditions of congenital defects in humans.**

Ontogenesis: type, periods and stages.

Stages of embryonic period of the development in human.. Differentiation on the molecular-genetic, cellular and tissue levels. The problem of determination and interaction of blastomeres. Embryonic induction. Critical periods of development. Teratogenesis. Teratogenic environmental factors. Congenital defects, its classification: hereditary, exogenic, multifactorial; gametopathy, blastopathy, embryopathy, fetopathy.

Critical periods of development. Teratogenesis. Teratogenic factors of environment.

### **Topic 10. Postnatal period of human ontogenesis.**

Postembryonic period of ontogenesis, its periodization. Growth and differentiation in postnatal period.

Types and ways of repair. Types of transplantation in humans.

Aging as a final stage of human ontogenesis. Modern theories of aging.

## **Content Module 3. Regularities of heredity and variation.**

### **Topic 11. Peculiarities of human genetics. Mono- and dihybrid, polyhybrid crossing. Mendelian characters in human.**

Genetics: subject and tasks, periods; main terms and notions.

Monohybrid cross: law of dominance, law of segregation. Law of "gamete purity". Cytological basis of the laws. Test cross and its practical usage. Lethal genes. Deviations from the expected ratio.

Di- and polyhybrid cross: law of independent assortment and its cytological basis. Mendelian traits in man.

### **Topic 12. Multiple alleles. Genetics of blood groups.**

Multiple alleles. Inheritance of blood groups of ABO and MN antigen systems. Rh-factor. Rh-conflict.

Immunogenetics: subject and tasks. Tissue and species specificity of the proteins, its antigen properties.

### **Topic 13. Interaction of allele and non-allele genes. Pleyotropy.**

Gene interaction and its manifestations in different types of inheritance. Interaction of the allele (dominance, incomplete dominance, overdominance, codominance) and non allele (complementarity, epistasis, polymery) genes. Polygenic inheritance of quantitative traits.

Primary and secondary pleyotropy.

### **Topic 14. Chromosomal theory of heredity. Genetics of sex.**

Gene linkage. Peculiarities of linked inheritance. Chromosomal theory of heredity.

Mechanisms of crossing over: cytological proves and biological importance. Genetic maps of human chromosomes. Methods of human chromosome mapping. Modern state of human genome studying. Non-chromosomal heredity.

Inheritance of sex in humans. Inheritance of sex-linked diseases in humans. Sex-linked, sex-influenced and sex-limited characters.

### **Topic 15. Variation, its forms and manifestations.**

Variation, its forms and manifestations on the organism level: phenotypic and genotypic variation. Law of homologous rows of genetic variation, its practical importance.

Modification and norm of reaction. The role of modifications in human ontogenesis.

Recombination mechanisms, biological significance.

Mutations in humans and its phenotypic manifestations. Classification of mutations: genomic (numerical chromosomal aberrations), chromosomal aberrations, gene. Somatic and germ mutations. Spontaneous and induced mutations. Natural mutagenesis, induced mutagenesis. Mutagens: physical, chemical, biological. Genetic monitoring. Genetic risk of environmental pollution. The notion of antimutagens and comutagens.

## **Content Module 4. Methods of studying of human genetics. Hereditary diseases.**

### **Topic 16. Methods of human heredity studying. Pedigree and twins methods of human genetics.**

Basis of medical genetics Man as a specific subject of genetic analysis. Methods of human heredity studying.

Classification of hereditary diseases: monogenic, chromosomal, and multifactorial diseases.

Genealogic methods. Rules of pedigree composition. Pedigree analyses. Twins method. Detection of the genotype and environment influence on the manifestation of pathological characters in humans.

**Topic 17. Cytogenetic method of human genetics. Chromosomal disorders.** Classification of hereditary disorders in humans.

Chromosomal diseases caused by quantitative or qualitative chromosomal aberrations; mechanisms of its formation. Cytogenetic methods. Karyotyping. Analysis of karyotypes of patients with hereditary disorders. Detection of X and Y-chromatin as method of diagnosis of chromosomal disorders.

**Topic 18. Biochemical method. DNA-diagnostics. Single gene disorders. Population-statistics method of human genetics. Medical-genetic counseling.**

Monogenic (molecular) human diseases. which are caused by a change in the molecular structure of the gene. Hereditary metabolic diseases. Methods of diagnosis of monogenic diseases. Biochemical method of medical genetics. DNA diagnostics.

The importance of dermatoglyphic, immunological methods of medical genetics and the method of hybridization of somatic cells.

Population-statistic method. Law of constancy of genetic structure of the ideal population. Usage of Hardy-Wineberg's equilibrium for studying of the genetic structure of the population.

Medical-genetic aspects of the family. Medical-genetic counseling. Prevention of heredity diseases. Prenatal diagnosis of the heredity pathology.

**Topic 19. Final practical lesson from content modules 1-4**

**Content Module 5. Medical protozoology.**

**Topic 20. Protists. Sarcodina. Dysentery and other species of amoeba. Infusoria. Balantidium.**

Introduction into the course of medical parasitology. The origin and evolution of parasitism. Principles of parasites and host classification. Morphological and physiological adaptation of the parasites.

