MINISTRY OF HEALTH OF UKRAINE
ODESSA NATIONAL MEDICAL UNIVERSITY
Department of clinical immunology, genetics and medical biology

APPROVED
A.I. Vice-rector for research and educational work
Professor _____ I.P. Shmakova
"01" 09 2021

CURRICULUM ON EDUCATIONAL DISCIPLINE
"MEDICAL BIOLOGY"

Level of higher education: second (master's)

Branch of knowledge: 22 «Health care»

Speciality: 221 «Stomatology»

Educational-professional program: Stomatology

Одеса 2021 - 2022

The program is based on the standard of higher education of Ukraine in specialty 221 "Stomatology" from 24.06.2019 № 879 and on the basis of educational-professional program "Stomatology", training of second (master's) level of higher education in specialty 221 "Stomatology" in the field of knowledge 22 "Health care", approved by the Academic Council of ONMedU, from 04.06.2020, protocol №11.

Developers: honoured worker of science and technology of Ukraine, laureate of the State Prize of Ukraine, Doctor of Medicine, Professor. **BAZHORA Y.I**, Phd of Medical Sciences, Associate Professor **SHEVELENKOVA A.V**., Phd of Medical Sciences, Associate Professor **CHESNOKOVA M.M**., Phd of Medical Sciences, Associate Professor **SMETYUK O.O.**

Program was discussed and approved on the methodic meeting of the department at 27.08.2021. Protocol № 1

Head of the department
Professor _____ **Goncharuk S. F.**

Program was approved on the meeting of the cycle methodical committee of the medical and biological disciplines at 27.08. 2021. Protocol № 1

Head of the committee of the medical and biological disciplines
Professor _____ **Appelhans O. L.**

Program was approved on the Central methodical committee meeting of ONMedU at "30" 08 2021. Protocol № 1 .

1. Description of the discipline

Name of indicators	Characteristics of the discipline	
	Full-time education	
The total number of: Credits - 3.5 Hours - 104 Sections - 2 Content sections - 8	Compulsory discipline	
	Year of preparation	1
	Semester	I-II
	Lectures	18 hours
	Practical classes	46 hours
	Independent work	40 hours
	Including individual tasks	0
	Form of final control	Exam

2. The purpose and tasks of the discipline

The **purpose** of the discipline is the formation of knowledge and practical skills in human biology for the further learning by the students of a block of disciplines providing natural sciences and professional and practical training.

The main **tasks** are:

1. To explain the regularities of human life manifestations at the molecular biological and cellular levels.
2. To explain the etiology of human hereditary diseases.
3. To determine the biological nature and mechanisms of the development of diseases that arise as a result of anthropogenic changes in the environment.
4. To make a preliminary conclusion about the presence of parasitic human invasions and identify ways for disease prevention.

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.

- ***Genera competenciesl:***

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 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:***
  SC2. Ability to interpret the results of laboratory and instrumental research.
  SC4. Ability to plan and implement measures for the prevention of diseases of organs and tissues of the oral cavity and maxillofacial region.
  SC13. Ability to assess the impact of the environment on the health of the population (individual, family, population).

"Medical biology" as an educational discipline sets the foundation for the further formation of the following **programm educational outcomes**:

PEO 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).

Learning outcomes for discipline: Upon completion of the study of the discipline "Medical biology" students **must know**:
• levels of living matter organization,
• life forms and their fundamental properties;
• structural and functional organization of the eukaryotic cell;
• molecular basis of heredity;
• cell cycle and methods of cell division;
• basic patterns of heredity in mono- and dihydro-interbreeding and inherited inheritance;
• inheritance of human blood groups by AB0 system and Rh factor;
• inheritance of a person's gender and signs associated with sex;
• variation, its forms and manifestations;
• Methods for the study of human heredity: genealogical, twin, dermatological, 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 sexual cells;
• determination of ontogenesis and its periodization;
• basic stages of embryonic development, molecular and cellular mechanisms of differentiation;
• types of regeneration;
• types of transplantation, causes of tissue incompatibility;
• forms of symbiosis, parasitism as a biological phenomenon;
• principles for the classification of parasites and hosts;
• ways of transmission of parasitic diseases; obligatory transmissive and obligatory transmissive diseases;
• natural-focal diseases; structure of the natural cell;
• the basics of prophylaxis of parasitic diseases;
• pathogens of the most common protozoosis, trematodozy, cestodiosis, nematodosis;
• principles of laboratory diagnosis of helminthiasis;
• arthropods - carriers and pathogens of human diseases, the concept of mechanical and specific carriers;
• poisonous representatives of the Arthropoda type;
• the concept of a population as an elementary unit of evolution, the population structure of mankind, demi, isolates;
• functional types of people's response to environmental factors ("sprinter", "stareer", "mix");
• the concept of biological rhythms, their medical significance;
• subject of ecology; types of environment, environmental factors;
• Adaptive ecotypes of people;
• The role of man as an environmental factor. Main directions and results of anthropogenic changes of the environment;

