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 September 2024

CURRICULUM ON EDUCATIONAL DISCIPLINE

«MEDICAL BIOLOGY»

Level of higher education: second (master's)

branch of knowledge: 22 «Health Care»

specialty: 222 «Medicine»

educational and professional program: Medicine

2024

The curriculum is composed on the base of the educational and professional program «Medicine» for training specialists of the second (master's) level of higher education standard of in speciality 222 «Medicine» 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,
Phd of Medical Sciences, Associate Professor Marina CHESNOKOVA.

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, professor. Gennady STEPANOV

Agreed with the guarantor of EPP Valeria MARICHEREDA

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 sections – 8	branch of knowledge 22 «Health care» speciality 222 «Medicine» level of higher education second (master's)	*Full-time education*	
		Compulsory discipline	
		Year of study	*1*
		Semester	*I-II*
		Lectures	*22 hours*
		Practical classes	*64 hours*
		Independent work	*64 hours*
		Individual tasks	*0*
		Forms of final control	*Exam*

2.The purpose and tasks of the discipline, competencies, program learning outcomes.

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 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. To determine the biological essence and mechanisms of the development of diseases arising as a result of the action of environmental factors.
3. Explain the etiology of hereditary human diseases.
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:

General competencies:

GC1. Ability to abstract thinking, analysis and synthesis
GC4. Knowledge and understanding of the subject area and understanding of professional activity
GC11. Ability to search, process and analyze information from various sources
GC13. Awareness of equal opportunities and gender issues
GC15. Ability to preserve and increase 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, technology and technologies, to use various types and forms of motor activity for active recreation and leading a healthy lifestyle
GC 16. Ability to evaluate and ensure the quality of the work performed.
GC 17. Desire to preserve the environment

Special competencies:

SC2. Ability to determine the necessary list of laboratory and instrumental studies and evaluate their results
SC17. Ability to assess the impact of the environment, socio-economic and biological determinants on the state of health of an individual, family, population

SC24. Adherence to ethical principles when working with patients and laboratory animals
SC28. Ability to apply fundamental biomedical knowledge at a level sufficient to perform professional tasks in the field of health care

Program learning outcomes:

PLO2. Understanding and knowledge of basic and clinical biomedical sciences, at a level sufficient for solving professional tasks in the field of health care.
PLO21. Searching for the necessary information in the professional literature and databases of other sources, analysing, evaluating and application of this information.
PLO23. Assessment of the impact of the environment on human health to assess the morbidity of the population.
PLO24. Organization of the necessary level of individual safety (own and the persons he cares for) in case of typical dangerous situations in the individual field of activity.
PLO28. Making effective decisions on health care issues, assessing the necessary resources, and taking into account social, economic and ethical consequences.

Upon completion of the study of the discipline "Medical biology" students must

Know:

- 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 AB0 system and Rh factor;
- inheritance of a sex and sex-linked traits;
- variation, its forms and manifestations;
- methods for the study of human heredity: genealogical, twins, dermatoglyphic, cytogenetic, molecular genetic, biochemical and population-statistical;
- 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 ofr 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 protozoosis, trematodosis, cestodiosis, nematodosis; principles of laboratory diagnosis of helminthiasis;
- 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"); human adaptive ecotypes;
- the concept of biological rhythms, their medical significance;
- subject of ecology; types of environment, environmental factors;
- The role of man as an environmental factor. 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;
- examples of poisonous plants and animals for humans;

be able to:

- make temporary slides, to study micro specimens under a light microscope at low and high magnifications;
- 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 law;
- 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.

3. Content of the academic discipline

Content section 1. Molecular and cellular levels of living matter organization

Topic 1. Introduction into the course of medical biology. Optical system 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.

Topic 2. Morphology of the eukaryotic cell.

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. Active and passive transport.

Organization of substances and energy flow in cell. Stage of dissimilation. Provision of energy, ATP. Energy distribution.

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 eukaryotes.

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. Genetic code and its properties. 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. Stages of protein synthesis. Regulation of gene expression in prokaryotes and eukaryotes.

Molecular mechanisms of heredity in humans. Transcription. Processing, splicing. Translation: initiation, elongation, termination. Post translation modifications of the proteins.

Regulation of gene expression in prokaryotes. Operon system. Peculiarities of gene activity regulation in eukaryotes. 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, 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 section 2. Biology of individual development

Topic 8. Biological peculiarities of human reproduction. Meiosis. Gametogenesis. Fertilization.

Peculiarities of the human reproduction as a result of his biosocial nature. Reproduction as a mechanism that provides morphogenetic continuity of generations. Gametogenesis. Fertilization in humans – restoration of diploid set of the chromosomes, recombination in posterity.