Prominent Parasitologists: V. A. Dogel, V. M. Beklemishev, E. N. Pavlovsky, K. I. Skryabin, O. P. Markevich, L.V. Gromashevsky etc.

Characteristics and classification of protozoa(*Protozoa*).

Phylum *Sarcomastigophora*, class *Lobosea*. Dysenteric amoeba (*Entamoeba histolytica*), intestinal amoeba (*Ent. coli*), oral amoeba (*Ent. gingivalis*). Geographical distribution, morphofunctional peculiarities, life cycles of dysenteric amoeba. Ways of infection, laboratory diagnosis and prophylaxis of amebiasis.

Infusoria (Phylum *Ciliophora*). Class *Rimostomatea*. Balantidium (*Balantidium coli*). Geographical distribution, morphofunctional peculiarities. Ways of infection, laboratory diagnosis and prophylaxis of balantidiasis.

**Topic 21.** Flagellates (*Zoomastigophora*). Lamblia, Trichomonas, Leishmania, Trypanosoma. Geographical distribution, morphology, life cycle of lamblia trichomonas, leishmania and trypanosome. Ways of infection, laboratory diagnosis and prophylaxis of lambliasis, urogenital trichomoniasis, leishmaniasis, tripanosomosis.

**Topic 22. Apycomplexa. Malaria parasites. Toxoplasma.**



Phylum *Apicomplexa*. Class *Sporozoea*. Geographical distribution, morphofunctional peculiarities, life cycles of malaria parasites and toxoplasma. Ways of infection, laboratory diagnosis and prophylaxis of malaria.

### **Content Module 6. Medical helminthology.**

#### **Topic 23. Medical helminthology. Flat worms. Flukes – agents of the human diseases.**

Medical helminthology. Flat worms – human parasites. Phylum *Plathelminthes*. Class Flukes (*Trematodes*) - agents of the human diseases. Geographical distribution, morphofunctional peculiarities, life cycle of liver fluke (*Fasciola hepatica*), cat fluke (*Opisthorchis felineus*), lung fluke (*Paragonimus westermani*). Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis.

Blood flukes – agent of parasitic diseases.

Principles and content of the main laboratory methods of diagnosis of helminthiasis.

#### **Topic 24. Tapeworms. Pork tapeworm and beef tapeworm.**

Phylum *Plathelminthes*. Class *Cestoidea*. Pork tapeworm and beef tapeworm. Class *Cestoidea*. Geographical distribution, morphofunctional peculiarities, life cycles of pork tapeworm, beef tapeworm. Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis of teniasis, cysticercosis, taeniarhynchosis.

#### **Topic 25. Dwarf tapeworm, echinococcus, alveococcus, broad tapeworm.**

Dwarf tapeworm, echinococcus, alveococcus, broad tapeworm. Geographical distribution, morphofunctional peculiarities, life cycle. Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis of hymenolepidosis, diphyllbothriasis, echinococcosis, alveococcosis.

#### **Topic 26. Nematodes. Ascaris, pinworm, whipworm.**

Phylum *Nemathelminthes*. Class *Nematoda*. Round worms as agents of the human disease. Ascaris, pinworm, whipworm. Geographical distribution, morphofunctional peculiarities, life cycle. Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis of ascariasis, enterobiosis, trichocephaliasis.

#### **Topic 27. Ancylostoma, necator, trichina worm, strongiloid, Guinea worm, filarial worms.**

Geographical distribution, morphofunctional peculiarities, life cycle of ancylostoma, necator, trichina worm, strongiloid. Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis.

Guinea worms, filarial worms as agents of human diseases. Vector-borne and natural-foci diseases. K. I. Stryabin's notion about dehelminthation and devastation, total and partial eradication of the parasites.

### **Content Module 7. Medical arachnoentomology.**

#### **Topic 28. Medical arachnoentomology. Arthropodes. Arachnoidea.**

Arthropods as pathogens and carriers of pathogens of infections and invasions. Class *Arachnoidea*. Features of morphology, nutrition and reproduction of species. Poisonous arachnids (scorpions, spiders).

Ticks morphology. The medical significance of mites as agents of diseases and ticks as vectors of human pathogens. Itch mite, follicle mite. Ixodida, Argasidae and Gamasidae ticks.

#### **Topic 29. Insects as agents and vectors of human diseases.**

Class *Insecta*. Order *Diptera*. Flies, mosquitoes, sand flies and its medical importance. Cockroaches, medical importance.

Midges: characteristics and importance as intermediate hosts of helminths.

Order *Anoplura* (Lice), *Aphaniptera* (Fleas), *Hemiptera* (Bugs). Medical importance of lice, fleas, bugs and as agents and vectors of the infectious diseases.

**Topic 30. Final practical lesson from content modules 5-7.**

**Content module 8. Biosphere and human being.**

**Topic 31. Biosphere as a system of man existence. Human ecology. Adaptation. Stress.**

Structure and functions of biosphere. Main aspects of the V. I. Vernadsky notion about biosphere organization. Noosphere. Modern concepts of biosphere. Mankind as an active geological force. Protection of biosphere in national and international programs.

