MEDICAL BIOLOGY

PRACTICAL BOOK FOR THE FIRST-YEAR STUDENTS STUDYING IN THE SPECIALTY "GENERAL MEDICINE"

Minsk BSMU 2025

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ КАФЕДРА БИОЛОГИИ

МЕДИЦИНСКАЯ БИОЛОГИЯ MEDICAL BIOLOGY

Практикум для студентов, обучающихся на английском языке по специальности «Лечебное дело»

4-е издание, исправленное



Минск БГМУ 2025

УДК 57:61(076.5)(075.8)-054.6 ББК 28.0я73 M42

Рекомендовано Научно-методическим советом университета в качестве практикума 19.02.2025 г., протокол № 6

А в т о р ы: В. В. Григорович, В. В. Давыдов, Ю. И. Корбут, Е. А. Черноус, В. Э. Бутвиловский

Рецензенты: канд. мед. наук, доц. О. Н. Ринейская; каф. общей химии

Медицинская биология = Medical Biology : практикум для студентов, M42 обучающихся на английском языке по специальности «Лечебное дело» / В. В. Григорович, В. В. Давыдов, Ю. И. Корбут [и др.]. – 4-е изд., испр. – Минск : БГМУ, 2025. – 111 с.

ISBN 978-985-21-1808-8.

Включены контрольные вопросы 37 тем практических занятий; основные термины и понятия; тесты; задачи; схемы биологических процессов; контуры рисунков изучаемых препаратов; экзаменационные вопросы. Первое издание вышло в 2022 году.

Предназначен для студентов 1-го курса, обучающихся по специальности «Лечебное дело» на английском языке.

УДК 57:61(076.5)(075.8)-054.6 ББК 28.0я73

ISBN 978-985-21-1808-8

© УО «Белорусский государственный медицинский университет», 2025

PLAN OF THE COURSE

1st semester

Name _____

_ Group _____

Week number	Торіс	
1.	Medical biology and its role in medical education. Subject, tasks, and methods of cytology	
2.	Structural and functional organization of the cell	
3.	Structural organization of the genome	
4.	Cell cycle	
5.	The flow of genetic information in the cell	
6.	Regulation of gene expression	
7.	Genomics. Techniques of molecular genetics	
8.	Genetic engineering	
9.	Omic technologies in medicine	
10.	COLLOQUIUM № 1	
11.	Basic laws of inheritance	
12.	Genetic linkage. genetics of sex	
13.	Variation. Mutagenesis. Carcinogenesis	
14.	Population genetics	
15.	Human genetics	
16.	Human hereditary disorders	
17.	Genetic counseling. Prenatal diagnosis	
18.	COLLOQUIUM № 2	

LAN OF THE COURSE

2nd semester

 Name
 Group

Week number	Торіс
1.	Reproduction of living matter
2.	Fundamentals of prenatal ontogenesis
3.	Fundamentals of postnatal ontogenesis
4.	Biological aspects of regeneration and transplantation
5.	General parasitology
6.	Phylum Apicomplexa, class Sporozoa
7.	Phylum Sarcomastigophora, classes Sarcodina and Zoomastigota. Phylum Infusoria, classe Ciliata
8.	Phylum platyhelminthes, class Trematoda
9.	Phylum plathelminthes, class Cestoda
10.	Phylum Nematoda (1)
11.	Phylum Nematoda (2)
12.	Phylum Arthropoda, class Arachnida, order Acari
13.	Phylum Arthropoda, class Insecta (1)
14.	Phylum Arthropoda, class Insecta (2)
15.	COLLOQUIUM № 3
16.	COLLOQUIUM № 4
17.	Poisonous and venomous organisms

CRITERIA FOR ACADEMIC PROGRESS ASSESSMENT	full comprehension of information from basic and recommended additional
OF STUDENTS IN THE BELARUSIAN STATE	literature in the discipline;
MEDICAL UNIVERSITY	ability to orient in theories, concepts, and issues of the studied discipline and
The decree of the Ministry of education of the Republic of Belarus	analytically estimate them; regular active individual work in practical and
№ 53 from 29.05.2012 «Rules for attestation of students, cadets, listeners for	laboratory classes, active and creative participation in group discussions, and a high
mastering the content of educational programs of higher education»	cultural level of solutions to questions.
 10 (ten), passed: comprehended, profound and full knowledge of the material of all the sections of the educational program and good knowledge of main issues beyond the educational program; accurate usage of scientific terminology (including terms in foreign languages), competent, logically correct presentation of answers to questions, ability to generalize and make logical and accurate conclusions; mastery skills of work with tools and instruments necessary for the discipline, the ability to efficiently use them for setting objectives and solving scientific and professional cases; the remarkable ability of individual creative solutions to problems in unconventional situations; a full and profound comprehension of information from basic and recommended additional literature in the discipline; ability to orient in theories, concepts, and issues of the studied discipline and analytically estimate them; creative individual work in practical and laboratory classes, active and creative participation in group discussions, and a high cultural level of solutions to questions. 9 (nine), passed: comprehended, profound and full knowledge of the material of all the sections of the educational program; accurate usage of scientific terminology (including terms in foreign languages), competent, logically correct presentation of answers to questions; skills of work with tools and instruments necessary for the discipline, ability to use them for setting objectives and solving scientific and professional cases; 	 8 (eight), passed: comprehended, profound and full knowledge of the material of all the sections of the educational program; usage of scientific terminology (including terms in foreign languages), logically correct presentation of answers to questions; skills of work with tools and instruments necessary for the discipline, ability to use them for solving scientific and professional cases; the ability of the individual solution of problems in the educational discipline; comprehension of information from basic and recommended additional literature in the discipline; ability to orient in theories, concepts, and issues of the studied discipline and analytically estimate them; active individual work in practical and laboratory classes, regular and active participation in group discussions, and a high cultural level of solutions to questions. 7 (seven), passed: comprehended, profound and full knowledge of the material of all the sections of the educational program; usage of scientific terminology (including terms in foreign languages), logically correct presentation of answers to questions; skills of work with tools and instruments necessary for the discipline, ability to use them for solving scientific and professional cases; the ability for the individual solution of problems in the educational discipline using typical methods; comprehension of information from basic and recommended additional literature in the discipline; ability to orient in theories, concepts and issues of the studied discipline and analytically estimate them; individual work in practical and laboratory classes, participation in group discussions, and a high cultural level of solutions to questions.

 6 (six), passed: full knowledge of the material of all the sections of the educational program; usage of necessary scientific terminology, logically correct presentation of answers to questions; skills of work with tools and instruments necessary for the discipline, ability to use them for solving scientific and professional cases; the ability for the individual solution of problems in the educational discipline using typical methods; comprehension of information from basic literature in the discipline; ability to orient in basic theories, concepts and issues of the studied discipline and analytically estimate them; active individual work in practical and laboratory classes, periodic participation in group discussions, and a high cultural level of solutions to questions. 5 (five), passed: enough knowledge in the material of the educational program; usage of necessary scientific terminology, logically correct presentation of answers to questions; skills of work with tools and instruments necessary for the discipline, ability to use them for solving scientific and professional cases; the ability for the individual solution of problems in the educational discipline using typical methods; comprehension of information from basic literature in the discipline; ability to orient in basic theories, concepts, and issues of the studied discipline using typical methods; comprehension of information from basic literature in the discipline; ability to orient in basic theories, concepts, and issues of the studied discipline and analytically estimate them; 	 skills of work with tools and instruments necessary for the discipline, ability to use them for solving typical professional cases; ability to solve standard cases under the commands of a lecturer; ability to orient in basic theories, concepts, and issues of the studied discipline and analytically estimate them; work at practical and laboratory classes under the commands of a lecturer, the acceptable cultural level of solutions to questions. 3 (three), not passed: not enough knowledge in the material of educational programs required for higher education; comprehension of some information from basic literature in the discipline; usage of scientific terminology, presentation of answers to questions with considerable mistakes; not enough skills to work with tools and instruments necessary for the discipline, incapacity to orient in basic theories, concepts, and issues of the studied discipline and analytically estimate them; passiveness in practical and laboratory classes, low cultural level of solutions to questions. 2 (two), not passed: very low knowledge of the material of educational programs required for higher education; knowledge of some basic literature in the discipline; massiveness in practical and laboratory classes, low cultural level of solutions to questions.
 active individual work in practical and laboratory classes, partial participation in group discussions, enough cultural level of solutions to questions. 4 (four), passed: enough knowledge in the material of educational program required for higher education; comprehension of information from basic literature in the discipline; usage of necessary scientific terminology, logically correct presentation of answers to questions, ability to make conclusions without considerable mistakes; 	 mistakes; passiveness in practical and laboratory classes, low cultural level of solutions to questions. 1 (one), not passed: absence of knowledge in the material of educational program required for higher education, refuse to answer, unjustified absence.

Class № 1. Topic: MEDICAL BIOLOGY AND ITS ROLE IN MEDICAL EDUCATION. SUBJECT, TASKS, AND METHODS OF CYTOLOGY

CONTENTS OF THE TOPIC	6. Differential centrifugation –
 The nature of life, and the role of proteins and nucleic acids in the organization of living systems. Organization levels of living matter. The cell theory. Prokaryotes and eukaryotes. 	7. Autoradiography –
5. Human as a biological and social being.6. The role of biology in medical education.	8. Cell culture –
7. Subject, objectives, and methods of cytology (light, electron, and fluorescent microscopy, histochemistry and immunohistochemistry,	
differential centrifugation, autoradiography, morphometry, etc.).8. The method of light microscopy. The structure of a light microscope. The rules of work with a microscope.	9. Histochemistry –
GLOSSARY	10. Fluorescent dye –
1. Life –	
2. Biopolymer –	11. Resolving power of a microscope –
3. Bacteriophage (phage) –	12. Eukaryotes –
4. Virion –	
5 Consid	13. Prokaryotes –
5. Capsia –	
	1





Task 2. Find the type of microscopy corre	sponding to each T	Fask 3	. Find	the de	scripti	ion coi	respo	nding	to the t	technio	ques.	
photograph. A – Common light microscopy [.]				Т	echniqu	ıe				Descr	ription	
B – Fluorescent microscopy; C – Transmission electron microscopy (TEM);	1	1 – ren transpl	noval o lantatio	of cell of on to oth	rganelle er cells	es and t	heir		A. Lig	ght mic	roscopy	,
D – Scanning electron microscopy (SEM).			 2 - tracking of chemical compounds in the metabolic pathways of the cell 3 - separation of cellular components by 					B. Transmission electron microscopy				
		a centr 4 - obt	ifuge taining	the cell	image	based of	on the u	isage	C. Dif	ferentia fugation	al n	
		5 - ass cells an	sessmer nd cher	nt of the nical re	chemie actions	cal con	positio ing in tl	n of hem	D. His immu	stochen nohisto	nistry ar chemist	nd try
1. Nucleus 2. Nucleus ar	nd mitochondria	6 – loc dves or	ating c r antibo	ell mac	romole ound wi	cules us th dves	sing spe	ecific	E. X-1	ay crys	stallogra	phy
ille ille		7 – det	ermina	tion of	spatial	arrange	ement a	nd	F. Cel	l cultur	e	
		physical properties of atoms in biological molecules				G. Cell microsurgery						
		8 - ana the dye	alysis o es whic	of biolog h fluore	gical ob esce wh	jects st ien exp	ained w osed to	vith light	H. Sca micro	anning scopy	electror	1
3. Cilia 4.	Cilia	9 – gro nutrier	nt medi	a under	sterile	conditi	rganisn ons	ns on	I. Bio	chemic	al meth	ods
		10 – ol compo	btaining ments b	g the impased or	nages of n the us	f the cel age of e	ll electron	is as	J. Isot	opic lal	beling	
			a source of illumination K. Fluorescent micr					nt micro	oscopy			
			face of	g a tridi Fa biolo	mensio gical ol	nai ima bject	ige of					
tratile of agent			2	3	4	5	6	7	8	9	10	11
5. Anaphase 6. Chro	omosomes											
1 2 3 4	5 6											