• examples of poisonous plants and animals for humans;
• the main statments of the doctrine of Academician V.I. Vernadsky on the biosphere and the noosphere;
• the position of the species *Homo sapiens* in the animal world, the main stages of anthropogenesis;
• regularities of phylogeny of organs, ontophilogenetic conditions of birth defects, examples of atavistic defects in the development of organs and systems of human organs.

be able:

- to study microspecimens under a light microscope at small and large magnifications;
- to make temporary microspecimens;
- to differentiate the components of the animal cell on electronic microphotographs and drawings;
- to identify (schematically) the primary protein structure, the amount of amino acids, the molecular weight of the polypeptide in the sequence of the nucleotides of the gene encoding it;
- to predict genotypes and phenotypes of descendants according to the genotypes of parents;
- to calculate the probability of birth of a sick child with monogenic diseases with known genotypes of parents:
- eliminate paternity in determining the blood groups of parents and the child:
- to calculate the probability of manifestation of hereditary diseases in posterity depending on the penetrance of the gene;
- to analyze the karyotype of a person and determine the diagnosis of the most common chromosomal diseases;
- to compose a pedigree and conduct his genealogical analysis;
- calculate the role of heredity and environment in the development of characters (based on the results of twin analysis);
- calculate the frequency of genes and genotypes under Hardy-Weinberg law;
- to distinguish the concept of teratogenic and hereditary birth defects;
- to determine the place of the biological object (pathogens of parasitic diseases) in the system of wildlife;
- to justify the affiliation of human parasitic diseases to a group of transmissive and natural-focal;
- to diagnose on macroscopic and microspecimens of pathogens and carriers of pathogens of parasitic diseases under study;
- to justify the methods of laboratory diagnosis of human parasitic diseases;
- to justify the methods of prophylaxis of parasitic diseases, based on the ways of their infection.

3. Contents of the curriculum

Section 1. Biological peculiarities of human activities

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

Topic 1. Introduction into the course of medical biology. Optical systems in biological experiences. 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 essense of life. Life forms, main properties and strategy of life. Levels of life organization and main biological phenomena in the 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.

Optical systems in biological experiences. Optical microscope and how to work with it. Techniques of temporal slides preparation and studying.

Topic 2. Morphology of the eukaryotic cell.

Structural and functional organization of eukaryotic cell

Cell as an open system. Assimilation and dissimilation.

Cellular membranes, their structure and functions. Compartment organization principle. Cells receptors. Transport across the cell membrane.

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

Topic 3. Structural components of nucleus. Chromosomes morphology. Human karyotype.

Nucleus as the central information apparatus of the cell. Structure of interphase nucleus. Chromosomal and genomic levels of organization of heredity material. Euchromatin and heterochromatin.

Structural components of nucleus: nuclear membrane, karyoplasm, chromosomes, nucleolus. Human karyotype. Morphofunctional characteristics and classification of human chromosomes. Rules of the chromosomes. Chromosomes analysis. Nucleolus as a derivative of chromosomes, its role in ribosome production. Ideogram.

Topic 4. Molecular basis of heredity.

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, self- correction and repair of DNA.

Gene as a unit of the genetic function. Gene structure in prokaryotes and eukaryotes. Exon-intron organization of eukaryotic gene. Genes: structural, regulatory genes, tRNA and rRNA.

Peculiarities of human genome organization.

Topic 5. Molecular basis of heredity. Stages of protein synthesis.

Molecular mechanisms of stages of protein synthesis. Transcription. Processing, splicing. Translation: initiation, elongation, termination. Post translation modifications of the proteins. Regulation of gene expression in prokaryotes. Molecular mechanisms of variation in humans .

Topic 6. Cell life cycle. Cell division. Regulation of mitotic cycle. Gametogenesis.

Temporal organization of the cell. Life cycle of the cell (cell cycle). Types of cell division: mitosis, amitosis. 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. Cultivation of cells beyond the organis. Cloning of the cells. The importance of meiosis in maintaining a constant number of chromosomes and ensuring combinatorial variability. Gametogenesis.

Content section 2. Biology of individual development

Topic 7. Peculiarities of the prenatal and postnatal periods of ontogenesis in humans.

Reproduction as a mechanism that provides morphogenetic continuity of generations.

Peculiarities of the human reproduction as a result of his biosocial nature. Structure of human gametes. Fertilization in humans – restoration of diploid set of the chromosomes, recombination in posterity.

Ontogenesis: type, periods and stages.

Embryonic period of the development in human. Differentiation on the molecular-genetic, cellular and tissue levels. Problem of differentiation and interaction of blastomeres. Embryonic induction.