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

Ontogenesis: type, periods and stages. Embryonic period of the development in human.. Differentiation on the moleculargenetic, cellular and tissue levels. Congenital defects, its classification: hereditary, exogenic, multifactorial; gametopathy, blastopathy, embryopathy, phetopathy.

Regulation of gene function in ontogenesis. Experimental studying of embryonic development. Problem of differentiation and interaction of blastomeres. Embryonic induction. Regulation of cleavage and its failure (twins, congenital defects)

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. Peculiarities of the postnatal period of human development because of its biosocial nature.

Biological fields, biological rhythms and its medical importance. Types and ways of repair. Types of transplantation in humans.

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

Content section 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. Principles of hybridological analysis.

Monohybrid cross: low of dominance, low of segregation. Low of “gamete purity”. Cytological basis of the lows.

Test cross and its practical usage.

Lethal genes. Deviations from the expected ratio.

Di- and polyhybrid cross: low of independent assortment and its cytological basis.

Dominant and recessive modes of inheritance of normal and pathological characters. Intermediate inheritance in humans.

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. Hemizygocity. Genetics of sex. Mechanisms of genetic differentiation in humans and its failure. Bisexual nature of humans. Psychosocial aspects.

Topic 15. Mutations, their forms and manifestation. Variation, its forms and manifestations on the organism level: phenotypic and genotypic variation. Modification and norm of reaction. Prolonged modifications. Statistic regularities of modification. Main differences between modifications and mutations. The role of modifications in human ontogenesis. Genotypic variation: recombination and mutations. Recombination mechanisms, biological significance.

Mutations in humans and its phenotypic manifestations. Classification of mutations: genomic (numerrical 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 comutagenes.

Low of homological rows of genetic variation, its practical importance.

Content section 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.

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.

Dermatoglyphic, immunological methods and hybridization of somatic cells.

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.

Single gene (molecular) diseases: inborn errors of metabolism, diseases of the protein, amino acids, carbohydrate, lipids, nucleic acids, minerals, vitamins, hormones metabolism. Mechanisms of its development and principles of laboratory diagnosis. .

Gene engineering. Biotechnology. Gene therapy.

Population-statistic method. Low 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. Summary class on content sections 1 - 4.

Content section 5. Medical protozoology.

Topic 20. Protozoa. Sarcodina. Dysentery amoeba and other amoeba species. Infusoria. Balantidium.

Introduction into the course of medical parasitology. The origin and evolution of parasitism.Principles of parasites classification. The principles of interaction between the parasite and the host. Morphological adaptation of the parasites. The concept of intensity and extensiveness of invasion.

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

Characteristics and classification of protozoa.

Sarcodina. 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. Balantidium.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.

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

Geographical distribution, morphofunctional peculiarities, life cycles of toxoplasma. Ways of infection, laboratory diagnosis and prophylaxis of toxoplasmosis Methods of laboratory diagnosis of the diseases.

Content section 6. Medical helmintology.

Topic 23. 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*), lancet fluke (*Dicrocoelium lanceatum*), lung fluke (*Paragonimus westermani*). Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis.

Agents of metagonimosis, nanophietosis.

Blood flukes – agent of parasitic diseases.

Mollusks, crustacean and chordates as intermediate hosts of helminthes.

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, teaeniarhynchosis.

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, diphyllobothriasis, 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, enterobiois, 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.

Principles and tecniques of the main micro- and macroscopic methods of stool test, water, soil and etc. for detection of helminthes. Peculiarities of egg morphology of the flukes, tapeworms and roundworms. K. I. Scryabin's notion about dehelminthation and devastation, total and partial eradication of the parasites.

Content section 7. Medical arachnoentomology.

Topic 28. Arthropodes. Arachnoidea. Spiders, ticks.

Arthropods as pathogens and carriers of pathogens of infections and invasions. Class *Arachnoidea*. Features of morphology, nutrition and reproduction of species. Poisonous arachnides (scorpions, spiders). The medical significance of ticks as agents of diseases and vectors of human pathogens.

Mites - dwellers of human shelters and their medical significance.

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. **Summary class on content sections 5 - 7**.

Content section 8. Biosphere and human being.

Topic 31. Biosphere as human environment. Human ecology. Adaptation to environment. 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. 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.

Characteristics of poisonous plants, fungi, animals.