Characteristics	Prokaryotes	Eukaryotes
Kingdoms of organisms		
Nucleus (+/-)		
Membrane-bound organelles (+/-)		
Ribosomes (+/-)		
Plasma membrane (+/-)		
Cytoskeleton (+/-)		
Multicellular organisms (+/-)		
Common sizes		
Metabolism		
Organization of DNA		
Ploidy		
Transcription occurs in		
Capability of phagocytosis (+/-)		
Types of cell division		
Sexual reproduction (+/-)		

Task 4. Fill in the table comparing prokaryotes and eukaryotes. Explain the difference or write "+" or "-".

Teacher's signature					
«	»	20			

Class № 2. Topic: STRUCTURAL AND FUNCTIONAL ORGANIZATION OF THE CELL

CONTENTS OF THE TOPIC	6. Dynein –				
 The structure of the plasma membrane. Transport across the membrane: passive transport (simple diffusion, facilitated diffusion, osmosis), active transport, endocytosis, exocytosis. Cytosol. Cytoskeleton: microtubules, intermediate filaments, microfilaments. 	7. Osmosis –				
4. Intracellular transport of substances.5. Assimilation. Ribosomes.	8. Peptidoglycan –				
6. Endomembrane system (nuclear envelope, endoplasmic reticulum, Golgi body, lysosomes, peroxisomes, endosomes, vesicles).					
 7. Dissimilation. Mitochondria. 8. Lysosomal and perovisomal disorders 	9. Pili –				
	-				
GLUSSARY					
1. Anuport –	10. Plasma membrane –				
2. Anabolism –	11. Simple diffusion –				
3. Glycolysis –	12. Cytosol –				
4. Concentration gradient –					
	13. Endocytosis –				
5. Dictyosome –					







Class № 3. Topic: STRUCTURAL ORGANIZATION OF THE GENOME

CONTENTS OF THE TOPIC	6. Chromatin remodeling –
 Evolution of the gene concept. Evidence that DNA is the genetic material. Structure and functions of DNA. Genetic material of viruses and bacteria. 	7. Nuclear localization signal –
 The structure and functions of the cell nucleus. Gene, chromosome, and genome levels of eukaryotic genetic material. DNA condensation. Remodeling of chromatin. The structure of metaphase chromosomes Euchromatin and 	8. Nuclear speckles –
9. Karyotype and idiogram. Methods for studying the human karyotype. Classifications of human chromosomes.	9. Telomeres –
10. Cytoplasmic inheritance. GLOSSARY	10. Transduction –
1. Genome –	11. Centromere index (CI) –
2. Karyotype –	12. Nucleolar organizer region –
3. Lamins –	13. Nucleosome –
4. Nucleoid –	14. Plasmagenes –
5. Nucleotide –	

Task 1. Label the pictures		Task 2. Ana	alyze the k	aryotype of t	he human an	d fill in the	table.
<i>Fig. 1.</i> TEM of the nucleus:							
	2 – inner membrane; 3 – intermembrane space; 4 – pore; 5 – karyoplasm;	Sold Ball					
	6 – chromatin; 7 – nucleolus	B ₁₃	静意	6 A	16 16	5,3	\$. 13
	8.5		83	â 6	1 No. 22	₩ ×	Ŷ
				Fig. 3. Huma	an karyotype		
		Groups		Morph	ology of chroi	nosomes	
Fig. 2. TEM of human		A (1-3)					
chromosomes: 1 – arm;		B (4-5)					
2 - centromere; 3 - chromatid:		C (6-12, X)				
4 – telomere		D (13-15)					
		E (16-18)					
		F (19-20)					
		G (21-22, Y	7)				

 Task 3. Solve the problems. Problem № 1. Write the complementary strands for the following ones: a. CTGATCTGTATCAACTA 	Problem № 5. Adenine makes 16 %, guanine — 28 %, and thymine — 34 % of a DNA strand. Determine the percentage of pyrimidine bases in the complementary strand.
b. 3'ACTGATCTGTATCAACT5'c. 5'GTACTAGCTAGCTAGCTAGCCAT3'	Problem № 6. A strand of DNA fragment contains 1200 bases. 25 % is adenine, 10 % is thymine, and 30 % is guanine. How many guanines would be in the complementary strand?
 Problem № 2. In a DNA molecule, cytosine is 18%. What is the percentage of other nucleotides in this DNA? Problem № 3. If a DNA molecule has 56% of GC pairs, what would be the percentage of A, G, C, and T, respectively? 	Problem No 7. A DNA fragment has the following sequence in one of its two strands: GAATCAGTAAGTAT. What is the percentage of each base type in this DNA fragment? What is the length of this DNA fragment? What is the $(A+T)/(G+C)$ ratio in that DNA fragment?
Problem № 4. 950 cytosines make up 20 % of the total number of bases in DNA. How many adenine, thymine, and guanine are contained in the DNA fragment?	Problem № 8. DNA was isolated from a bacteriophage. The bases of its genome are A — 25 %, T — 33 %, G — 24 %, and C — 18 %. How can this result be explained?

CONTENTS OF THE TOPIC	7. Hayflick's limit –
 Cell cycle. Interphase. Semi-conservative mechanism of DNA replication. Replicon. Cell cycle regulators (cyclins and cyclin-dependent kinases). Tymes of cell division: mitoric amitoria endomitoria Dinary division 	8. Necrosis –
 Types of centary division: initosis, annosis, endomnosis. Binary division of bacteria. Mitosis: characteristics of phases, distribution of genetic material, biological significance. 	9. Primase –
6. Meiosis as a type of mitosis: characteristic of phases, distribution of genetic material, biological significance.7. Cell proliferation and cell death. Necrosis and apoptosis. Caspases.	10. Replisome –
GLOSSARY	11. Synaptonemal complex –
 Apoptosis – Bivalent – 	12. Topoisomerase –
	13. Origin of replication –
3. Caspases –	
4. Kinetochore –	14. Okazaki fragment –
5. Cohesins –	15. Chiasmata –
6. Crossing over –	16. Cyclins –

Class № 4. Topic: CELL CYCLE



Task 2. Fill in the table. Write the functions of the enzymes taking part in DNA replication.

1. DNA-polymerase	
2. Primase	
3. Helicase	
4. Topoisomerase	
5. Ligase	

Task 3. Write the contents of genetic material in the cell at different periods of interphase, mitosis, and meiosis (for example 1n1chr1c, $1n_{biv}$ 4chr4c, etc.).

Interphase	Mitosis	Meiosis I	Meiosis II
G ₁ :	A. Prophase:	A. Prophase:	A. Prophase:
		1. Leptotene:	
S:	B. Metaphase:		B. Metaphase:
		2. Zygotene:	
G ₂ :	C. Anaphase:		C. Anaphase:
	_	3. Pachytene:	_
	D. Telophase:		D. Telophase:
		4. Diplotene:	
		5. Diakinesis:	
		B. Metaphase:	
		C. Anaphase:	
		D. Telophase:	

Task 4. Match the characteristics of proteins in the left column with
their functions in the right one.Task 6. Determine the stages of prophase I by their photographs.

1. Form nuclear pore complex						A. Caspases			
2. Form	nucleos	omes					B.	B. Cyclins	
3. Phos	phorylate	other pro	oteins to	activate o	or inactiv	ate	C. Cohesins		
them		_							
4. Take	part in p	rogramm	ed cell de	eath			D.	Histones	5
5. Form	nuclear	lamina					E. Kinases		
6. Bind homologous chromosomes together in meiosis					F. Condensins				
7. Bind sister chromatids together					G.	Lamins			
8. Regulate cell cycle						H. Nucleoporins			
9. Form the central scaffold of a metaphase					I. Synaptonemal				
chromosome					co	mplex			
1 2 3 4 5 6 7						7		8	9

Task 5. Solve the case problems.

Case No 1. The haploid cells 1 and 2 mutated and became unable to replicate their DNA. In cell 1 the mutations happened during the G1 phase while in cell 2 they happened during G2. What is the theoretical chance that the cells transmit their mutations to at least one of their daughter cells?

Case \mathbb{N}_{2} . The same gene mutated in cells 1 and 2 during interphase. After mitosis cell 1 transmitted the mutation to only one daughter cell and cell 2 — to both of them. How can this be explained?

Case No 3. There is a protein with an unknown function. Its concentration in the cell is low and increases only during G2. How the inactivation of the gene coding for this protein could affect mitosis? Suggest your theories







Class № 5. Topic: THE FLOW OF GENETIC INFORMATION IN THE CELL

CONTENTS OF THE TOPIC	6. Penetrance –
 The Central Dogma of Molecular Biology. The concept of the gene. Properties and functions of genes. Ribonucleic acid, its types. The functions of RNA. Genetic code and its properties. Transcription. Transcription factors. Production of mRNA in eukaryotes: primary transcript and its processing. Recognition. Translation: initiation, elongation, and termination. Posttranslational modifications of proteins, folding of proteins. Chaperones. 	 7. Transcription factors – 8. Degeneracy of genetic code –
GLOSSARY	9. Aminoacyl-tRNA synthetase –
 Promoter – Intron — 	10. Capping –
	11. Protein folding –
3. Spliceosome –	
	12. Chaperone –
4. Terminator –	
5. Poly-A tail –	13. Proteasome –



Task 3. Solve the problems. Problem № 1. A fragment of the human insulin gene contains 2,764 base pairs (bp). Three exons of the gene contain 42, 204, and 205 bp. The entire first exon, the first 17 bp of the second one, and the last 62 pairs of the third one code for untranslated regions of mRNA. The 72 bp of the second exon code for a signaling sequence of amino acids that is removed from insulin. The last 25 bp and the first 80 bp of the second and third exons code for C-peptide, which is also removed from the insulin. How many amino acids does the ultimate insulin molecule contain? What is the percent of base pairs coding for that molecule in the gene fragment?	 Problem № 4. Here is a diagram showing the exons (white) and introns (black) of the <i>HBB</i> gene encoding β-globin, a subunit of human hemoglobin. The numbers indicate the lengths of introns and exons in base pairs. 142 113 223 856 263 A. How many nucleotides does this gene's mRNA contain? B. The non-translated regions located at the 5' and 3' ends of this mRNA contain 50 and 134 nucleotides (the stop codon is not included). How many amino acids does beta-globin contain?
Problem № 2. A fragment of adrenocorticotropic hormone (ACTH) produced by the anterior pituitary lobe has the structure: ser-ser-met-glu-his-phe-arg. What are the theoretically possible tRNA anticodon variants involved in the biosynthesis of the ACTH fragment?	Problem № 5. The average molar mass of a nucleotide is near 300 g/mole. There is a single-strand DNA of a bacteriophage and its molar mass is approximately 10 ⁷ g/mole. The average number of amino acids in each protein of this phage is near 400. How many protein-coding genes can be in this DNA? The non-coding regions can be ignored for the simplicity of calculations.
Problem No 3. The distance between adjacent base pairs in DNA is 3.4×10^{-10} m. What is the length of the DNA region coding for 200 amino acids (without stop-codons)?	Problem № 6. Each turn of the DNA double helix is 3.4 nm long and contains 10 pairs of nucleotides. The protein fragment consists of 30 amino acid residues. What is the length in nm of the DNA region that encodes this protein fragment?