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

Congenital defects, its classification: hereditary, exogenic, multifactorial; gametopathy, blastopathy, embryopathy, phetopathy.

Postembrionic period of ontogenesis in human, its periodisation.

Growth and differentiation in postnatal period.

Biological fields, biological rhythms and its medical importance.

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

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

Content section 3. Patterns of inheritance and variation.

Topic 8. Peculiarities of human genetics. Mono- and dihybrid, polyhybrid crossing. Multiple alleles. Genetics of blood groups.

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.

Mendelian characters in man.

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 9. Interaction of allele and non-allele genes. Chromosomal theory of heredity.

Gene interaction and its manifestations in different types of inheritance.

Interaction of the allele (dominance, incomplete dominance, overdominance,co-dominance) and non allele (complementarity, epistasis, polymery) genes. Intermediate pattern of inheritance in humans. Polygenic inheritance of quantitative traits.

Primary and secondary pleyotropy.

Gene linkage. Peculiarities of linked inheritance. Genetic maps of human chromosomes. Chromosomal theory of heredity.

Non-chromosomal heredity.

Inheritance of sex in humans. Mechanisms of genetic differentiation in humans and its failure. Inheritance of sex-linked diseases in humans. Sex-linked, sex-influenced and sex-limited characters.

Topic 10. Variation, its forms and manifestation.

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

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

Combinative variation, its sources, biological significance.

Mutational variation in humans and its phenotypic manifestations. Classification of mutations: genomic, chromosomal aberrations, genetic. 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.

Content section 4. Methods of studying of human genetics. Hereditary diseases.

Topic 11. Methods of human heredity studying. **Pedigree and twins methods of human genetics. Biochemical method. DNA-diagnostics. Single gene disorders.**

Basis of medical genetics

Man as a specific subject of genetic analysis.

Methods of human heredity studying.

Classification of hereditary disorders in humans

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.

Monogenic (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 . DNA-diagnostics.

Dermatoglyphic, immunological methods and hybridization of somatic cells.

Topic 12. Cytogenetic method of human genetics. Chromosomal disorders.

Population-statistics method of human genetics. Medical-genetic consulting.

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.

Population-statistic method. Low of constancy of genetic structure of the population. Usage of Hardy-Wineberg's low 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 13. Summary class on "HUMAN HREDITY AND VARIATION".

Section 2. Population, species, biogeoceonotic and biosphere levels of living matter organization.

Content section 5. Medical and biological bases of parasitism. Medical protozoology..

Topic 14. Medical and biological bases of parasitism. Sarcodina. Infusoria.

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.

Characteristics and classification of protozoa.

Sarcodina. Dysenteric amoeba (Entamoeba histolytica), intestinal amoeba (Ent. coli), gingival amoeba (Ent. gingivalis). Geographical distribution, morphofunctional peculiarities, life cycles of dysenteric amoeba. Ways of infection, laboratory diagnosis and prophylaxis of amebiasis.

Geographical distribution, morphofunctional peculiarities, life cycle of balantidium. Ways of infection, laboratory diagnosis and prophylaxis of balantidiasis.

Topic 15. Flagellates. Lamblia, Trichomonas, Leishmania, Trypanosoma.

Flagellate class. Geographical distribution, morphology, life cycle of lamblia trichomonas, leishmania and trypanosome. Ways of infection, laboratory diagnosis and prophylaxis of lambliosis, urogenital trichomoniasis, leishmaniasis, tripanosomosis.

Topic 16. Apycomplexa. Malaria parasites. Toxoplasma.

Type Apicomplexa. Class Sporozoa. 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.

T

o Medical helminthology. Flat worms – human parasites. Type Flat worms (Plathelminthes).

p Class Flukes (Trematoda) - agents of the human diseases.

i Geographical distribution, morphofunctional peculiarities, life cycle of liver fluke (fasciola), cat fluke (Opisthorchis felineus), lancet fluke (Dicrocoelium lanceatum), lung fluke (Paragonimus). Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis.

1 Agents of metagonimosis, nanophietosis

7 Blood flukes – agent of parasitic diseases.

. Principles of laboratory diagnosis of helminthiasis.

Topic 18. Flat worms – agents of human diseases.

Flat worms. Flukes – agents of the human diseases. Phylum Flat worms (Plathelminthes). 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.

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

Topic 19.

Phylum Roundworms (Nemathelminthes). Class Nematodae (Nematoda) Round worms as agents of the human disease. Geographical distribution, morphofunctional peculiarities, life cycle of ascaris, pinworm, whipworm. Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis of ascariasis, enterobiois, trichocephaliasis. Geographical distribution, morphofunctional peculiarities, life cycle of ancylostoma, necator, trichina worm, strongiloid. Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis.

Topic 19.

Guinea worms, filarial worms as agents of human diseases

Vector-born and natural-foci helminthiasis

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 20.