Human ecology. Environment as ecological concept. Kinds of environment. Unity of organism and environment. Factors of environment. Types of ecosystems. Anthropocenosis. Anthropogenic migration of elements. Ecological prediction. Healthy, discomfort, extreme environment. Adequate and inadequate environmental conditions. Human adaptation to extreme conditions. Adaptive ecological types of humans: arctic, tropic, zones of temperate climate, deserts, highland.

The influence of anthropogenic factors of environmental pollution on the health of the population.

Characteristics of poisonous plants, fungi, animals.

**4. Structure of the discipline**

Topic	Hours			
	Total			
		Lectures	Practical classes	ISW
<b>Content Module 1. Molecular and cellular levels of living matter organization</b>				
Topic 1. Introduction into the course of medical biology. Optical systems in biological research. Levels of organization and fundamental characters of living matter. Morphology of the eukaryotic cell.	2,5	0,5	2	-
Topic 2. Morphology of the eukaryotic cell. Structural components of cytoplasm	3,5	0,5	2	1
Topic 3. Biological membranes. Transport across the cell membrane.	3	-	2	1
Topic 4. Structural components of the nucleus. Chromosomes morphology. Human karyotype.	3	1	2	-
Topic 5. Molecular basis of heredity. Gene structure in eukaryotes.	3	1	2	-
Topic 6. Organization of information flow in the cell. Stages of protein synthesis.	4	1	2	1
Topic 7. Cell cycle. Cell division. Regulation of mitotic cycle.	4	-	2	1
<i>Totally for content module 1</i>	<i>23</i>	<i>4</i>	<i>14</i>	<i>4</i>
<b>Content Module 2. Biology of individual development</b>				

Topic 8. Biological features of human reproduction. Meiosis. Gametogenesis. Fertilization.	3	-	2	
Topic 9. Peculiarities of the prenatal period of ontogenesis. Role of ontogenesis failure in human pathology.	3	-	2	1
Topic 10. Postnatal period of human ontogenesis.	7	2	2	3
<i>Totally for content module 2</i>	<i>13</i>	<i>2</i>	<i>6</i>	<i>4</i>
<b>Content Module 3. Regularities of inheritance and variation</b>				
Topic 11. Peculiarities of human genetics. Mono- and dihybrid, polyhybrid crossing. Mendelian characters in human.	4	1	2	1
Topic 12. Multiple alleles. Blood groups genetics	3,5	0,5	2	1
Topic13. Interaction of allele and non-allele genes. Pleiotropy.	3,5	0,5	2	1
Topic 14. Chromosomal theory of heredity. Genetics of sex.	3	-	2	1
Topic 15. Variation, its forms and manifestation.	7	2	2	3
<i>Totally for content module 3</i>	<i>21</i>	<i>4</i>	<i>10</i>	<i>7</i>
<b>Content Module 4. Methods of studying of human genetics. Hereditary diseases</b>				
Topic 16. Bases of human genetics. Methods of studying of human genetics. Pedigree and twins methods of human genetics	3,5	0,5	2	1
Topic 17. Cytogenetic method of human genetics. Chromosomal disorders.	4	1	2	1
Topic 18. Biochemical method. DNA-diagnostics. Populationstatistics of human genetics. Single gene disorders. Medical-genetic counselling.	7.5	0,5	2	5
Topic 19. Final practical lesson from content modules 1-4	5	-	2	3
<i>Totally for content module 4</i>	<i>20</i>	<i>2</i>	<i>8</i>	<i>10</i>
<b>Content Module 5. Medical protozoology</b>				
Topic 20. Medical biological basis of parasitism. Medical protozoology. Sarcodina. Infusoria.	4	1	2	1
Topic 21. Flagellates. Lamblia, Trichomonas, Leishmania, Trypanosoma.	3	-	2	1
Topic 22. Apycomplexa (Sporozoa). Malaria species. Toxoplasma	3	-	2	1
<i>Totally for content module 5</i>	<i>10</i>	<i>1</i>	<i>6</i>	<i>3</i>
<b>Content Module 6. Medical helminthology</b>				
Topic 23. Medical helminthology. Flat worms. Flukes as agents of human diseases.	7,5	0,5	2	5

Topic 24. Tapeworms. Pork (armed) and beef (unarmed) tape worms.	3	-	2	1
Topic 25. Dwarf tapeworm, echinococcus, alveococcus, broad tapeworm.	3	-	2	1
Topic 26. Roundworms. Ascaris, pinworm, whipworm.	4	-	2	2
Topic 26. Hookworms, trichina worm, Guinea worm.	4	-	2	2
<i>Totally for content module 6</i>	21,5	0,5	10	11
<b>Content Module 7. Medical arachnoentomology</b>				
Topic 28. Arthropodes. Arachnoidea. Spiders, Ticks.	4,5	0,5	2	2
Topic 29. Insects as agents and vectors of human diseases.	5	-	2	3
Topic 30. Final practical lesson from content modules 5-7	5	-	2	3
<i>Totally for content module 6</i>	14,5	0,5	6	8
<b>Content Module 8. Biosphere and human being</b>				
Topic 31. Human ecology. Adaptation and stress.	7	2	2	3
<i>Totally for content module 8</i>	7	2	2	3
Summary test control	9	-	2	7
Independent preparation for the exam	12	-	-	12
<b>Total (hours)</b>	<b>150</b>	<b>16</b>	<b>64</b>	<b>70</b>