CONTENTS OF THE TOPIC 5. Housekeeping genes – 1. Human genome: protein-coding genes, RNA genes, non-coding sequences (repeats, introns, junk DNA). DNA transposons and 6. Chromatin remodeling – retrotransposons. Transcriptome. Proteome. Metabolome. 2. Genome redundancy, its significance. 3. Projects Human genome, ENCODE, Roadmap. 4. Classification of genes (structural and functional genes, housekeeping, 7. Satellite DNA – and tissue-specific genes). 5. Operon. Lac- and trp-operons. Polycistronic RNA. 6. Regulation of transcription in eukaryotes: preinitiation complex. 8. Enhancer – Enhancers, silencers. 7. Epigenetics: histone modifications, cytosine methylation, CpG-islands. 8. Regulation of gene expression by non-coding RNAs. 9. Epigenetics – GLOSSARY 1. Gene expression – 10. Proteomics – 2. Retrotransposon – 11. RNA interference – 12. Common transcription factors – 3. Single nucleotide polymorphism – 13. CpG-island -4. DNA methylation –

Class № 6. Topic: REGULATION OF GENE EXPRESSION



Task 4. Solve the problems: Problem № 1. Researchers studied the expression of a particular gene and discovered that deleting a DNA region located 50,000 upstream from the promoter of the gene significantly reduces the production of protein encoded by the gene. Deleting neighboring regions had no such effect. How can this be explained?	Problem № 4. The distance between the promoter and terminator of a gene is 2700 bp. The gene codes for a protein having the mass 22 000 Da (the mass of one amino acid is approximately 110 Da). What is approximate percent of exons in the gene?
Problem № 2. Researchers performed experiments with two groups of mice: in the first group the color of the coat was yellow. In the second group, it was dark. These traits were inherited. However, it was found that adding folic acid to the diet of pregnant yellow-colored mice makes the color of little mice dark. How could this be explained?	Problem No 5 . Let's take a hypothetic operon where each promoter, operator, and terminator contain 10 base pairs. This operon has 3 structural genes, each code for a protein consisting of 50 amino acids. What is the number of nucleotides in this operon? Any other regions can be ignored for simplicity.
Problem No 3. One of the operons of a certain bacterium contains five genes. Gene A, which is closest to the promoter, and gene B, which is farthest from the promoter, are approximately equal in length. However, it was found that the protein encoded by gene A commonly appears in the cell earlier than the protein encoded by gene B. How can this difference be explained?	
	Teacher's signature «»20

Class № 7. Topic: GENOMICS. TECHNIQUES OF MOLECULAR GENETICS

CONTENTS OF THE TOPIC	7. Restriction analysis –
 Methods of nucleic acids isolation. DNA research methods: gel electrophoresis, restriction analysis, nucleic acid hybridization, DNA microarrays, PCR, sequencing. PCR and its types: quantitative PCR, reverse transcription PCR, multiplex PCR. Genome sequencing methods (Sanger sequencing, pyrosequencing, 	8. Nucleic acid hybridization –
nanopore sequencing, bisulfite sequencing).	9. Polymerase chain reaction –
GLOSSARY	
 Gel electrophoresis – Restriction endonuclease – 	10. DNA microarray –
3. DNA probe –	11. Bisulfite sequencing –
4. DNA sequencing –	12. Quantitative PCR –
5. Sanger sequencing –	13. Intercalating dye –
6. Dideoxynucleotide –	



Task 2. Match the sequencing method with its characteristic (write the correct letter in the table): a) Sanger sequencing; b) pyrosequencing; c) nanopore sequencing; d) bisulfite sequencing.

Uses nucleotides lacking a 3' OH group	
Known as the chain termination method	
Based on the measurement of ion current through a non-conductive	
membrane	
The nucleotide sequence is determined by chemiluminescence	
Uses a nanopore in a special membrane	
Reveals methylated cytosine in the DNA	
Nucleotide sequencing is determined by differences in the length of	
synthesized DNA fragments	

Task 3. Solve the problems.

Problem N_{2} **1.** The photograph shows an agarose gel in which DNA is visualized after electrophoresis. Using a length marker (labeled as "M"), determine the approximate length of the presented fragments in base pairs.



Problem № 2. Restriction endonuclease *Hind*III recognizes and cuts the site 5' AAGCTT3'. What is the chance of finding this nucleotide combination in a random DNA? What is the expected average length of the fragments formed when the DNA is cut by *Hind*III?

Problem № 3. Theoretically, after each PCR cycle, the amount of DNA is doubled. How many minutes would it take to obtain one million copies from one molecule? The denaturing, annealing, and extension last 15, 30, and 90 seconds.	Problem No 5. Mutations in the <i>PAH</i> gene cause phenylketonuria. The disease is autosomal recessive (develops when the gene <i>PAH</i> is altered in both chromosomes). Here are the results of Sanger sequencing of the <i>PAH</i> gene for two families. In family A, both parents have a c.728G>A mutation in exon 7, i.e., replacing the 728 th G nucleotide with A. In family B, one parent has the mutation c.721C>T (replacing CD with T) and the other has the mutation c.1238G>C (replacing G with CD). Examine the data in the figure and conclude whether children in both families have the disease or not. Explanation: control is the gene regions of other individuals without mutations that are needed for comparison; G, C, A, T are the Latin notations for G, C, A, and T shown by the software that processes the sequencing data.
Problem Nº 4. The gene <i>RHO</i> encodes the protein called rhodopsin. Various mutations in this gene cause a hereditary disorder retinitis pigmentosa that causes loss of vision. Sanger sequencing was performed. The diagram shows a fragment of the coding strand from the <i>RHO</i> gene (bases encoding $21^{st}-27^{th}$ amino acids). Read the codons from the first nucleotide at the bottom of the figure. Which mutation occurred in the sick person? What is the change in the amino acid sequence in the protein? G A T C G A T C	$\begin{array}{c} \text{Control} & & & & & & & & & & & & & & & & & & &$

CONTENTS OF THE TOPIC	6. Selectable marker genes –	
 Genetic engineering: goals, objectives, and stages. Methods for obtaining genes for transgenesis. Recombinant DNA. Construction of vectors, their types. Introduction of recombinant DNA into a recipient cell. Selection of 	7. Shuttle vector –	
transformed cells. Selective and reporter genes.5. Biotechnology, its importance for medicine. Genetically modified organisms. Food products containing GMOs.	8. Lipofection –	
GLOSSARY 1. Vector –	9. Electroporation –	
2. Recombinant DNA –	10. Transformation –	
	11. Sticky ends –	
3. Transgenesis –	12. DNA cloning –	
4. Polylinker –	13. Biolistics –	
5. Reporter genes –	14. Phagemids –	

Class № 8. Topic: GENETIC ENGINEERING

Task	1.	Match	the	method	of	introducing	recombinant	DNA	into
a cell	wi	th its na	me:						

1. The method is based on the ability of bacteria to take up DNA molecules from a solution					A. Transduction	
2. Delivery of DNA into a cell in a vesicle with one or more bilipid layers					B. Electroporation	
3. Transfer of recombinant DNA into a bacterial cell using a bacteriophage					C. Lipofection	
4. Direct introduction of DNA into the nucleus with a thin needle					D. Transformation	
5. Formation of temporary channels in the membrane by electric impulses E. M					icroinjection	
1	2	3	4		5	

Task 2. Label the diagram of cloning a human gene in a bacterial cell.



Some restriction endonucleases and their restriction sites				
№	Restriction endonuclease	Restriction sites and cut points		
1.	BalI	5 [°] -TGG↓CCA-3 [°] 3 [°] -ACC↑GGT-5 [°]		
2.	BamHI	$5^{\circ} - G \Psi GATCC - 3^{\circ}$ $3^{\circ} - CCTAG \uparrow G - 5^{\circ}$		
3.	EcoRI	$5^{\circ} - G \Psi AATTC - 3^{\circ}$ 3^{\circ} - CTTAA $\uparrow G - 5^{\circ}$		
4.	HindIII	$5^{\circ} - A \Psi A G C T T - 3^{\circ}$ 3^{\circ} - T T C G A $\uparrow A - 5^{\circ}$		
5.	SalI	Sall $5^{\circ} - G \lor TCGAC - 3^{\circ}$ $3^{\circ} - CAGCT \uparrow G - 5^{\circ}$		
6.	XbaI	$5'-T\Psi CTAGA-3'$ 3'-AGATC \uparrow T-5'		
7.	HaeIII	$5' - \overline{GG \Psi CC - 3'}$ 3' - CC $\bigwedge GG - 5'$		

Table 1

Task 3. Solve the problems.

Problem № 1. There is a 27-bp DNA fragment:

5'-CTGAATTAGGATCCAGGCAATAGTGTG-3' 3'-GACTTAATCCTAGGTCCGTTATCACAC-5'

What endonuclease from the table can cut this DNA? How many fragments will be formed?