Arthropods (Arthropoda) as pathogens and carriers of pathogens of infections and invasions. ClassSpiders (Arachnoidea). Features of morphology, nutrition and reproduction of species. Poisonous Spiders (scorpions, spiders). The medical significance of ticks as pathogens of diseases and carriers of human pathogens.

Mites - dwellers and their medical significance.

Topic 20. Arthropodes. Arachnoidea. Spiders, ticks.

Class Insects (Insecta). Order Diptera. Flies, mosquitoes, sand flies and its medical importance. Cockroaches, medical importance.

Midges: characteristics and importance as intermediate hosts of helminths.

Gnus, its components: characteristic, meaning as intermediate hosts of helmints and carriers of human pathogens

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

Topic 21. Insects as agents and vectors of human diseases.

Content module 8. Interaction between ontogenesis and phylogenesis. Biosphere and human being.

Topic 21.

Synthetic theory of evolution. Peculiarities of evolution factors in human populations. Population structure of mankind. Anthropogenesis. Human races as reflection of adaptation rules in human evolution.

Notion about macro- and microevolution. Biogenetic law.

Topic 22. Synthetic theory of evolution. Phylogenesis of skin, skeleton, digestive, respiratory and circulatory systems of Vertebrates. Systematically based (Section 2).

Evolution of skin, skeleton, digestive, respiratory, circulatory and reproductive systems of Vertebrates. Systematically based (Section 2). congenital defects in humans.

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 extreme4 conditions. Adaptive ecological types of humans: arctic, tropic, zones of temperate climate, deserts, highland.

Characteristics of poisonous plants, fungi, animals.

Topic 22.

3. Summary test control.

Structure of the credit "Medical biology"

Topic	Hours			
	Total	L	PC	SIW
Section 1 Biological peculiarities of human activity				
Content section 1. Molecular and cellular levels of life organization				
Topic 1. Introduction into the course of medical biology. Optical systems in biological studies. Levels of organization and fundamental characters of living matter.	3,5	0,5	2	1
Topic 2. Morphology of the eukaryotic cell.	3,5	0,5	2	1
Topic 3. Structural components of the nucleus. Chromosomes morphology. Human karyotype.	4	1	2	1
T	4	1	2	1
Topic 5. Organization of information flow in the cell. Stages of protein synthesis.	4	1	2	1
T	3	0	2	1
Content section 2. Biology of individual development				
Topic 7. Peculiarities of the prenatal and postnatal periods of ontogenesis in humans.	5	2	2	1
Content section 3. Principles of inheritance and variation				
Topic 8. Peculiarities of human genetics. Mono- and dihybrid, polyhybrid crossing. Mendelian characters in human. Blood groups genetics.	6	1	2	3
Topic 9. Interaction of allele and non-allele genes. Chromosomal theory of heredity.	4	1	2	1
Topic 10. Phenotypic and genetic variation, its forms and manifestation.	5	2	2	1
Content section 4. Methods of studying of human genetics. Hereditary diseases				
Topic 11. Bases of human genetics. Methods of studying of human genetics. Pedigree and twins methods of human genetics. Biochemical method. DNA-diagnostics. Single gene disorders.	4	1	2	1
Topic 12. Cytogenetic method of human genetics. Chromosomal disorders.Population-statistics of human genetics. Medical-genetic counselling.	4	1	2	1
Topic 13. Summary class on "Biological peculiarities of human activities".	3	0	2	1
Section 2. Population, species, biogeoceonotic and biosphere levels of living matter organization.				
Content section 5. Medical and biological bases of parasitism. Medical protozoology				
Topic 14. Medical and biological bases of parasitism. Medical protozoology. Sarcodina. Infusoria.	4	1	2	1
Topic 15. Flagellates. Lamblia, Trichomonas, Leishmania, Trypanosoma.	3	0	2	1
Topic 16. Apycomplexa (Sporozoa). Malaria parasites. Toxoplasma.	3	0	2	1
Content section 6. Medical helminthology				

T	5	1	2	2
T	3	0	2	1
T	4	0	2	2
Content section 7. Medical arachnoentomology				
Topic 20. Arthropodes. Arachnoidea. Spiders, Ticks.	3	0	2	1
Topic 21. Insects as agents and vectors of human diseases.	3	0	2	1
Content module 8. Interaction between ontogenesis and phylogenesis. Biosphere and human being				
Topic 22. Synthetic theory of evolution. Phylogenesis of organ systems of vertebrates. Biosphere as a system of human existence. Human ecology. Adaptation and stress. Summary class on "Population, species, biogeoceonotic and biosphere levels of living matter organization."	9	4	2	3
Topic 23. Summary test control	4	0	2	2
Independent preparation for the exam	10			10
Total hours	104	18	46	40