## 5. Topics of the lectures / seminar / practical / laboratory classes

### 5.1. Topics of the lectures

№ 3/π	Topic	Hours
1	Lecture 1. Introduction into the medical biology. Structural and functional organization of the cell	2
2	Lecture 2. Molecular basis of heredity. Realisation of hereditary information.	2
3	Lecture 3. Postnatal period of ontogenesis. Modern aspects of regeneration and transplantation.	2
4	Lecture 4. Organism level of organization of genetic information. Laws of heredity	2
5	Lecture 5. Variation of man as a property of life and genetic phenomenon	2
6	Lecture 6. Basics of human genetics. Methods of medical genetics.	2
7	Lecture 7. Medical- biological bases of parasitism..	2
8	Lecture 8. Biosphere as a system of human existence. Human ecology	2
	Total	16

### 5.2. Topics of seminar classes

Seminar classes are not provided.

### 5.3. Topics of practical classes

№ 3/π	Topic	Hours
1	Practical class 1. Levels of organization and fundamental characters of living matter.	2

	Optical systems in biological research	
2	Practical class 2. Morphology of the eukaryotic cell. Structural components of cytoplasm	2
3	Practical class 3. Biological membranes. Transport across the cell membrane. Structural components of cytoplasm.	
4	Practical class 4. Structural components of nucleus. Chromosomes morphology. Human karyotype.	2
5	Practical class 5. Molecular basis of heredity. Gene structure in eukariotes.	2
6	Practical class 6. Organization of information flow in the cell. Stages of protein biosynthesis.	2
7	Practical class 7. Cell cycle. Cell division. Regulation of mitotic cycle.	2
8	Practical class 8. Meiosis. Gametogenesis. Fertilization.	2
9	Practical class 9. Peculiarities of the prenatal period of ontogenesis and preconditions of congenital defects in humans	2
10	Practical class 10. Postnatal period of human ontogenesis.	2
11	Practical class 11. Peculiarities of human genetics. Mono- and dihybrid, polyhybrid crossing. Mendelian characters in human.	2
12	Practical class 12. Multiple alleles. Blood groups genetics.	2
13	Practical class 13. Interaction of allele and non-allele genes. Pleiotropy.	2
14	Practical class 14. Chromosomal theory of heredity. Genetics of sex.	2
15	Practical class 15. Variation, its forms and manifestations	2
16	Practical class 16. Pedigree and twins methods of human genetics	2
17	Practical class 17. Cytogenetic method of human genetics. Chromosomal disorders.	2
18	Practical class 18. Biochemical method. DNA-diagnostics. Population-statistics of human genetics. Single gene disorders. Medical-genetic counseling.	2
19	Practical class 19. Final practical lesson from content modules 1-4	2
20	Practical class 20. Protozoa. Sarcodina. Dysentery amoeba and other amoeba species. Infusoria. Balantidium.	2
21	Practical class 21. Flagellates. Lamblia, Trichomonas, Leishmania, Trypanosoma.	2
22	Practical class 22. Apycomplexa (Sporozoa). Malaria parasites. Toxoplasma.	2
23	Practical class 23. Flat worms. Flukes. Liver fluke, cat fluke, lung fluke.	2
24	Practical class 24. Tapeworms. Pork (armed) and beef (unarmed) tape worms.	2
25	Practical class 25. Tapeworms. Dwarf tapeworm, echinococcus, alveococcus, broad tapeworm.	2
26	Practical class 26. Roundworms. Ascaris, pinworm, whipworm.	2
27	Practical class 27. Roundworms. Hookworms, trichina worm, Guinea worm.	2
28	Practical class 28. Arthropodes. Arachnoidea. Spiders, Ticks.	2
29	Practical class 29. Insects as agents and vectors of human diseases.	2
30	Practical class 30. Final practical lesson from content modules 5-7.	2
31	Practical class 31. Human ecology. Adaptation and stress.	2
32	Practical class 32. Summary test control	2
	<b>Total</b>	64

#### 5.4. Topics of laboratory classes

Laboratory classes are not provided.