CONTENTS OF THE TOPIC 6. Gene therapy – 1. Internet databases containing information about nucleotide sequences, specialized online services, Blast, NCBI. Bioinformatics. Phylogenetic 7. Cancer immunotherapy – analysis. 2. Applications of genetic engineering in medicine: production of protein products, mono- and polyclonal antibodies, recombinant proteins, DNA probes. 8. Personalized medicine – 3. Genome editing tools: CRISPR/Cas9, TALEN. Prospects for use in medicine and bioethical problems of genomic editing. Gene therapy. 4. Pharmacogenetics. Personalized medicine. 9. CRISPR/Cas9 -5. Molecular genetic markers of tumors. Cancer gene diagnostics. 6. Ways to diagnose hereditary gene diseases: direct sequencing, PCR, RFLP-, SSCP-analysis, DNA microarrays. 10. Hybridoma – GLOSSARY 1. Monoclonal antibody -11. Vector vaccine – 2. Recombinant protein -12. Recombinant vaccine – 3. Personalized medicine – 13. Biomarker – 4. Pharmacogenomics -14. Phylogenetic tree – 5. Variable regions of an antibody-

Class № 9. Topic: OMIC TECHNOLOGIES IN MEDICINE


Problem № 2. A patient with oligodentia (absence of several teeth) was examined for mutations that might cause this condition. He was found to have a mutation in exon 2 of the MSX1 gene. His family members (parents and mother's parents) without oligodentia were also examined, for which the RFLP method was used because the mutation detected creates a restriction site for the TaqI endonuclease. As a result, the studied fragment of exon 2 of the MSX1 gene (length -557 bp) could be cut by the given nuclease into fragments of 365 and 192 bp, which indicated the presence of the mutation. The results are shown in the figure.

- C control (a person without the mutation);
- 1 maternal grandfather of the person under study;
- 2 maternal grandmother of the person under study;
- 3 -father of the researched person;
- 4 mother of the person under study;
- P the person under investigation;
- U uncut fragment of the studied DNA;
- M standard (a marker of fragment length)



Who has the mutation in this family?

Problem No 3. The vast majority of cases of Friedreich's ataxia are caused by amplification (multiple copy number increase) of the GAA repeat in the first intron of the *FXN* gene. As a result, the length of the DNA fragment containing the repeat increases, and the mobility in the agarose gel decreases. The figure shows the result of electrophoresis of the *FXN* gene fragment containing the indicated repeat. "M" is the length marker, and "C" is the control (healthy person). Identify the numbers of samples in which both copies of the gene have amplification (sick individuals), one copy has amplification (healthy mutation carriers), or no amplification (healthy individuals).



Teacher's signature

20

« »

 CONTENTS 1. The nature of life, and the role of proteins and nucleic acids in the organization of living systems. Organization levels of living matter. The cell theory. 2. Prokaryotes and eukaryotes. 3. Human as a biological and social being. 4. The role of biology in medical education. 5. Subject, objectives, and methods of cytology (light, electron, and fluorescent microscopy, histochemistry and immunohistochemistry, differential centrifugation, autoradiography, morphometry, etc.). 6. The method of light microscopy. The structure of a light microscope. The rules of work with a microscope. 7. The structure of the plasma membrane. 8. Transport across the membrane: passive transport (simple diffusion, facilitated diffusion, osmosis), active transport, endocytosis, exocytosis. 9. Cytosol. Cytoskeleton: microtubules, intermediate filaments, microfilaments. Intracellular transport of substances. 10. Assimilation. Ribosomes.Endomembrane system (nuclear envelope, endoplasmic reticulum, Golgi body, lysosomes, peroxisomes, endosomes, vesicles). 11. Dissimilation. Mitochondria. Lysosomal and peroxisomal disorders. 12. Evolution of the gene concept. Evidence that DNA is the genetic material. 13. Structure and functions of DNA. Genetic material of viruses and bacteria. 14. The structure of metaphase chromosomes. Euchromatin and heterochromatin. Types of chromosomes. Rules of chromosomes. 18. Karyotype and idiogram. Methods for studying the human karyotype. Classifications of human chromosomes. 19. Cytoplasmic inheritance. 20. Cell cycle. Interphase. 21. Semi-conservative mechanism of DNA replication. Replicon. 22. Cell cycle regulators (cyclins and cyclin-dependent kinases). 23. Types of cell division: mitosis, anitosis, endomitosis. Binary division of bacteria. Mitosis: characteristics of phases, distribution of genetic material, biolo	 Cell proliferation and cell death. Necrosis and apoptosis. Caspases. The Central Dogma of Molecular Biology. The concept of the gene. Properties and functions of genes. Ribonucleic acid, its types, functions. Genetic code and its properties. Transcription. Transcription factors. Production of mRNA / mRNA synthesis in eukaryotes: primary transcript and its processing. Recognition. Translation: initiation, elongation, and termination. Posttranslational proteins modifications, protein folding, chaperones. Human genome: protein-coding genes, RNA genes, non-coding sequences (repeats, introns, junk DNA). DNA transposons and retrotransposons. Transcriptome. Proteome. Metabolome. Genome redundancy, its significance. Projects Human genome, ENCODE, Roadmap. Classification of genes. Operon. Lac- and trp-operons. Polycistronic RNA. Regulation of transcription in eukaryotes: preinitiation complex. Enhancers, silencers. Epigenetics: histone modifications, cytosine methylation, CpG-islands, Regulation of gene expression by non-coding RNAs. Methods of nucleic acids isolation. DNA research methods: gel electrophoresis, restriction analysis, nucleic acid hybridization, DNA microarrays. PCR and its types: quantitative PCR, reverse transcription PCR, multiplex PCR. Genome sequencing methods (Sanger sequencing, pyrosequencing, nanopore sequencing, bisulfite sequencing). Genetic engineering: goals, objectives, and stages. Methods for obtaining genes for transgenesis. Recombinant DNA into a recipient cell. Selection of transformed cells. Selective and reporter genes. Biotechnology, its importance for medicine. Genetically modified organisms. Food products containing GMOs. Introduction of genetic engineering in medicine: production of protein products, mono- and polyclonal antibodies, recombinant protens, DNA probes.<
significance. Meiosis as a type of mitosis: characteristic of phases, distribution of genetic material, biological significance.	46. Ways to diagnose hereditary gene diseases: direct sequencing, PCR, RFLP-, SSCP- analysis, DNA microarrays.

Class № 10. Topic: COLLOQUIUM № 1

CONTENTS OF THE TOPIC	5. Phenotype –
 Genetics as a science. Hybridological analysis. 	
 Laws of inheritance in a monohybrid cross. Law of purity of gametes Testcross. Backcrossing. Laws of inheritance in networked cross. 	6. Polymeric gene action –
 5. Limitations of Mendel's laws. Pleiotropy. 6. Intraallelic gene interactions (complete and incomplete dominance) 	7. Codominance –
superdominance, codominance, and allelic exclusion).7. Multiple alleles. Inheritance of blood groups in the ABO system	
Inheritance of MN blood groups and Rh factor. 8. Interallelic interaction of genes (complementary, inhibitory, polymeri	8. Genotype –
gene action). Bombay blood group as an example of recessiv epistasis in humans.	9. Backcrossing –
GLOSSARY	
1. Allele –	10. Epistasis –
2. Complementation –	11. Intraallelic interactions –
3. Superdominance –	12. Allelic exclusion –
4. Testcross –	13. Pure lines –

Class № 11. Topic: BASIC LAWS OF INHERITANCE

Task 1. Solve the problems.		Problem № 4. A woman has blood groups O,	Phenotype	Gene	Genotype
Problem No 1. How many and what types of gametes could be formed by	Rh-, MN. Her husband has groups AB, Rh+	System AB0			
organisms with the following genotypes?	8	(homozygote), and N. What combinations of	Group 0 (I)	\mathbf{I}^0	I ⁰ I ⁰
AaBbDd	AAbbCCddRR	blood groups can then enharen have?	Group A (II)	IA	I ^A I ^A , I ^A I ⁰
			Group B (III)	IB	$I^{B}I^{B}, I^{B}I^{0}$
			Group AB (IV)	$I^A + I^B \\$	I ^A I ^B
			System MN		
			Group M	L ^M	L ^M L ^M
			Group N	L ^N	L ^N L ^N
Problem № 2. A blue-eved male married a brow	vn-eved female. Her father was		Group MN	L ^M +L ^N	L ^M L ^N
blue-eyed and her mother was brown-eyed. It's	known that the allele of brown		System Rh	-	
eyes is dominant. What phenotypes of children c	ould be expected in this family		Rh+	D	DD, Dd
and what is their chance?			Rh-	d	dd
Problem № 3. In humans, brown eyes and de determined by the dominant alleles of two diffe sinistrality (left-handedness) are determined A browned-eyed right-hander man married a What traits could be expected in children if the m	xtrality (right-handedness) are brent genes. The blue eyes and by their recessive alleles. blue-eyed left-hander woman. an is double-heterozygous?	Problem № 5. In humans, congenital deafness alleles of two different genes (d and e). Nor alleles of both the genes (D and E). There is a while all their seven children have normal hearing genotypes of all members in this family?	ss can be cau mal hearing ro family where ng. What are t	sed by equires parent he mos	recessive dominant s are deaf t probable

Problem № 6. Healthy parents have got two children. The older one was healthy, but the younger one has two autosomal recessive disorders: cystic fibrosis and galactosemia. What is the chance that the healthy child is a carrier of at least one of these diseases? What is the chance of giving birth to a child sick with at least one of the diseases in the family?	Problem Ne 7. In "Fleur" begonia, leaf variegation is caused by a recessive allele of the gene f , and in "Sank" begonia by a recessive allele of the gene s (genes are in different chromosomes). When two dihomozygous variegated plants of these varieties are crossed, all resulting hybrids have green leaves. How many begonias (in %) among plants with green leaves (F2) will carry only one (any) variegated leaf gene?
	Teacher's signature «»20

CONTENTS OF THE TOPIC 5. Genetic map of chromosome -1. Experiments of T. Morgan. Complete and partial genetic linkage. Linkage groups. 6. Primary sexual characteristics -2. Crossing-over. 3. Chromosomal theory of inheritance. 4. Genetic and cytological chromosome maps. 5. Sex as a biological trait. Sex-influenced and sex-limited traits. X and 7. Heterogametic sex – Y linked traits. 6. Definition, differentiation, and redefinition of sex in ontogeny. Genetic regulation of gonadogenesis in humans. 8. Barr body --7. Peculiarities of sex determination in humans: physical, intermediate and socio-psychological determinants. 8. Disorders of sex development in humans. Ethical and legal aspects of 9. Mosaicism – morphological and civil sex changes. 9. X-inactivation. M. Lyon's hypothesis of female mosaicism by sex chromosomes. 10. Androgen insensitivity syndrome -**GLOSSARY** 1. Linked genes -11. Holandric traits -2. Sex-linked genes -12. Hemizygosity – 3. Crossover gametes – 13. Genetic sex – 4. Chromosomal theory of sex determination –