4. Structure of the academic discipline

Topic	Hours			
	Total			
		Lectures	Practical classes	ISW
Content section 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 organization and fundamental characters of living matter.	2,5	0,5	2	-
Topic 2. Morphology of the eukaryotic cell.	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.	4	1	2	1
Topic 5. Molecular basis of heredity. Gene structure in eukaryotes.	4	1	2	1
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	1	2	1
Total for content section 1	*25*	*5*	*14*	*6*
Content section 2. Biology of individual development				
Topic 8. Meiosis. Gametogenesis. Fertilization.	4	1	2	1
Topic 9. Peculiarities of the prenatal period of ontogenesis. Role of ontogenesis failure in human pathology.	5	2	2	1
Topic 10. Postnatal period of human ontogenesis.	7	2	2	3
Total for content section 2	*16*	*5*	*6*	*5*
Content section 3. Regularities of heredity and variation				
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
Topic 13. Interaction of allele and non-allele genes. Pleiotropy.	3,5	0,5	2	1
Topic 14. Chromosomal theory of heredity. Genetics of sex.	5	2	2	1
Topic 15. Variation, its forms and manifestation.	7	2	2	3
Total for content section 3	*23*	*6*	*10*	*7*
Content section 4. Methods of studying of human genetics. Hereditary diseases				
Topic 16. Bases of human genetics. Methods of studying of human genetics. Pedigree and twins methods of human genetics	5,5	0,5	2	3
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.	5,5	0,5	2	3
Topic 19. Summary class on content sections 1 - 4.	7	-	2	5
Total for content section 4	*22*	*2*	*8*	*12*
Content section 5. Medical protozoology				
Topic 20 Protozoa. Sarcodina. Dysentery amoeba and other amoeba species. Infusoria. Balantidium.	4	1	2	1
Topic 21. Flagellates. Lamblia, Trichomonas, Leishmania, Trypanosoma.	3	-	2	1
Topic 22. Apycomplexa (Sporozoa). Malaria parasites. Toxoplasma	3	-	2	1
Total for content section 5	*10*	*1*	*6*	*3*
Content section 6. Medical helminthology				
Topic 23. Flat worms. Flukes as human parasites	6	1	2	3
Topic 24. Tapeworms. Pork (armed) and beef (unarmed) tape worms.	3	-	2	1
Topic 25. Tapeworms. Dwarf tapeworm, echinococcus, alveococcus, broad tapeworm.	3	-	2	1
Topic 26. Roundworms. Ascaris, pinworm, whipworm.	4	-	2	2
Topic 27. Roundworms. Hookworm, American hookworm, trichina worm, Guinea worm.	3	-	2	1
Total for content section 6	*19*	*1*	*10*	*8*
Content section 7. Medical arachnoentomology				
Topic 28. Arthropodes. Arachnoidea. Spiders, Ticks.	3	-	2	1
Topic 29. Insects as agents and vectors of human diseases.	4	-	2	2
Topic 30. Summary class on content sections 5 - 7.	5		2	3
Total for content section 7	*12*	-	*6*	*6*
Content section 8. Interaction between ontogenesis and phylogenesis. Biosphere and human being				
Topic 31. Biosphere as a system of human existence. Human ecology. Adaptation and stress.	7	2	2	3
Total for content section 8	*7*	*2*	*2*	*3*
Summary test control	6	-	2	4
Independent preparation for the exam	10	-	-	10
Total (hours)	**150**	**22**	**64**	**64**

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

5.1. Topics of the lectures

№ з/п	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. Realization of hereditary information.	2
3	Lecture 3. Cell division. Regulation of the cell cycle.	2
4	Lecture 4. Molecular – genetic mechanisms of ontogenesis. Ontogenesis failure and its role in human pathology.	2
5	Lecture 5. Modern aspects of regeneration and transplantation. Biological mechanisms of homeostasis.	2
6	Lecture 6. Organism level of organization of genetic information. Laws of heredity	2
7	Lecture 7. Gene interactions. Chromosomal theory of heredity	2
8	Lecture 8. Variation of man as a property of life and genetic phenomenon	2
9	Lecture 9. Basics of human genetics. Methods of medical genetics.	2
10	Lecture 10. Medical- biological bases of parasitism..	2
11	Lecture 11. Biosphere as a system of human existence. Human ecology	2
	Total	22

5.2. Topics of seminar classes

Seminar classes are not planned.

5.3. Topics of practical classes

№ з/п	Topic	Hours
1	Practical class 1. Levels of organization and fundamental characters of living matter. Optical systems in biological researches	2
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.	2
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	2

	human genetics. Single gene disorders. Medical-genetic counseling.	
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. Apicomplexa (Sporozoa). Malaria parasites. Toxoplasma.	2
23	Practical class 23. Flat worms. Flukes. Liver fluke, cat fluke, Chinese liver fluke, lung fluke and lancet fluke.	2
24	Practical class 24. 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. Hookworm, American hookworm, 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
	Total	**64**

5.3. Topics of laboratory classes

Laboratory classes are not planned.