#### 6. Independent work

№ з/п	Type of ISW	Hours
1	Work on the themes that are not included into the plan of classroom work	18

<b>Content Module 2. Biology of individual development</b>		
1.1	Aging as a final stage of ontogenesis. Theory of aging.	2
<b>Content Module 3. Regularities of heredity and variation</b>		
1.2	Genetic danger of environmental contamination. Notion of antimutagens and comutagens	2
<b>Content Module 4. Methods of studying of human genetics. Hereditary diseases</b>		
1.3	Methods of human genetics: dermatoglyphic, immunologic, hybridization of somatic cells	2
1.4	Application of Hardy-Weinberg equilibrium for detection of genetic structure of human population.	2
<b>Content Module 6. Medical helminthology</b>		
1.5	Blood flukes – causative agents of human diseases. Causative agents of metagonimosis, nanophyctosis	2
1.6	Guinea worm and filaria – causative agents of human diseases	2
1.7	Principles and characteristics of main laboratory methods of helminthoses diagnosis	2
<b>Content Module 7. Medical arachnoentomology</b>		
1.8	Midges: characteristics and importance as intermediate hosts of helminthes and vectors of human diseases	2
<b>Content Module 8. Interaction of individual and historical development. Biosphere and a human being.</b>		
1.9	Plants and animals poisonous to a human	2
2	<i>Preparation for practical classes</i>	29
3	<i>Preparation for Summary test control</i>	7
4	<i>Preparation for content Module controls</i>	6
5	<i>Preparation for exam</i>	10
	<b>Total</b>	<b>70</b>

## 7. Teaching methods

### Lectures.

**Practical classes:** heuristic conversation, explanations, discussion, case studies, practical work.

**Independent work:** independent work with the textbooks from main and additional list of the literature, independent work with the data base, solving of MCQ tasks for Krok-1, independent case studies.

## 8. Forms of control and methods of evaluation (including criteria for evaluating the results of training)

**Current control** is carried out on the basis of control of theoretical knowledge, practical skills and abilities: oral survey, testing, assessment of practical skills conducting, case studies, assessment of activity in the classroom.

**Final control:** exam.

### *The structure of the current assessment in the practical lesson:*

1. Assessment of theoretical knowledge on the topic of the lesson:

- methods: recitation, interview, case studies;
  - maximum point - 5, minimum point - 3, unsatisfactory point - 2.
2. Assessment of practical skills and abilities on the topic of the lesson:
- Case studies, methods: assessing the accuracy of practical skills conducting
  - maximum point- 5, minimum point - 3, unsatisfactory point - 2;

**Criteria for current assessment in the practical class:**

Excellent «5»	The student is fluent in the material, takes an active part in the discussion and case studies, confidently demonstrates practical skills during performing and interpreting of practical work on the topic of the lesson, expresses his opinion on the topic of the lesson.
Good «4»	The student is well versed in the material, participates in the discussion and case studies, demonstrates practical skills while performing practical work with some mistakes, expresses his opinion on the topic of the lesson.
Satisfactorily «3»	The student does not have enough knowledge on theoretical material, insecurely participates in the discussion and case studies, performs practical work with significant errors.
Unsatisfactorily «2»	The student does not have knowledge on theoretical material, does not participate in the discussion and case studies, does not demonstrate practical skills during the practical work on the topic of the lesson.

Only those applicants who have fulfilled the requirements of the training program in the discipline, have no academic debt, their average score for the current educational activity in the discipline is at least 3.00, and they have passed the test control according to the tests "Krock - 1" are admitted to the final control in the form of an exam. » at least 90% (50 tasks). Test control is carried out in the the Educational and production complex of innovative technologies of learning, informatization and internal monitoring of the quality of education of the University at the last lesson

**Evaluation of the results of the students' training during the final control - exam.**

The method of final control in the form of an exam is unified and involves the use of standardized forms. The number of questions submitted to the exam corresponds to the amount of credits assigned to the study of the academic discipline.

The ticket form is standardized and consists of structural elements (components): theoretical questions and practical tasks (situational tasks, case tasks, descriptions, etc.).

**Exam structure**

The content of the evaluation activity	Number
Answer to theoretical questions	2
Practical task on medical genetics	1
Practical task for parasite identification	1

Theoretical questions are short, simple, understandable, clear and transparent, a complete answer to one theoretical question lasts no more than 5 minutes. Practical tasks are clearly and clearly formulated, a complete answer to one practical question lasts no more than 5 minutes. The timing of the exam is standard - no more than 30 minutes.

For each ticket, a check list (answer standard) is drawn up, which provides full correlation with the ticket, contains a similar number of structural elements (components), has answer standards, which are mandatory for providing complete answers to the questions.

During the exam, the applicant receives a ticket, and the examiners use a check sheet for the corresponding ticket with reference answers and determine which mandatory components of the answer were named or not named by the applicant.

The overall grade for the exam is calculated as the arithmetic average of all grades obtained for answers to theoretical questions and practical tasks on a traditional four-point scale, rounded to two decimal places.

The exam is held in the Educational and production complex of innovative technologies of learning, informatization and internal monitoring of the quality of education of the University during the examination sessions at the end of the semester (autumn and spring) according to the schedule.