Class № 12. Topic: GENETIC LINKAGE. GENETICS OF SEX



Problem No 4. Two patients, 15 and 18 years old with a female phenotype, have primary amenorrhea. Clinical examination revealed underdevelopment of primary sex characteristics. Barr body was not detected. The karyotype was determined to be 46, XY. Male sex hormone levels were not elevated, but closer to the upper limit of the normal range. Sequencing of the <i>AR</i> gene was performed to verify one of the suspected causes of the disease, which revealed a nonsense mutation c.2657T>A — codon TAA instead of TAT. As result, the protein encoded by this gene is not being produced. What diagnosis was confirmed by sequencing of the <i>AR</i> gene? What does this gene encode?	Problem № 6. Hemophilia and color blindness are cau alleles of two different genes (h and d). The genes as chromosome at a distance of 10 cM. A woman whethe diseases and mother had no such recessive alleles mawhat is the probability of giving birth to a child: 1) with the one disease; 3) phenotypically healthy?	sed by the recessive re situated in the X ose father had both urried a healthy man. both diseases; 2) with
Problem No 5. Elliptocytosis and blood group Rh+ are determined by the dominant alleles of genes El and D respectively. Both the genes are situated in the same chromosome at a distance of 3 cM. There is a man who is heterozygous for both genes. He inherited Rh+ from his mother and elliptocytosis from his father. His wife has blood group Rh- and normal erythrocytes. What phenotypes can their children have and what is their chance in percent?	Teacher's signature «»20	

Class № 13. Topic: VARIATION. MUTAGENESIS. CARCINOGENESIS

CONTENTS OF THE TOPIC	6. Phenocopies –
 Variation and its types. Phenotypic plasticity. Combinative variation. Mutations. Causes of mutations: DNA copying errors, unequal crossing over, mutagens. 	7. Anaphase lag –
 Physical, chemical, and biological mutagenic factors. Genetic hazards of environmental pollution by mutagens. Classifications of mutations. Stability and repair of genetic material. 	8. Non-homologous end joining –
 Types of DNA repair. Excision repair, repair of double-stranded breaks. Photoreactivation. Role of repair disorders in human pathology. Carcinogenesis. Oncogenes and tumor suppressor genes. 	9. Oncogene –
GLOSSARY 1. Mutation –	10. Tumor suppressor genes –
2. Unequal crossing over –	11. Reciprocal translocation –
3. Reparation of genetic material –	12. Combinative variability –
4. Insertion –	13. Transversion –
5. Reading frameshift –	14. Missense mutation –

Task 1. Label the figure of nucleotide excision repair and explain its	Task 2. Match the D	NA repair me	chanism wit	th its name	
mechanism.	1. Error-prone mecha	nism for joining	double-stran	ded A. Dire	ect reversal
Damaged DNA 1 –	2. Single nucleotide i	s replaced		B. Nuc	leotide
		1		excisio	n repair
5 [°]	3. Method by which	pyrimidine dimer	rs are elimina	ted C. Base	e excision
	in humans			repair	
r	4. Damage is repaired	d without nucleot	ide replacem	ent D. Nor	homologous
0	5 Denoir involving	nataina wit	h anda	end joi	ning
2-	exonuclease activity	and subsequent f	illing in the	and E. Kep	aration by
	in the DNA strand wit	h DNA-polymer	ase	recomb	oination
	6. Use of the sequer	ice of homologo	us chromoso	me F. Misi	match repair
0	or sister chromatid to	repair double-stra	anded breaks		•
	1 2	3	4	5	6
n han han han han han han han han han ha	Task 3. Model ch	anges of pro	teins in ca	ase of dif	ferent point
	mutations.				
	Initial mRNA	5'AUGAC	CGACCCC	GAAAGGG	ACC3'
₩ @	Peptide				
	Silent mutation	5'AUGAC	CGACCC	CAAAGGG	ACC3'
4 –	Peptide				
4	Missense mutation	5'AUGCC	CGACCCC	GAAAGGG	ACC3'
	Peptide				
	Nonsense mutation	5'AUGAC	CGACCCC	GUAAGGG	ACC3'
	Peptide				
	Frameshift mutation	5'AUGACO	CGACGCC	GAAAGG	GACC3'
	Peptide				

Task 4. Solve the problems.Problem № 1. Some cells of a person have a normal karyotype, others have 47 or 45 chromosomes. What is the name of this phenomenon? What is the mechanism of its origination?	 Problem № 5. Burkitt's lymphoma (cancer that develops from B-lymphocytes) is known to develop because of an increase in the activity of the <i>C-MYC</i> oncogene located in chromosome 8. The disease can be caused by several aberrations: a) translocation of a q-arm fragment from chromosome 8 to the q-arm of chromosome 14:
Problem № 2. A man has got brown eyes, his wife has got blue eyes and their daughter has one blue and the other brown eyes. How can it be explained?	b) translocation of a p-arm fragment from chromosome 2 to the q-arm of the chromosome 8;c) translocation of the q-arm region from chromosome 8 to the q-arm of chromosome 22.
 Problem № 3. Aged spouses got a son who is heterozygous in the causing hemophilia. What conclusion about his karyotype can be drawn? Problem № 4. Every day in every human cell about 200 cytosines per haploid genome 	Is one of these mutations present in the chromosomes shown in the photograph? Explain your answer. 1 2 3 4 5
are converted to uracil by spontaneous deamination. What is the consequence of deamination of methylated cytosine? $ H_2 O - NH_3 - NH_3 - H_2 O - H_$	
Cvtosine	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
H ₃ C	Teacher's signature «»20

Class № 14. Topic: POPULATION GENETICS

CONTENTS OF THE TOPIC	5. Immigration –
 Population. Characteristics of a population. Gene pool. Ideal population. Hardy–Weinberg equilibrium. Factors disturbing Hardy–Weinberg equilibrium: natural selection, genetic drift, mutations, migration, non-random mating. Human genetic polymorphism, its biological, medical, and social aspects. Distinctive features of the human population. Types of marriages Inbreeding Mating assortativity. Inbreeding coefficient 	6. Founder effect –
 5. Large and small populations. Peculiarities of the gene pool of isolates. Founder and bottleneck effects. 6. Effects of elementary evolutionary factors on human populations. 7. Genetic load, its biological essence, and medical significance. 	7. Inbreeding –
GLOSSARY	8. Genetic load –
1. Population –	
2. Gene pool –	9. Inbreeding coefficient –
3. Natural selection –	10. Assortative mating –
4. Genetic drift –	11. Bottleneck effect –

Task 1. Solve the problems. Problem № 1. In a study of 4,300 individuals from a certain population, it was found that 3,009 of them could feel the bitter taste of phenylthiocarbamide (PTC), while 1,291 could not. The ability to taste PTC is determined by the dominant allele of an autosomal gene. Based on these data, calculate the frequencies of the dominant and recessive alleles and the frequencies of the genotypes that should be observed in this population.	Problem № 3. Cystic fibrosis is an autosomal recessive disorder. The incidence of this disease in the Republic of Belarus is about 1 : 8000. Based on these data, calculate the probability to carry this allele (frequency of heterozygotes) for the people living in Belarus. Taking these data into account, determine what is the probability of giving birth to a child with cystic fibrosis in a family where the mother is heterozygous and the father is phenotypically healthy, but his exact genotype is not known.
Problem № 2. Sickle cell anemia is an autosomal recessive disorder. Heterozygous carriers of the disease have increased protection against severe forms of malaria. The incidence of sickle cell anemia in some African countries (e.g. Nigeria) is about 2 %. Calculate the percentage of people who have an increased protection against severe forms of malaria in these countries.	Problem № 4. Phenylketonuria (PKU) is inherited in an autosomal recessive manner. The incidence of PKU in Belarus is about 1 : 6000. Calculate the probable number of heterozygous carriers of the disease in Belarus (in thousands) assuming the population is 9408.4 thousand (in 2019).

Problem № 5. In a population, the incidence of X-linked recessive color blindness among women is about 0.5 %. What is the incidence of the disease in males of this population?	Problem № 7. Assume there is a disease with an autosomal dominant pattern of inheritance and incidence 1 : 50. This disease occurs only in males and the penetrance of the gene is 20 % (in females it is 0 %). Taking the ratio of males to females as 1 : 1, determine the genetic structure of the population according to the analyzed trait.
Problem № 6. Congenital dislocation of the hip may be caused by the dominant allele of an autosomal gene with an average penetrance of 25 %. According to one research (Efroimson et al., 1968), the frequency of this pathology is 6 : 10 000. What is the frequency of recessive homozygotes in the studied population?	
	Teacher's signature «»20

CONTENTS OF THE TOPIC	6. Holzinger's formula –
 Humans as a specific object of genetic analysis. Methods of human genetics: genealogical analysis, twin study, biochemical tests, molecular-genetic methods. Methods of diagnosing human chromosomal diseases: standard karyotyping, SKY, FISH, and single-nucleotide polymorphism array 	7. Spectral karyotyping –
 karyotyping. 4. Rapid diagnostic methods: microbiological tests, detection of X- and Y-sex chromatin, biochemical tests, genetic dermatoglyphics. 5. Neonatal screening of monogenic disorders. 	8. Pedigree –
GLOSSARY	9. Fluorescence in situ hybridization –
 Karyotyping – DNA probe – 	10. Screening –
	11. Propositus –
3. Prenatal diagnosis –	12. Single transverse palmar crease –
4. Concordance of twins –	13. Medical Genetics –
5. Rapid diagnostic methods –	

Class № 15. Topic: HUMAN GENETICS

Task 1. Solve the problems.

Problem № 1. What is the pattern of inheritance of the trait from the pedigree? What are the genotypes of all pedigree members?



Problem № 2. What is the pattern of inheritance of the trait from the pedigree? What are the genotypes of all pedigree members?



Problem № 3. What is the pattern of inheritance of the trait from the pedigree? What are the genotypes of all pedigree members?



Problem № 4. What is the pattern of inheritance of the trait from the pedigree? What are the genotypes of all pedigree members?



Problem № 5. What is the pattern of inheritance of the trait from the pedigree? What are the genotypes of all pedigree members?



Problem No 6. The concordance of monozygotic and dizygotic twins in body mass is 80 % and 30 %. What is the degree of genetic determination of body mass? What is the influence of the environment on this trait?

Problem № 7. To determine the degree of genetic determination of bronchial asthma, 44 pairs of monozygotic and 120 pairs of dizygotic twins were studied. Twenty-three pairs of monozygotic twins and six pairs of dizygotic twins were concordant. Estimate the role of hereditary and environmental factors in the formation of this trait?

Problem No 8. FISH was used to detect a deletion in the long arm of the fifth chromosome. The signals from the probes to the p- and q-arms of this chromosome are green and red, respectively (in the black and white photo – white and gray).