5. Topics of the lectures

№	Topic	Hours
1	Introduction into the medical biology. Structural and functional organization of the cell.	2
2	Molecular basis of heredity. Realisation of hereditary information.	2
3	Postnatal period of human ontogenesis. Modern aspects of regeneration and transplantation.	2
4	Organism level of organization of genetic information. Interaction of genes.	2
5	Variation of man as a property of life and genetic phenomenon	2
6	Basics of human genetics. Methods of medical genetics.	2
7	Medical- biological bases of parasitism.	2
8	Synthetic theory of evolution. Peculiarities of elementary evolutionary factors in human population.	2
9	Biosphere as a system that ensures human existence.	2
	Total hours	18

6. Topics of practical classes

№	Topic	Hours
1	Optical systems in biological studies. Levels of organization and fundamental characters of living matter.	2
2	Morphology of the eukaryotic cell.	2
3	Structural components of nucleus. Chromosomes morphology. Human karyotype.	2
4	M	2
5	Organization of information flow in the cell. Stages of protein synthesis.	2
6	C	2
7	Peculiarities of the prenatal and postnatal periods of in humans.	2

8	Peculiarities of human genetics. Mono- and dihybrid, polyhybrid crossing. Mendelian characters in human. Blood groups genetics.	2
9	Interaction of allele and non-allele genes. Chromosomal theory of heredity.	2
10	Variation, its forms and manifestations	2
11	Pedigree and twins methods of human genetics. Biochemical method. DNA-diagnostics. Single gene disorders.	2
12	Cytogenetic method of human genetics. Chromosomal disorders.Population-statistics of human genetics. Medical-genetic counseling.	2
13	Summary class on “Biological peculiarities of human activities”.	2
14	Protozoa. Sarcodina. Infusoria.	2
15	Flagellates. Lamblia, Trichomonas, Leishmania, Trypanosoma.	2
16	Apycomplexa (Sporozoa). Malaria parasites. Toxoplasma.	2
17	F	
18	T	2
19	R	2
20	Arthropodes. Arachnoidea. Spiders, Ticks.	2
21	Insects as agents and vectors of human diseases.	2
22	Summary class on “Population, species, biogeoceonotic and biosphere levels of living matter organization.”	2
23	Summary test control	2
	Total hours	46

7. Student’s independent work

№	Types of SIW	Hours
1	**practical classes**	
Content section 3 Principles of heredity and variation		
1.1	Immunogenetics, subject, task. Tissue and species specificity of proteins, their antigenic properties	2
Content section 6. Medical helminthology		
1.2	Flukes as the causative agents of human parasitic diseases.	1
1.3	Filariasis - the causative agent of human diseases	1
Content section 8. Interaction of individual and historical development. Biosphere and a human being.		
1.4	Characteristics of poisonous to humans plants and animals.	2
2.	Preparation for practical classes	22
3.	Preparation for Summary test control	2
4.	Preparation for exam	10
	Total hours	40

8. Individual tasks

Not provided

9. Teaching methods

Lectures. Verbal and visual teaching methods are used - explanatory-illustrative method (students gain knowledge by listening to a lecture and studying illustrative material in the form of multimedia presentations).

Practical classes: conversation, explanations, case studies, practical work.

Independent work: independent work with the textbook, independent work with the data base of MCQ tasks for Krok-1, independent case studies.

10. Methods of control and evaluation criteria of educational outcomes

Summary 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: oral exam, testing.

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 grade - 5, minimum grade - 3, unsatisfactory grade - 2.
2. Assessment of practical skills and abilities on the topic of the lesson:
- Case studies, methods: assessing theaccuracy of practical skills conducting
- maximum score - 5, minimum score - 3, unsatisfactory score - 2;

Criteria for current assessment in the practical lesson:

«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.
«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.
«3»	The student does not have enough knowledge in theoretical material, insecurely participates in the discussion and case studies, performs practical work with significant errors.
«2»	The student does not have knowledge in 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.

An obligatory component of the implementation of the curriculum "Medical Biology" is the final test control of the discipline, which includes 50 test questions (30 minutes), as an indicator of students' acquisition of knowledge. Test control is carried out in the Training and Production C

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m A student who has not passed the final test control in the discipline is considered to have p failed the program in the discipline.

l At the end of the discipline, the current performance is calculated - the average current s score (arithmetic mean of all current grades on a traditional scale, rounded to two decimal places). T The current grades "3" or "4" are not reattempted in aim to increase the average score in the discipline.

o If a student receives a minimum grade point average of 3.00 for current academic p performance, even if there are unsatisfactory grades, he receives a credit for the discipline.

Evaluation of independent work.