### 9. Distribution of points obtained by applicants of higher education

The obtained average score for the academic discipline for applicants who have successfully mastered the work program of the academic discipline is converted from a traditional four-point scale to points on a 200-point scale, as shown in the table:

**Conversion table of a traditional assessment into a multi-point scale**

National grade for the discipline	Multipoint 200-point scale
«5»	185-200
«4»	151-184
«3»	120-150

A multi-point scale (200-point scale) characterizes the actual success of each applicant in learning the educational component. The conversion of the traditional grade (average score for the academic discipline) into a 200-point grade is performed by the information and technical department of the University.

According to the obtained points on a 200-point scale, the achievements of the applicants are evaluated according to the ECTS rating scale. Further ranking according to the ECTS rating scale allows you to evaluate the achievements of students from the educational component who are studying in the same course of the same specialty, according to the points they received.

The ECTS scale is a relative-comparative rating, which establishes the applicant's belonging to the group of better or worse among the reference group of fellow students (faculty, specialty). An "A" grade on the ECTS scale cannot be equal to an "excellent" grade, a "B" grade to a "good" grade, etc. When converting from a multi-point scale, the limits of grades "A", "B", "C", "D", "E" according to the ECTS scale do not coincide with the limits of grades "5", "4", "3" according to the traditional scale. Acquirers who have received grades of "FX" and "F" ("2") are not included in the list of ranked acquirers. The grade "FX" is awarded to students who have obtained the minimum number of points for the current learning activity, but who have not passed the final examination. A grade of "F" is assigned to students who have attended all classes in the discipline, but have not achieved a grade point average (3.00) for the current academic activity and are not admitted to the final examination.

According to the points got on a 200-point scale, students are evaluated on a rating scale ECTS. Students enrolled in one course (one specialty) based on the number of points scored in the discipline are ranked on a scale according to ECTS system by the following way:

### Conversion of the traditional grade from the discipline and the sum of points on the ECTS scale

ECTS Point	Statistics indicator
«A»	The best 10 % of the students
«B»	Next 25 % students
«C»	Next 30 % students
«D»	Next 25 % students
«E»	The last 10 % students



## 10. Methodological support of the discipline

- Curriculum of the discipline;
- Syllabus of the discipline;
- Power point presentations of lectures;
- Methodological recommendations and developments for the teacher;
- Methodical instructions for students for practical classes;
- Methodical materials providing independent work of students;
- Electronic data bank of MCQ tasks by Modules of the discipline.

## 11. List of control questions for the exam

1. Definition of biology as a science. The place and the goals of biology in medical education. Definition of life according to a modern level of biology science. Life forms, main properties and strategy of life. Levels of life organization
2. Cell as an elementary structural and functional unit of living matter. Cell theory, its modern state and importance for medicine. The pro- and eukaryotic cell.
3. Morphology and physiology of the cell. Cytoplasm and organelles.
4. Cell membranes. Chemical composition of the cytoplasmic membrane. Its structure and functions.
5. The structure of the cell nucleus during interphase. Chromatin: levels of organization (condensation) of hereditary material (euchromatin, heterochromatin).
6. Chemical composition of chromosomes. The structure of chromosomes in metaphase of mitosis. Shapes of metaphase chromosomes.
7. Karyotype of human. The classification of human chromosomes. The significance of the karyotype studying in medicine.
8. Nucleic acids. DNA structure and functions. DNA replication, its role.
9. Peculiarities of RNA structure. Types of RNA and functions.
10. The structure of eukaryotic gene. Classification of genes.
11. The genetic code and its properties.
12. The main stages of protein biosynthesis in the cell.
13. Translation: initiation, elongation, termination. Posttranslational modification.
14. Peculiarities of realization of hereditary information in eukaryotes. Exon-and-intron organization of eukaryotic genes. Processing, splicing.
15. Cell cycle, its periods. Mitosis. Failure of mitosis.
16. Meiosis. Mechanisms of genetic variation in gametes.
17. Subject and goals of human genetics and medical genetics. Heredity and variation. Allele genes. Homozygotes and heterozygotes. Genotype, phenotype
18. Monohybrid cross. First and second Mendel's laws. Mendelian characters in man. Single gene disorders.
19. Di and polyhybrid cross. Third Mendel law
20. Multiple alleles. Inheritance of ABO blood groups and Rh-factor. Significance for medicine. Rh-conflict.
21. Interaction of allelic genes: dominance, incomplete dominance, co-dominance.
22. Interactions of non-allelic genes: complementary, epistasis, polymery.
23. Pleiotropy.
24. Linked inheritance (the law of Morgan). Crossing over.
25. Chromosomal theory of heredity.
26. Determination of sex in humans. Chromosomal disorders caused by abnormal number of sex chromosomes.
27. Sex-linked inheritance.
28. Variation, its forms and importance for ontogenesis and evolution.
29. Modification, its characteristics. Norm of reaction. Phenocopy.