Class № 16. Topic: HUMAN HEREDITARY DISORDERS

CONTENTS OF THE TOPIC	6. Full trisomy
 Etiology and pathogenesis of human hereditary diseases. Classification of human hereditary diseases. Monogenic and polygenic diseases: disorders of amino acid, carbohydrate, lipid, nucleic acid, mineral metabolism, disorders of blood clotting, and hemoglobin structure. 	7. Mosaic trisomy –
 Human chromosome disorders caused by changes in the structure and number of autosomes, full and partial monosomies and trisomies. Mitochondrial diseases. 	8. Partial trisomy –
 Multifactorial diseases. Principles of treatment of human hereditary pathology. 	9. Kayser–Fleischer ring –
GLOSSARY	
1. Albinism –	10. Tophus –
2. Monogenic disorders –	11. Muscle hypotonia –
3. Inborn errors of metabolism –	12. Anemia –
4. Chromosomal aberration –	13. Brushfield spots –
5. Multifactorial disease-	14. Failure to thrive –

Task 1. Solve the cases. Case № 1. A woman gave birth to a baby whose cry sounded like a cat's meowing. He has a moon-like face, muscular hypotonia, microcephaly, upslanting palpebral fissures, squint, deformed low-set auricles, and arrest of psychomotor development. What disease can be supposed? Which methods should be used to confirm the diagnosis? What is the prognosis for this child?	Case No 4. In the family of healthy parents, a full-term child with low body weight (2600 g) was born. The baby has microcephaly, low backward-sloping forehead, narrow eye slits, microphthalmia, deformed auricles, double-sided cleft of lip and palate, toe dactylion, and single transverse palmar creases, ventricular septum defect in the heart, significant delay of motor and physiological development. What disease can be supposed? What tests can be used to diagnose this disease?
Case No 2. The family has got a child who has muscular hypertonia, seizures, intellectual disability, musty odor, lighter skin and hair than unaffected family members. What disease can be supposed? How can it be diagnosed? What is the probability of giving birth to the next child with this pathology?	Case N_2 5. Identify the hereditary disorder: the disease is associated with bleeding of different intensities and hemorrhages in the joints, bones, and muscle tissue. What is the probability of giving birth to a child with the disease in a family where the parents are healthy and the son is sick?
Case № 3. In the family of healthy parents who are second cousins, a full-term baby was born. The baby was breastfed by the mother. Gradually the child developed vomit and diarrhea, jaundice, liver and lien enlargement, failure to thrive, and cataract. The symptoms got stronger in course of time. What disease can be supposed? What laboratory tests should be made? Is it possible to stop the progression of the disease? What is the probability of giving birth to another sick child in this family?	Case № 6. Identify the disorder: The disorder occurs almost exclusively in males. Patients are normal at birth. Psychomotor delay becomes evident after several months. The disorder is characterized by neurological and behavioral abnormalities. There are symptoms of gout such as arthritis, and kidney and bladder stones. The urine of the patients may have "orange sand". Neurological and behavioral disturbances include abnormal involuntary muscle movements, and self-injury (including biting and head banging). People with the disorder usually cannot walk, require assistance sitting, and generally use a wheelchair. Patients usually show mild to the moderate intellectual deficit. What is the name of the disorder described above? Why the disorder occurs almost exclusively in males? What is the prognosis for affected individuals?

Case .	№ 7. I	ldentif	fy a h	eredit	ary pa	atholog	gy base	ed on	the ka	aryoty	vpe.			Case № 8. A 45-year-old woman and her 50-year-old husband have got a full-
))(),	-	() 5)	FR)()(4	(ال ر ۱۰	term baby. The child has a flat face, low backward-sloping forehead, big head, upslanting palpebral fissures, epicanthus, light spots on the iris, thick lips, thick tongue protruding from the mouth, underdeveloped low-set auricles, high palate, improper growth of the teeth, unclosed interatrial septum, single transverse palmar crease. There is a significant delay of neurologic-and- babagioral davalopment
<pre>«</pre>	7	8	9 9	10	11	12	{(7	8	9	10	11	12	What disease can be supposed? Which methods should be used to confirm
13	11	15		1 6	17	18	13	15	15		16	17	18	the diagnosis? What is the future viability prognosis for this child?
1 9	11 20	21	22 22	×		•	1 9	11 20	21	* * 22 R	×	1		
ĬĬ	۲			,	,		ĬĨ	١.	A SHORE	V	1	,	11	Task 2. What are the inheritance patterns of the following diseases?
11	1		N	I	[·	וי		Л		N	i	ſ	- Al	1. Galactosemia
,	2		3	4		5	,	2		3	4		5	2. Lesch–Nyhan syndrome
((]])į	\mathbf{p}	12	17)1	- KC]])ļ	\mathbf{p}	2		11	3. Wilson disease
6	7	8	9	10	11	12	6	7	8	9	10	11	12	4. Hemophilia A
11	11	16		16	17	18	11	ŧ1	łť		ŧi	11	ŝ.	5. Sickle cell anemia
							13	14	15		16	17	18	6. Oculocutaneous albinism
19	20	21	* * 22	Ì			1 9	11 20	21	22		k	ð Y	7. Phenylketonuria
Δ			С							D				
B-														
С-														Teacher's signature
D –														«»20

CONTENTS OF THE TOPIC	5. Invasive diagnostic tests –
 Genetic counseling and its tasks. Indications for directing a family to genetic counseling. Stages of genetic counseling: clinical examination, risk calculation, evaluation of consequences, prognosis. Genetic risk calculation. Laws of addition and multiplication, Bayes' 	6. Cordocentesis –
 theorem, calculation of posterior probability. 4. Prenatal diagnostic tests for hereditary disorders (alpha-fetoprotein evaluation, ultrasonography, chorionic villus sampling, amniocentesis, cordocentesis, and fetoscopy). 	7. Amniocentesis –
 5. Moral and ethical aspects of prenatal diagnosis. Induced termination of pregnancy. 6. Ethical and legal problems of genetic consulting. 	8. Independent events –
GLOSSARY 1. Prenatal diagnosis –	9. Alpha-fetoprotein –
2. Medical genetic counseling –	10. Ultrasonography –
3. Screening –	11. Prior probability –
4. Indirect methods of prenatal diagnosis –	12. Posterior probability –

Class № 17. Topic: GENETIC COUNSELING. PRENATAL DIAGNOSIS

Task 1.	Solve the	problems.
---------	-----------	-----------

Problem No 1. The son of American banker Twister suffered from three genetic conditions: hemophilia, color blindness, and total absence of teeth. All of them are X-linked recessive. Twister junior had been living far away from his parents, in Paris, for many years when he died in 1944. After his death, a French woman with a 15-year-old boy came to Twister senior. The boy had hemophilia, color blindness, and the absence of teeth. The woman said that the boy is a son of Twister junior, but the documents proving that had been lost. Despite the absence of the documents, Twister senior recognized the boy to be his grandson. The family doctor convinced him that such a coincidence of three rare hereditary disorders proved that the boy was his grandson. Do you agree with the doctor's opinion?

Problem No 2. There is a pregnant woman whose son and husband have hemophilia. Being afraid that she will give birth to a son with haemophilia, she applied to genetic counselling to clear up the sex of the fetus and have the pregnancy terminated if it is a boy. A doctor recommended terminating the pregnancy without carrying out the amniocentesis. Is the doctor's advice correct?

Problem No 3. The propositus is a boy having Duchenne muscular dystrophy. Proband's parents and two sisters are healthy. On the paternal side, two uncles, an aunt, a grandfather, and a grandmother were healthy. Two daughters of the uncle and the son of the aunt are healthy. On the mother's side, one of the two uncles (the oldest) had myopathy. The second uncle (the healthy one) had two healthy sons and a healthy daughter. The proband's aunt had a sick son. The grandfather and grandmother were healthy. Draw a family tree. Determine the pattern of inheritance and the genotypes of the family members. What is the probability of having a sick child in the family if the proband marries a healthy woman whose father has Duchenne muscular dystrophy?

Problem № 4. Analyze the family whose members have hemophilia. Answer Problem № 5. Analyze the family. Determine the pattern of inheritance. Assuming that II-4 is not a carrier, calculate the probability that the propositus the questions.



is a carrier of the recessive allele. Based on this probability, calculate the probability of having a sick child in the family of propositus.



Class № 18. Topic: COLLOQUIUM № 2

42. Applications of genetic engineering in medicine: production of protein	61. Population. Characteristics of a population. Gene pool. Ideal population.
products, mono- and polyclonal antibodies, recombinant proteins, DNA probes.	Hardy–Weinberg equilibrium. Factors disturbing Hardy–Weinberg equilibrium:
43. Genome editing tools: CRISPR/Cas 9, TALEN. Prospects for use in medicine	natural selection, genetic drift, mutations, migration, non-random mating.
and bioethical problems of genomic editing. Gene therapy.	62. Human genetic polymorphism, its biological, medical, and social aspects.
44. Pharmacogenetics. Personalized medicine. Molecular genetic markers of	Distinctive features of the human population. Types of marriages. Inbreeding.
tumors. Cancer gene diagnostics.	Mating assortativity. Inbreeding coefficient. Large and small populations.
45. Ways to diagnose hereditary gene diseases: direct sequencing, PCR, RFLP-,	Peculiarities of the gene pool of isolates. Founder and bottleneck effects.
SSCP-analysis, DNA microarrays.	63. Effects of elementary evolutionary factors on human populations. Genetic load,
46. Genetics as a science. Hybridological analysis. Laws of inheritance in a	its biological essence, and medical significance. Humans as a specific object of
monohybrid cross. Law of purity of gametes. Testcross. Backcrossing.	genetic analysis.
47. Laws of inheritance in polyhybrid cross. Limitations of Mendel's laws.	64. Methods of human genetics: genealogical analysis, twin study, biochemical
Pleiotropy.	tests, molecular-genetic methods.
48. Intraallelic gene interactions (complete and incomplete dominance,	65. Methods of diagnosing human chromosomal diseases: standard karyotyping,
superdominance, codominance, and allelic exclusion). Multiple alleles. Inheritance	SKY, FISH, and single-nucleotide polymorphism array karyotyping. Rapid diagnostic
of blood groups in the ABO system. Inheritance of MN blood groups and Rh factor.	methods: microbiological tests, detection of X- and Y-sex chromatin, biochemical
49. Interallelic interaction of genes (complementary, inhibitory, polymeric gene	tests, genetic dermatoglyphics. Neonatal screening of monogenic disorders.
action). Bombay blood group as an example of recessive epistasis in humans.	66. Etiology and pathogenesis of human hereditary diseases. Classification of
50. Experiments of T. Morgan. Complete and partial genetic linkage. Linkage	human hereditary diseases.
groups.	67. Monogenic and polygenic diseases: disorders of amino acid, carbohydrate, lipid,
51. Chromosomal theory of inheritance. Crossing-over. Genetic and cytological	nucleic acid, mineral metabolism, disorders of blood clotting, and hemoglobin structure.
chromosome maps.	68. Human chromosome disorders caused by changes in the structure and number
52. Sex. Sex-influenced and sex-limited traits. X and Y linked traits.	of autosomes, full and partial monosomies and trisomies.
53. Definition, differentiation, and redefinition of sex in ontogeny. Genetic	69. Mitochondrial diseases.
regulation of gonadogenesis in humans. Peculiarities of sex determination in	70. Multifactorial diseases.
humans: physical, intermediate and socio-psychological determinants.	71. Principles of treatment of human hereditary pathology.
54. Disorders of sex development in humans. Ethical and legal aspects of	72. Genetic counseling and its tasks. Indications for directing a family to genetic
morphological and civil sex changes.	counseling.
55. X-inactivation. M. Lyon's hypothesis of female mosaicism by sex chromosomes.	73. Stages of genetic counseling: clinical examination, risk calculation, evaluation
56. Variation and its types. Phenotypic plasticity. Combinative variation.	of consequences, prognosis.
57. Mutations. Causes of mutations: DNA copying errors, unequal crossing over,	74. Genetic risk calculation. Laws of addition and multiplication, Bayes' theorem,
mutagens.	calculation of posterior probability.
58. Physical, chemical, and biological mutagenic factors. Genetic hazards of	75. Prenatal diagnostic tests for hereditary disorders (alpha-fetoprotein evaluation,
environmental pollution by mutagens.	ultrasonography, chorionic villus sampling, amniocentesis, cordocentesis, and
59. Classifications of mutations. Stability and repair of genetic material. Types of	fetoscopy).
DNA repair. Excision repair, repair of double-stranded breaks. Photoreactivation.	76. Moral and ethical aspects of prenatal diagnosis. Induced termination of
Role of repair disorders in human pathology.	pregnancy.
60. Carcinogenesis. Oncogenes and tumor suppressor genes.	77. Ethical and legal problems of genetic consulting.