I Self independent work of students, which is included in the topic of the lesson along with t the auditory work, is evaluated during current control of the topic on the proper lesson. Mastering n of themes which are placed out only on self independent work is checked during the exam.

o

v **Final control of the discipline - Exam.**

a The exam is held at the stage of completion of the student's study of the discipline. A student

t

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is allowed to take the discipline exam if he has performed all types of work provided for in the working curriculum and has not passed the final test control in the discipline and has received a minimum grade point average of 3.00 for current academic performance.

The results of the exams are evaluated on a 4-point national scale ("excellent", "good", "satisfactory", "unsatisfactory").

Exam structure

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

Criteria for assessing the educational outcomes of students at the exam:

«5»	is given to the student who systematically worked during a semester, showed during examination various and deep knowledge of a program material, is able to successfully carry out tasks which are provided by the program, has mastered the maintenance of the basic and additional literature, has understood interrelation of separate sections of discipline. importance for the future profession, showed creative abilities in understanding and using educational material, showed the ability to independently update and replenish knowledge; level of competence - high (creative);
«4»	is given to a student who has shown full knowledge of the curriculum, successfully completes the tasks provided by the program, mastered the basic literature recommended by the program, showed a sufficient level of knowledge in the discipline and is able to independently update and renew during further study and professional activity; level of competence - sufficient (constructive-variable);
«3»	is given to the student who has shown knowledge of the basic educational program material in the volume necessary for the further training and the subsequent work on a profession, copes with performance of the tasks provided by the program, has made separate mistakes in answers on examination and during conducting of examination tasks, but has the necessary knowledge to overcome mistakes under the guidance of a researcher; level of competence - average (reproductive);
«2»	is given to the student who did not show sufficient knowledge of the basic educational and program material, made fundamental mistakes in performance of the tasks provided by the program, cannot use the knowledge at the further training without the teacher's help, failed to master skills of independent work; level of competence - low (receptive-productive).

11. Distribution of grades obtained by applicants for higher education

The grade obtained for the answer to the exam and the score of the average current performance during the study of the discipline are used to calculate the arithmetic mean, which is the

Converting of the traditional grade from the discipline to 200-point is performed by the information and computer center of the university program "Contingent" by the formula: average grade point of success (current /in discipline) x 40

National grade for the discipline	Total grades for the discipline
«5»	**185-200**
«4»	**151-184**
«3»	**120-150**

Further calculations are made by the information and computer center of the University.

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:

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

Marks ranging "A", "B", "C", "D", "E" are made by the Dean office or by *any other structural department according to the Academic council decision by the educational department* for the students of the definite course, which have the same specialty and **successfully** finished the discipline study.

12. List of control questions for the exam

1. Definition of biology as a science. The place and tasks of biology in the training of physicians. Defining the notion of life at the current level of development of biological science. Forms and basic properties of living matter. Structural levels of life organization, their significance for medicine.
2. Cell as an elementary structural and functional unit of living matter. The pro- and eukaryotes.
3. Mophology and physiology of the cell. Cytoplasm and organelles.
4. Cell membranes. Chemical composition of the cytoplasmic membrane. Its structure.
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. What is DNA replication? DNA proof-reading and reparation.
9. The structure of eukaryotic gene. Classification of genes. RNA. Types of RNA, its function
10. The genetic code and its properties.
11. The main stages of protein biosynthesis in the cell.
12. What is translation? Initiation, elongation, termination. Posttranslational modification.
13. Peculiarities of realization of hereditary information in eukaryotes. Exons and introns organization of eukaryotic genes. Processing, splicing.
14. Regulation of genes expression in pro- and eukaryotes. Operon
15. Cell cycle, its periods. Interphase and its stages. 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's law
20. Multiple alleles. Inheritance of ABO blood groups and Rh-factor. Significance for medicine.
21. Interaction of allelic genes: dominance, incomplete dominance, co-dominance.
22. Interactions of non-allelic genes: complemantary, epistasis, polymery.
23. Pleyotropy.
24. Linked inheritance of genes (the law of Morgan). Crossing over.
25. Chromosomal theory of inheritance.