30. Genotypic variation, its forms. Recombination. Mechanisms of origin and significance.
31. Mutations and its phenotypic manifestations. Classification of mutations according to the genotype changes. Spontaneous and induced mutations
32. Gene mutations, mechanisms of origin. The concept of single gene disorders.
33. Chromosomal aberrations. Mechanisms. Examples of the diseases.
34. Genome mutations (numerical chromosomal aberration): polyploidy, haploidy, monosomy, polysomy.
35. Chromosomal disorders caused by abnormal number of autosomes and sex chromosomes.
36. Mutations in germ and somatic cells, their significance. Mosaicism.
37. Spontaneous and induced mutations. Mutagenic agents, its classification. Genetic monitoring.
38. Classification of hereditary disorders. Disorders with hereditary predisposition. Concept of multifactorial disorders.
39. Genealogic method (pedigree analysis) and twins methods of medical genetics.
40. Biochemical method for the study of genetic diseases. Screening programs.
41. Methods of DNA analysis
42. Cytogenetic methods of medical genetics.
43. Population-statistical method of human genetics.
44. Structure of human population. Dem, isolate.
45. Multiplication as universal characteristics of life. Forms of multiplication. Organism cloning.
46. Gametogenesis. Spermatogenesis and oogenesis. Human germ cells. Fertilization. Peculiarities in human
47. Ontogenesis, its periods. Embryonic development, its stages. Provisory organs.
48. Molecular and cellular mechanisms of differentiation. Embryonic induction.
49. Critical periods of embryonic development in human. Teratogenic factors.
50. Modern classification of congenital defects: hereditary, teratogenic, multifactorial, embryopathy, fetopathy, phylogenetic (ancestral) and non-phylogenetic.
51. Postnatal development of man and its periodization. Neuro-hormonal regulation of growth and development.
52. Aging as a stage of ontogenesis. Theories of aging. The concept of gerontology and Geriatrics.
53. Clinical and biological death.
54. Regeneration of tissues and organs. Types of regeneration, importance for medicine.
55. Problems of transplantation. Types of transplants (grafts). Problem of graft rejection.
56. Parasitism as biological phenomenon The principles of interaction between the parasite and the host. Morphological adaptation of the parasites.
57. Vector-borne (transmissible) disease. Facultative-transmissible and obligate-transmissible diseases. Specific and mechanical vectors.
58. Classification of parasites (obligate, facultative, temporary, constant, endo- and exoparasites). The definitive and intermediate hosts.
59. Natural focal diseases. The components of the natural focus. Examples of diseases. Anthroponotic and zoonotic diseases.
60. Giardia Lamblia, the name of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of disease
61. Trichomonas vaginalis, the name of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of disease.
62. Agents of cutaneous and visceral leishmaniasis, the names of diseases, morphology, life cycles of parasites. Way of transmission, the principles of diagnosis and prevention of diseases.
63. Trypanosoma species, names of the diseases, morphology, life cycles of parasites. Way of transmission, the principles of diagnosis and prevention of the diseases.
64. Dysentery amoeba, name of the disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
65. Balantidium, name of the disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.

66. Plasmodium (malaria parasite) species, the names of the diseases, morphology, life cycles of parasites. Way of transmission, the principles of diagnosis and prevention of the disease.
67. Toxoplasma, the names of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
68. Liver fluke, the names of disease, morphology, life cycles of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
69. Cat (Siberian) fluke, the names of disease, morphology, life cycle of parasites. Way of transmission, the principles of diagnosis and prevention of the disease.
70. Lung fluke, the names of diseases morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
71. Chinese, lancet, blood flukes. The names of diseases, morphology, life cycles of parasites. Way of transmission, the principles of diagnosis and prevention of the diseases.
72. Pork (armed) tapeworm, the names of diseases, morphology, life cycle of parasites. Way of transmission, the principles of diagnosis and prevention of the diseases.
73. Beef (unarmed) tapeworm, the names of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
74. Cysticercosis. Modes of transmission and prevention measures.
75. Dwarf tapeworm, the names of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
76. Echinococcus and alveococcus. The names of diseases, morphology, life cycles of parasites. Way of transmission, the principles of diagnosis and prevention of the diseases.
77. Broad (fish) tapeworm, the names of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
78. Ascaris, the names of disease, morphology, life cycle of parasites. Way of transmission, the principles of diagnosis and prevention of disease. Larva of animal round worms as the agents of the diseases (*Larva migrans* syndrome).
79. Pinworm. The name of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
80. Whipworm, the names of disease, morphology, life cycles of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
81. Ancilostomids (american hookworm and hookworm), the names of diseases, morphology, life cycles of parasites. Way of transmission, the principles of diagnosis and prevention of the diseases.
82. Trichina worm, the name of disease, morphology, life cycle of parasites. Way of transmission, the principles of diagnosis and prevention of diseases.
83. Guinea worm. The name of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
84. Filaria worms: Wuchereria Bancrofti, Brugia, loa loa, onchocercus. The names of diseases, morphology, life cycles of parasites. Way of transmission, the principles of diagnosis and prevention of the diseases.
85. Laboratory diagnostics of helminthes. Ovo-, larvo- and helminthoscopy.
86. Phylum Arthropoda. Classification, morphology, medical importance. Poisonous Arthropods.
87. Mites as human pathogens (itch mite and follicle mite).
88. Ticks as the vectors of human diseases (Ixodidae, Gamasidae and Argasidae ticks).
89. Class Insecta. Morphology, peculiarities of development, medical importance
90. Flies. Species of the flies. Peculiarities of the morphology and life cycle, medical importance.
91. Mosquitoes. Species, peculiarities of the structure and development, medical importance.
92. Lice. Species, morphology and life cycle, medical importance.
93. Fleas. Morphology and life cycle. Species of fleas. Bed bug and its medical importance.
94. Problems of genetic load and an influence of mutagens (radiation, chemical ones) on human population. Functional types of people respond to environmental stress ("sprinter", "stayer", "mixt")
95. Doctrine of biosphere and noosphere. Functions of living matter.