Class № 01 (19). Topic: REPRODUCTION OF LIVING MATTER

CONTENTS OF THE TOPIC	5. Hermaphrodites –
 Reproduction is a universal property of living things. Forms of asexual reproduction. Forms of sexual reproduction, biological significance. Lateral gene transfer. Hermaphroditism. 	6. Asexual reproduction –
 Ovogenesis and spermatogenesis in humans. Regulation of gametogenesis in humans. Morphological and functional characteristics of mature human gametes. 	7. In vitro fertilization –
 6. Insemination. Peculiarities of fertilization in humans. 7. Overcoming infertility in humans. 8. Implantation of an embryo, preimplantation diagnosis. 	8. Infertility –
GLOSSARY 1. Pre-implantation genetic diagnosis –	9. Zona pellucida –
2. Gynogenesis –	10. Spermatogenesis –
	11. Parthenogenesis –
3. Gamete –	12. Acrosome –
4. Insemination –	13. Lateral gene transfer –





Problem № 2. Planarians can multiply asexually and sexually by self-fertilization. Is the genotype of the progeny produced by self-fertilization the same as that of the progeny produced by asexual reproduction? Explain your answer?

Problem No 3. Semen analysis of persons A and B revealed that their spermatozoa have normal morphology, but the spermatozoa of A are immovable and the spermatozoa of B stay on the surface of the egg cell and do not pass inside. What structures of sperms may not perform their normal functions in these cases?

Problem № 4. Autopsy of 22-year-old dead women revealed that her ovaries contained:

Left ovary (smaller)	Right ovary (bigger)
17 000 follicles	25 000 follicles
26 corpora albicantia	48 corpora albicantia

If one follicle forms one corpus luteum, then at what approximate age did ovulations begin in this woman?

Teacher's signature

« » 20

Class № 02 (20). Topic: FUNDAMENTALS OF PRENATAL ONTOGENESIS

6. Gastrulation –
7. Germ layers –
8. Amnion –
9. Neural tube –
10. Aplasia –
11. Extraembryonic membranes –
12. Trophoblast –
13. Hypoblast –



Task 3. Match the germ layer	in the left column with the tissues they
produce in the right column.	

			1. Brain									
A. Ectoderm			2. Epidermis									
			3. Epithelial lining of the pancreas									
			4. Bones									
B. Mes	B. Mesoderm			5. Epithelial lining of the bronchial tree								
			6. Dermis									
			7. Blood vessels									
C. Ende	oderm		8. Epithelial lining of the small intestine									
			9. Pituitary gland									
	А			В		С						

Task 4. Match the concepts in the left column with their names in the right column.

1. Participates in t hematopoietic orga	A. Yolk sac	
2. The outgrowth participates in the	B. Amnion	
3. A sac with fluid the embryo and fet	C. Chorion	
4. External covering participates in form	D. Allantois	
1	4	
1	4	

Task 5. Match the concepts in the left column with their names in the right column.

1. The process in which one group of cells, the inducing	A. Positional
tissue, directs the development of another group of cells	information of
	the cell
2. Signaling molecule that acts over long distances to	B. Morpho-
induce responses in cells based on the concentration of	genesis
these molecules	
3. The coordinate system associated with concentration	C. Induction
gradients of signaling molecules	
4. The process by which a cell or group of cells	D. Morphogen
becomes specialized in structure and function	
5. The developmental process by which tissues and	E. Differentiation
organs acquire the shape that is critical to their function	

1	2	3	4	5

Task 6. The twinned tadpole of the frog shown was made in an experiment demonstrating embryonic induction. How such an experiment can be conducted?



Teacher's signature

«_____20__

Class № 03 (21). Topic: FUNDAMENTALS OF POSTNATAL ONTOGENESIS

CONTENTS OF THE TOPIC	6. Resuscitation –
 Periods of postnatal ontogenesis. Growth and development of the human body and its regulation. Acceleration. Human constitution and habitus, their medical significance. Critical periods of postnatal ontogenesis. 	7. Euthanasia –
 5. Biological aspects of ageing. The concepts of gerontology, geriatrics, and valeology. Molecular and genetic aspects of aging. 6. Clinical and biological death. Resuscitation and its biological aspects. Moral and ethical problems of euthanasia. 	8. Biological age –
GLOSSARY	9. Gerontology –
 Postnatal ontogenesis – Ageing – 	10. Biological death –
3. Habitus –	11. Telomeres – 12. Valeology –
4. Clinical death –	13. Neonate –
5. Acceleration –	

Task 1. Match the type of growth in the left column with corresponding tissues, organs, or body parts in the right column.

	1. Liver					
A. General	2. Brain					
	3. Spleen					
	4. Fallopian tubes					
B. Cerebral	5. Prostate					
	6. Tonsils					
	7. Eyes					
C. Lymphoid	8. Skeleton					
	9. Thymus					
	10. Spinal cord					
D. Reproductive	11. Ovaries					
	12. Muscles					
A	B C D					

Task 2. Match the phenomenon in the left column with a hallmark of ageing in the right column.

1. Aging-associated accumulation of point mutations,					A. Mitochondrial					
transloca	translocations, chromosomal gains, losses, etc.				Dysfunction					
2. Shorte	ening of t	erminal re	egions of	chromos	omes		B . E	B. Epigenetic		
explains	limited a	bility for	division				Alterations			
3. Anabo	olic signa	ling is ass	sociated v	vith agein	ıg		C. Telomere Attrition			
4. Altera	tions in I	DNA metl	nylation p	oatterns,			D. A	ltered Int	ercellula	
modifica	tions of h	istones, c	hromatin	remodel	ing		Communication			
5. Changes in biogenesis, folding, trafficking, and				E. Stem Cell						
degradation of proteins				Exhaustion						
6. Alterations in the normal function of mitochondria				F, G	F, Genomic Instability					
7. Phenomenon characterized by the cessation of cell				G. Loss of Proteostasis						
division										
8. Decrease in the number of undifferentiated cells able to				H. Deregulated						
produce new specialized cells					Nutrient-sensing					
9. Changes in signals transmitted from cell to cell					I. Ce	ellular Sei	nescence			
1	1 2 3 4 5 6				7	8	9			

Task 3. Write the names of the following constitutional types to the table.



Task 4. Which periods of postnatal ontogenesis are longer in males than in females?

Task 5. Which periods of postnatal ontogenesis are longer in females than in males?

Task 6. What is the difference between clinical death and biological death?

Tea	cher's	signature	
«	»		20

Class № 04 (22). Topic: BIOLOGICAL ASPECTS OF REGENERATION AND TRANSPLANTATION

CONTENTS OF THE TOPIC	5. Organ donor –		
 Regeneration. Physiological regeneration as a mechanism for maintaining homeostasis. Classification of cells according to their regenerative ability. Reparative regeneration. 	6. Morphollaxis –		
 Regulation of regeneration. Importance of regeneration for biology and medicine. Regenerative medicine. Transplantation of organs and tissues, its 	7. Epimorphosis —		
 types: autotransplantation, allotransplantation, homotransplantations, and xenotransplantation. 5. Tissue incompatibility and ways to overcome it. 6. Moral, ethical and legal aspects of tissue and organ transplantation. 	8. Hypertrophy –		
 7. Cultivation of cells and tissues outside the human body, tissue preservation. Stem cells. Cell lines in biological and medical experiments. 8. Artificial energy Cultivation of human framework from enirghbound. 	9. Hyperplasia –		
8. Artificial organs. Cultivation of numan organs from animals and decellularization, therapeutic cloning, 3D-bioprinting.	10. Orthotopic transplantation –		
GLOSSARY			
1. Physiological regeneration –	11. Heterotopic transplantation –		
2. Asymmetric division –	12. Tissue incompatibility –		
3. Stem cell –	12 Craft rejection		
4. Organ transplantation –	15. Graft rejection –		



Task 3. Match the type of stem cells in the right column with its characteristics in the left column.

1. Capable of diff extraembryonic me	A. Totipotent		
2. Capable of difficells from endoder	B. Multipotent		
3. Capable of diffe	C. Unipotent		
4. Capable of diffe	D. Pluripotent		
1	4		

Task 4. Match the type of transplantation in the right column with its characteristics in the left column.

1. Transplantation of the organism's structures				A. Allotransplantation	
2. Transplantation from an organism of another species				B. Autotransplantation	
3. Transplantation of tissues or organs from a genetically identical organism (e.g. monozygotic twin)				C. Xenotransplantation	
4. Transplantation of tissues or organs from an organism of the same species				otransplantation	
1	2	3		4	

Task 5. Why best donors of tissues are often relatives of the recipient?
Task 6. There are two theories explaining the origin of blastema cells in morphollaxis.

Hypothesis A. Undifferentiated cells are present in the body.

Hypothesis B. Undifferentiated cells are produced from differentiated cells.

Evidence in favor of only one of these hypotheses was obtained in experiments on planarians, flatworms capable of regeneration by morphollaxis.

1. Two groups of planarians were exposed to lethal doses of X-rays, which also results in stem cell loss (Fig. 1).

 2. Differentiated cells, were injected into the planaria of the first group, and stem cells (neoblasts) — into the worms of the other group.
 3. The planaria in the first group subsequently died, while those in the second group survived.

Which hypothesis is supported by the results of the experiment?



Fig. 1. Planaria that exposed to different doses of X-rays (1000–6000 rads). Neoblasts are visualized in the body of each worm, which allows estimating their number **Task 7.** To determine whether neoblasts (the stem cells that provide regeneration in planaria) are pluripotent or multipotent stem cells, an experiment was conducted in which worms were exposed to lethal doses of X-rays (causing all neoblasts to die). Some planarians were no longer exposed to any procedures (control group), and the rest were injected with just one neoblast each (experimental group). Subsequently, progressive cell death was observed in all worms, but planarians in the experimental group survived and regenerated completely within two months (Fig. 2), while planarians in the control group died. Based on these results, conclude what stem cells are neoblasts (pluripotent/multipotent).