26. Inheritance 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. Hereditary 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. Disorders with hereditary predisposition. Concept of multifactorial disorders.
39. Methods of medical genetics. Human as a specific subject of genetic analysis.
40. Genealogic method (pedigree analysis) and twins methods of medical genetics.
41. Biochemical method for the study of genetic diseases. Screening programs.
42. DNA diagnostics
43. Cytogenetic methods of medical genetics.
44. Medical genetic aspects of a family. Medical genetic concealing. Prenatal diagnostics of hereditary diseases
45. Population-statistical method of human genetics.
46. Reproduction as universal property of life. Forms of multiplication. Possibility of organism cloning.
47. Gametogenesis. Spermatogenesis and oogenesis. Human germ cells. Fertilization. Peculiarities in human
48. Ontogenesis, its periods. Embryonic development, its stages. Provisory organs.
49. Molecular and cellular mechanisms of differentiation
50. Differentiation of germ layers and tissues. Embryonic induction. Cloning of tissues and organisms.
51. Critical periods of embryonic development in human. Teratogenic factors.
52. Modern classification of congenital abnormalities: heredirtary, teratogenic, multifactorial, embryopathy, fetopathy, phylogenetic (ancestral) and non-phylogenetic.
53. Postnatal development of man and its periodization. Neuro-hormonal regulation of growth and development.
54. Aging as a stage of ontogenesis. Theories of aging. The concept of gerontology and Geriatrics.
55. Clinical and biological death. Thanatology.
56. Regeneration of tissues and organs. Types of regeneration, importance for medicine.
57. Problems of transplantation. Types of transplants (grafts). Problem of graft rejection.
58. Homeostasis. Mechanisms of its regulation on different levels of organization of living matter.
59. Parasitism. Principles of interaction between the parasite and the host at the level of individuals. Ways of morpho-physiological adaptation of parasites.
60. Vector-borne (transmissive) disease. Facultative-transmissive and obligate-transmissive diseases. Specific and mechanical vectors.
61. Classification of parasites (obligate, facultative, temporary, constant, endo- and exoparasites). The definitive and intermediate hosts.
62. Natural focal diseases. The components of the natural focus. Examples of diseases. Anthroponotic and zoonotic diseases.

63. Giardia Lamblia, the name of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of disease
64. Trichomonas vaginalis, the name of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of disease.
65. 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.
66. Trypanosoma species, names of the diseases, morphology, life cycles of parasites. Way of transmission, the principles of diagnosis and prevention of the diseases.
67. Dysentery amoeba, name of the disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
68. Balantidium, name of the disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
69. Plasmodium (malaria parasite), the names of the diseases, morphology, life cycles of parasites. Way of transmission, the principles of diagnosis and prevention of the disease.
70. Toxoplasma, the names of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
71. Liver fluke, the names of disease, morphology, life cycles of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
72. Cat (Siberian) fluke, the names of disease, morphology, life cycle of parasites. Way of transmission, the principles of diagnosis and prevention of the disease.
73. Lung fluke, the names of diseases morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
74. 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.
75. Pork (armed) tapeworm, the names of diseases, morphology, life cycle of parasites. Way of transmission, the principles of diagnosis and prevention of the diseases.
76. Beef (unarmed) tapeworm, the names of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
77. Cysticercosis. Modes of transmission and prevention measures.
78. Dwarf tapeworm, the names of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
79. Echinococcus and alveococcus. The names of diseases, morphology, life cycles of parasites. Way of transmission, the principles of diagnosis and prevention of the diseases.
80. Broad (fish) tapeworm, the names of disease, morphology, life cycle of parasite. Way of t
81. Roundworms. Classification, characteristics of the organization, medical significance of species
82. 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).
83. Pinworm. The name of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
84. Whipworm, the names of disease, morphology, life cycles of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.
85. 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.
86. Trichina worm, the name of disease, morphology, life cycle of parasites. Way of transmission, the principles of diagnosis and prevention of diseases.
87. Guinea worm. The name of disease, morphology, life cycle of parasite. Way of transmission, the principles of diagnosis and prevention of the disease.

88. 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.
89. Laboratory diagnostics of helminthes. Ovo-, larvo- and helminthoscopy.
90. Phylum Arthropoda. Classification, morphology, medical importance. Poisonous Arthropods.
91. Mites as human pathogens (itch mite and follicle mite).
92. Ticks as the vectors of human diseases (Ixodidae, Gamasidae and Argasidae ticks).
93. Class Insecta. Morphology, features of development, medical significance of representatives.
94. Flies. Species of the flies. Peculiarities of the morphology and life cycle, medical importance.
95. Mosquitoes. Species, peculiarities of the structure and development, medical importance.
96. Lice. Species, morphology and life cycle, medical importance.
97. Fleas. Morphology and life cycle. Species of fleas. Bed bug and its medical importance.
98. Synthetic theory of evolution.
99. Structure of human population. Dem, isolate.
100. 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").
101. Doctrine of biosphere and noosphere. Characteristics of living matter.
102. Medical and biological aspects of biosphere influence on human health. Biological fields and biorhythms, it medical importance.
103. Onto- and phylogenesis interreletion. The biogenetic low of Heckel and Muller.
104. Atavistic (ancestral) congenital malformations in human.
105. Phylogenesis of the integument of chordates. Congenital ancestral defects.
106. Comparative review of the skeletal system of the chordates. Congenital ancestral defects.
107. Phylogenesis of the digestive system of the chordates. Congenital ancestral defects.
108. Ecology. Environment as an ecological notion. Types of environment. Ecological factors. The unity of an organism and environment.
109. Man as an environmental factor. The main directions and results of anthropogenic environmental changes. Protection of the environment.
110. Plants, fungi and animals poisonous for human.