96. Medical and biological aspects of biosphere influence on human health. Biological fields and biorhythms, its medical importance.
97. Ecology. Environment as an ecological notion. Types of environment. Ecological factors. The unity of an organism and environment.
98. Biological variation in humans as the reflection of biogeographic peculiarities of the environment. Adaptive ecotypes of man.
99. Man as an environmental factor. The main directions and results of anthropogenic environmental changes. Protection of the environment.
100. Plants, fungi and animals poisonous for human.

### **List of practical skills that are controlled during the exam:**

- to analyze a human karyotype, to identify chromosomal disorder and type of mutation
- to identify the primary structure of polypeptide, amino acids number, molecular weight of it by the sequence of nucleotides in gene
- to determine genotypes and phenotypes of offspring by the genotypes of the parents
- to calculate the probability of birth of a sick child with monogenic diseases if genotypes of parents are known
- to exclude paternity by determining blood groups of parents and child
- to analyze a pedigree, determine mode of inheritance and genotypes of affected individuals;
- to calculate the role of heredity and environment in formation of certain trait (based on the results of twins analysis);
- to calculate the frequency of genes and genotypes by Hardy-Weinberg equilibrium rule;
- to identify on gross and micro specimen and microphotographs the agents of parasitic diseases on different life stages and substantiate laboratory diagnosis and prophylaxis of human parasitic diseases based on their modes of infection
- to identify on gross and micro specimen and microphotographs arthropods that have medical importance as venomous animals and vectors of human diseases, to propose the laboratory diagnosis and prophylaxis of parasitic diseases

## **12. List of recommended materials**

### **Main literature**

1. Medical biology. Yu. I. Bazhora, R. Ye. Bulyk, M.M. Chesnokova, A. V. Shevelenkova, O.O. Smetyuk, Yu. V. Lomakina. - Vinnytsya: Nova Knyha – 2019. - P.448

### **Additional literature**

1. Before we are born : Essentials of embryology and birth defects / Keith L. Moore, T. V. N. Persaud, Mark G. Torchia. – 9th ed. – Elsevier, 2016. – 348 pp.
2. Campbell biology / Lisa Urry, Michael Cain, Steven Wasserman, Peter Minorsky, Jane Reece. – 11th restricted ed. – Hoboken : Pearson Higher Education, 2016. - 560pp
3. Chiodini P. L. Atlas of Medical Helminthology and Protozoology 4th ed. – Churchill Livingstone, 2003. – 87 pp.
4. Emery's Elements of medical genetics. 15th ed. / Peter Turnpenny, Sian Ellard. – Elsevier, 2017. – 400 pp.
5. Essential Cell Biology by Bruce Alberts [et al] 4<sup>th</sup> edition – 2014 – 864 pp.
6. Human parasitology / Bruton J. Bogitsh, Clint E. Carter. – 4th ed. – Elsevier, 2013. – 430 pp.
7. Langman's medical embryology / T. W. Salder. – 14th ed. – Wolter Kluwer Health, 2018. – 423 pp.
8. Lynn B. Jorde, John C. Carey, Michael J. Bamshad. Medical genetics. 5th ed. Elsevier, 2016. 356 pp.

9. Markell and Voge's Medical parasitology / David. T. John, William A. Petri. – 9th ed. – Elsevier, 2017. – 463 pp.
10. Vogel and Motulsky's human genetics. Problems and approaches / M. R. Speicher, S. E. Antonarakis, F. G. Motulsky. 4th edition. – Springer, 2010. – 981 pp.
11. Young Ian. D. Medical genetics. – 2nd ed. – Oxford university press, 2010. – 304 pp.

**Information resources:**

1. Testing Center - the base of licensing test tasks "Krok" - 1: <http://testcentr.org.ua/>
2. OMIM (Online Mendelian Inheritance in Man) – An Online Catalog of Human Genes and Genetic Disorders <http://omim.org/>
3. The tech interactive: <https://genetics.thetech.org/genetics-news>
4. Phys.org internet news portal provides the latest news on science. <https://phys.org/biology-news/>
5. Sci-News.com provides the latest science news from around the world, covering breaking news in astronomy and astrophysics, archaeology, paleontology, medicine, biology, physics, genetics & more <http://www.sci-news.com/news/biology>
6. link to the most thought-provoking, well researched online items in the world of science and technology <https://scitechdaily.com/news/biology/>
7. Web atlas of medical parasitology <http://www.atlas.or.kr/about/index.html>