6. Independent work

№ з/п	Type of ISW	Hours
1	*Work on the themes that are not included into the plan of classroom work*	*16*
Content section 2. Biology of individual development		
	Aging as a final stage of ontogenesis. Theory of aging.	2
Content section 3. Regularities of heredity and variation		
	Genetic danger of environmental contamination. Notion of antimutagenes and comutagenes	1
Content section 4. Methods of studying of human genetics. Hereditary diseases		
	Methods of human genetics: dermatoglyphic, immunologic, hybridization of somatic cells	2
	Application of Hardy-Weinberg equilibrium for detection of genetic structure of human population.	2
Content section 6. Medical helminthology		
	Blood flukes – causative agents of human diseases. Causative agents of metagonimosis, nanophyetosis	2
	Guinea worm and filaria – causative agents of human diseases	2
	Principles and .characteristics of main laboratory methods of helminthoses diagnosis	2
Content section 7. Medical arachnoentomology		
	Midges: characteristics and importance as intermediate hosts of helminthes and vectors of human diseases	1

Content section 8. Interaction of individual and historical development. Biosphere and a human being.		
	Plants and animals poisonous to a human	2
2	*Preparation for practical classes*	*26*
3	*Preparation for Summary test control*	*4*
4	*Preparation for content section controls*	*8*
5	*Preparation for exam*	*10*
	Total	**64**

7. Teaching methods

Lectures.

Practical classes: conversation, explanations, 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 evaluation methods (including criteria for evaluating learning outcomes)

Current control is carried out on the basis of control of theoretical knowledge, practical skills and abilities: recitation, 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 theaccuracy of practical skills conducting
- maximum point- 5, minimum point - 3, unsatisfactory point - 2;

The grade for one practical session is the arithmetic average of all components and can only have a w value (5, 4, 3, 2), which is rounded according to the statistical method.

Criteria for current assessment in the practical class

Grade	Criteria for assessment
Exellent «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 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 number 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.).

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 sections of the discipline.

11. List of control questions for the summary control

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. Mophology 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. Its function. Chromatin and levels of organization of hereditary material. Give the definition of euchromatin and heterochromatin.
6. Chemical composition of chromosomes. The structure of chromosomes in metaphase of mitosis. Shapes of 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, proof-reading and reparation. RNA. Types and functions.
9. The structure of eukaryotic gene. Classification of genes.

10. The genetic code and its properties.
11. The main stages of protein biosynthesis in the cell.
12. Translation: initiation, elongation, termination. Posttranslational modification.
13. Peculiarities of realization of hereditary information in eukaryotes. Exon-and-intron organization of eukaryotic genes. Processing, splicing.
14. Regulation of genes expression in pro- and eukaryotes. Operon
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: complemantary, epistasis, polymery.
23. Pleyotropy.
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.
32. Gene mutations, mechanisms of origin. The concept of single gene disorders.
33. Chromosomal aberrations. Mechanisms. Examples of the deseases.
34. Genome mutations (numerical chromosomal aberration) and it origin (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, it 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. Medical genetic aspects of a family. Medical genetic concealing. Prenatal diagnostics of hereditary diseases
44. Population-statistical method of human genetics. 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: heredirtary, 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. Thanatology.
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 pphenomenon The principles of interaction between the parasite and the host. Morphological adaptation of the parasites.
57. Vector-borne (transmissive) disease. Facultative-transmissive and obligate-transmissive 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, it 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 an 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 analysis 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 equilibtium 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 / Bazhora Yu. I., Bulyk R. Ye., Chesnokova M. M. [et al.]. – 2nd ed. – Vinnytsia: Nova Knyha, 2019. 448 p.

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, [et al.].– 11th rectricted ed. – Hoboken : Pearson Higher Education, 2016. - 560 pp.
3. Chiodini P. L. Atlas of Medical Helmintology and Protozoology 4th ed. – Churchill Livingstone, 2003. 87 pp.
4. Peter Turnpenny, Sian Ellard. Emery's Elements of medical genetics.-15th ed.,– Elsevier, 2017. 400 pp.
5. Essential Cell Biology : textbook / B.M. Alberts, D. Bray, K. Hopkin [et al]. – 4th ed., rev. and upd. NY: Garland Publishing Inc., 2019. 862 p.
6. Bruton J. Bogitsh, Clint E. Carter. Human parasitology – 4th ed., – Elsevier, 2013. 430 pp.
7. T. W. Salder. Langman's medical embryology. – 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. David. T. John, William A. Petri. Markell and Voge's Medical parasitology. – 9th ed. – Elsevier, 2017. 463 pp.
10. M. R. Speicher, S. E. Antonarakis, F. G. Motulsky. Vogel and Motulsky's human genetics. Problems and approaches.- 4th ed. – Springer, 2010. 981 pp.
11. Young Ian. D. Medical genetics. – 2nd ed. – Oxford university press, 2010. 304 pp.

13. 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 & morehttp://www.sci-news.com/news/biology
6. link to the most thought-provoking, well researched online items in the world of science and technologyhttps://scitechdaily.com/news/biology/
7. Web atlas of medical parasitology http://www.atlas.or.kr/about/index.html