List of practical skills and abilities:

- to master the technique of microscoping
- to prepare temporary specimens
- to differentiate cell components
- to make ideogram of a healthy and sick human on chromosome diseases
- to identificate the primary structure, amino acids number, molecular weight of polypeptide by the gene structure encoding it
- to analyze the sequence of gene regulation expression stages in pro- and eukaryotes
- to determine the type of inheritance of normal and pathological human mendelian traits
- to diagnose genotypes and phenotypes of offspring by the genotypes of the parents
- to exclude paternity in determining blood groups of parents and child
- to analyze the complex mechanisms of human traits inheritance
- to develop measures to reduce the manifestation of a pathological condition in patients with hereditary pathology
- to choose appropriate methods for the study of human heredity for diagnosis of various genetic diseases
- to calculate the probability of hereditary diseases manifestation in the offspring depending on gene penetrance
- to differentiate human chromosomal diseases

- to build a family tree and spend its genealogical analysis of a patient with hereditary disease
- to calculate the role of heredity and environment in the characters development (for twins analysis results)
- to calculate the genetic structure of human populations
- to use the biogenetic law to determine ontophylogenetically determined congenital malformations in human
- to compare origin mechanisms of human congenital malformations of different genesis
- to learn the basic principles of regeneration and transplantation
- to determine the place of a biological object in the system of nature
- to prove the belonging of human parasitic diseases to the group of vector born diseases
- to diagnose the carriers of pathogens and parasitic diseases on micro and macro specimens
- to determine the species identity of human protozoa pathogens
- to identify the different stages of the parasites life cycle
- to justify the methods of laboratory diagnosis of parasitic diseases in human
- to identify worms and their eggs species belonging
- to differentiate diagnosis of invasive disease with the help of laboratory methods
- to determine the species identity of infections carriers
- to prove the effectiveness of parasitic diseases prevention methods based on their modes of infection

List of specimen that should be determined during the final control of medical biology:

Giardia liamblia
Trihomonas vaginalis
Disenteric Amoeba
Malarial plasmodium
Toxoplasma
Liver fluke
Cat (Siberian) fluke
Mature proglottide of armed (pork) tapeworm
Mature proglottide of unarmed (beef) tapeworm
Phynn of a armed (pork) tapeworm
Phynn of a unarmed (beef) tapeworm
Dwarf tapeworm
Echinococcus cyst
Mature proglottide of a broad tapeworm
Ascaris
Pinworms
Whipworm
Ancilostoma
Trichinellas' encapsulated larvae
Karakurt
Tarantula
Itch mite (Sarcoptes scabiei)
Follicle mite
Dog (taiga) tick
Larvae of ticks Ixodes
Ornithodorus papillipes
Head louse
Body louse

Pubic louse
Human flea
Bed bug
Eggs of malarial mosquitoes
Eggs of non malarial mosquitoes
Larvae of malarial mosquitoes
Larvae of non malarial mosquitoes
Pupae of non malarial mosquitoes
Pupae of malarial mosquitoes
Female head of malarial mosquitoes
Male head of malarial mosquitoes
Female head of non malarial mosquitoes
Male head of non malarial mosquitoes

Methodological support:

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

14. List of recommended literature materials

Main

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. Emery's Elements of medical genetics. 15th ed. / Peter Turnpenny, Sian Ellard. – Elsevier, 2017. – 400 pp. Young Ian. D. Medical genetics. – 2nd ed. – Oxford university press, 2010. – 304 pp.
2. Vogel and Motulsky's human genetics. Problems and approaches / M. R. Speicher, S. E. Antonarakis, F. G. Motulsky. 4th addition. – Springer, 2010. – 981 pp.
3. Human parasitology / Bruton J. Bogitsh, Clint E. Carter. – 4th ed. – Elsevier, 2013. – 430 pp.
4. Markell and Voge's Medical parasitology / David. T. John, William A. Petri. – 9th ed. – Elsevier, 2017. – 463 pp.
5. Chiodini P. L. Atlas of Medical Helmintology and Protozoology 4th ed. – Churchill Livingstone, 2003. – 87 pp.
6. Langman's medical embryology / T. W. Salder. – 13th ed. – Wolter Kluwer Health, 2015. – 423 pp.
7. Before we are born : Essentials of embryology and birth defects / Keith L. Moore, T. V. N. Persaud, Mark G. Torchia. – 8th ed. – Elsevier, 2013. – 348 pp.
8. Medical genetics/ Lynn B.Jorde, John C.Carey, Michael J. Bamshad. – 4th ed. – Elsevier, 2010. – 368 pp.
9. Campbell biology / Lisa Urry, Michael Cain, Steven Wasserman, Peter Minorsky, Jane Reece. – 11th RECTRICTED ed. – Hoboken : Pearson Higher Education, 2016.

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/