Fig. 2. Planarian exposed to a lethal dose of X-rays on days 15, 30, 36, 54, and after day 60. The asterisk marks the head end where the most intense tissue death begins, the arrow marks the blastema formed by regeneration of the lost body part, and the triangular arrows mark the eyes

Teacher's signature

>>

20

	CONTENTS OF THE TOPIC	6. Obligate parasite –
1. 2. 3.	Parasitism. Criteria for parasitism. Medical parasitology, its goals and objectives. Parasite-host system. Parasitic system. Classification of parasites and their hosts.	7. Molecular mimicry –
4. 5. 6. 7. 8.	Pathogenic action and specificity of parasites. Morphophysiological and biological adaptations of parasites. Response of the host organism to the introduction of parasites. Classification of parasitic diseases.	8. Definitive host –
	GLOSSARY	9. Intermediate host –
1. 2.	Symbiosis – Parasite –	10. Transmission route of a parasite –
		11. Biological vector –
3.	Host of a parasite –	
		12. Pathogenicity
4.	Ectoparasite –	
		13. Host specificity –
5.	Temporary parasite –	

Class № 05 (23). Topic: GENERAL PARASITOLOGY

Fask 1. Clas	sify the parasites	s:			Task 2. Study the life cycle of the tapeworm. Classify the hosts of this
Parasite	Description	Based on interaction with the host:	Based on location in the host:	Based on duration of interaction with the host:	parasite according to its life cycle stage. Fertilized eggs of the parasite are excreted from the human body (1) with feces In the water, a larva (coracidium) hatches from the egg and is swallowed b a freshwater crustacean (2).
Sarcoptes scabiei	Permanently resides in the outer layer of the skin. Infection occurs through direct contact with patients or their bedlinen, etc.				The next larval stage (procercoid) is formed in the crustacean's gut. When the crustacean is swallowed by a small fish (3), the procercoid becomes a plerocercoid in its muscles and genital organs. Predatory fish (4) can eat the affected fish, accumulating plerocercoids. Infection of humans (1) occurs when small or big fish are eaten. Soles of pleroceroid intestinal mucos and adult grows in small intestine of human in raw of restwater fish (3), the proceeding of human (3) occurs when small or big fish are eaten. Been by humans (1) occurs when small or big fish are eaten. Soles of pleroceroid in datus grows in small intestine of human (3) of hum
Head louse	Spends its entire life on the human scalp and feeds exclusively on human blood				
Entamoeba histolytica	The parasite may exist in the host's intestine for months or years and not cause any symptoms. Can't multiply outside the host.				
Ixodid tick	Lives by feeding on the blood. Contact with the host lasts from several hours to several days				$\begin{array}{c} \text{(paratenic host)} & & & & & & & & & & & & & & & & & & &$

Task 3. Match the transmission route of the parasite in the left					arasite in	Task 4. Fill in the table	«Adaptations to parasitism».	
column with its name in the right column:							Progressive morphologic	al and physiological adaptations of parasites:
 Pathogens pass from the pregnant woman to the fetus during the period of intrauterine development Pathogens are localized on the mucosa of the respiratory tract and pass to the susceptible organism through the air 			A. Con	tact				
			B. Sexu	ıal				
3. Pathogens are localized on the skin or the mucous membranes, from where they can get on the surface of various objects, and contact with them infects the susceptible organism		C. Vert	ical					
4. Transn sucking an	nission of pa thropods	thogens is n	nediated by	blood-	D. Resp	piratory		
5. Pathog tract and p Infection	5. Pathogens are mainly localized in the gastrointestinal tract and pass from the infected organism with feces. Infection occurs when the parasite is ingested		E. Fecal-oral		Regressive morphological and physiological adaptations of parasites:			
6. The pa during sex	6. The pathogen is transmitted to the susceptible person during sexual intercourse			F. Iatro	genic	;		
7. Infection occurs during medical procedures, such as blood transfusion			G. Vector-borne		Biological adaptations of	parasites:		
1	2	3	4	5	6	7		
							-	
								Taashan's signature
								«2020

Class № 06 (24). Topic: PHYLUM APICOMPLEXA, CLASS SPOROZOA

CONTENTS OF THE TOPIC	6. Schizont –
 General characteristics of the kingdom Protista. Life cycle of malaria pathogens (<i>Plasmodium spp.</i>). Species of plasmodia and their morphological characteristics in a thin blood smear. Life cycle of plasmodia, symptoms, and diagnosis of malaria. 	7. Oocyst –
 Prevention of malaria. 4. <i>Toxoplasma gondii</i>: morphology, life cycle, routes of transmission, pathogenic action. Diagnosis and prevention of toxoplasmosis. 	8. Tissue cyst –
5. <i>Cryptosporidium parvum</i> : morphology, life cycle, routes of transmission, pathogenic action. Diagnosis and prevention of cryptosporidiosis.	9. Sporogony –
GLOSSARY 1. Exoerythrocytic cycle –	10. Congenital toxoplasmosis –
2. Hypnozoites –	11. Cryptosporidiosis –
3. Sporozoite –	12. Schizogony –
4. Merozoite –	13. Biological vector –
5. Malaria –	





Task 5. Make a diagnosis in the following cases. Case № 1. A patient was hospitalized with complaints of fever, headache and muscle ache, weakness. The patient said that the disease began 4 days ago. The first symptoms were chill which changed to a fever of 40 °C in two hours. In several hours, the temperature lowered to 35 °C, and profuse sweating occurred. The patient recently came back from a business trip in Africa. What disease should be supposed?	Case № 3. Peripheral blood of the patient has red blood cells with ring-shaped trophozoites, multiply infected cells are common. There are crescent-shaped gametocytes. Schizonts contain from 12 to 24 nuclei. Identify the parasite.
Case № 2. Unicellular parasites 4–7×2–4 µm in size were found in the cerebrospinal fluid of the patient. Cells were crescent-shaped, one end of the cell is tapered, and the other one is rounded. Identify the parasite.	Case № 4. A case of miscarriage happened in a 22-year-old woman in the 5 th month of pregnancy. Histological tests of the placenta, fetal membranes, and organs of the fetus revealed aggregations of protists of crescent shape 4–7 micrometers in size. The nucleus is clearly stained in red and the cytoplasm in blue color. The woman likes animals and has two cats and a guinea pig. What disease should be supposed?
	Teacher's signature «»20

Class № 07 (25). Topic: PHYLUM SARCOMASTIGOPHORA, CLASSES SARCODINA AND ZOOMASTIGOTA. PHYLUM INFUSORIA, CLASSE CILIATA

CONTENTS OF THE TOPIC	5. Pellicle –
 Entamoeba histolytica. Morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of amebiasis. Parasitic flagellates (<i>Leishmania spp., Trypanosoma brucei</i>, <i>Trypanosoma cruzi</i>, <i>Giardia duodenalis</i> and <i>Trichomonas vaginalis</i>): morphology, life cycle, routes of transmission, pathogenic action. 	6. Taxis –
Symptoms, diagnosis, and prevention of the diseases caused by the parasites.	7. African trypanosomiasis –
 <i>Balantidium con</i>. Inorphology, me cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of balantidiasis. 4. Biological basis for the prevention of protozoal diseases. 	8. Trichomoniasis –
GLOSSARY 1. Amoebiasis –	9. Undulating membrane –
2. Chagas disease –	10. Chagoma –
3. Visceral leishmaniasis –	11. Amastigote –
4. Cutaneous leishmaniasis –	12. Trypomastigote –



 Task 2. Make a diagnosis in the following cases. Case № 1. Four-nucleated round cysts 8–16 µm in diameter were found in the stool test of a kindergarten teacher. What parasite do the cysts belong to? Is it possible to admit the kindergarten teacher to work? 	Case No 4. A 42-year-old worker of a pig farm was hospitalized with the following symptoms: fever, bloody diarrhea, and abdominal pain. Oval cysts 50 to 70 μ m in size were found in stool specimens. What disease should be supposed?
Case No 2. A 32-year-old patient consulted a dermatologist about a deep, long- lasting ulcer on his face. The ulcer is 2 cm in diameter and has raised indurated painless edges. Microscopy of a specimen from the ulcer revealed cells containing multiple oval protists without flagella, 2–6 μ m in size. What disease is confirmed by microscopy? What protists were found in the smear?	Case No 5. A patient consulted a physician with complaints of fever, weight loss, and gastrointestinal disturbances. Examination revealed a slightly darkened color of skin, enlarged liver, and spleen. The patient was on a business trip to Samarkand, Uzbekistan. Laboratory tests revealed decreased number of all types of blood cells. What parasitic disease could be supposed?
Case № 3. A 22-year-old citizen of Cameroon was hospitalized. The patient was in a state of confusion and answered all questions simply. Lack of coordination of voluntary movements and daytime sleepiness were observed. The disease began several months ago. The patient had a red, painful, indurated, nodular swelling about 5 cm in size on the skin where an inset had bitten him. It resolved within 2 weeks. Other symptoms were fever, malaise, headache, weight loss, and painless lymph node enlargement in the posterior side of the neck. What pathogen caused these symptoms and what is the name of the disease? What laboratory diagnostic methods should be used to confirm the diagnosis?	Case № 6. A woman sought medical help from a doctor with complaints of itching, burning, redness of the genitals, and yellowish foul-smelling vaginal discharge. A native smear prepared from freshly collected secretions revealed mobile pear-shaped protists, 15–30 microns in size, 4 flagella, and an undulating membrane at the anterior end. What parasitic disease can be supposed?
	Teacher's signature «»200

Class № 08 (26). Topic: PHYLUM PLATYHELMINTHES, CLASS TREMATODA

CONTENTS OF THE TOPIC	4. Fascioliasis –	
 General characteristic and classification of trematodes. Characteristics of the class Trematoda. Features of the life cycle of trematodes. <i>Fasciola hepatica</i>: morphology, life cycle, routes of transmission, 	5. Paragonimiasis–	
 4. Opisthorchis felineus: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of opisthorchiasis. 	6. Metacercaria –	
 5. Paragonimus westermani: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of paragonimiasis. 6. Solvitagenus and a morphology life cycle routes of transmission 	7. Miracidium –	
 Schistosoma spp.: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of schistosomiasis. Cercarial dermatitis 	8. Gynecophoral canal –	
8. Biological basis for the prevention of the diseases caused by flukes.	9. Urogenital schistosomiasis –	
GLOSSARY		
1. Swimmer's itch –	10. Intestinal schistosomiasis –	
2. Sporocyst –	11. Redia –	
3. Cercaria –	12. Tegument –	



Task 3. Make a diagnosis in the following cases. Case No 1. A patient with symptoms of pneumonia was examined for the presence of helminth eggs in his feces. Large ($60 \times 100 \mu m$) oval yellow-brown eggs with a lid on one pole were found. Identify the parasite.	Case № 4. A 22-year-old patient complains of ache in the right hypochondrium, weakness, bad appetite, nausea, vomit. Sclerae have a yellowish color. During the examination, the patient said that several months ago he was at a picnic where he used water from the lake for drinking because he didn't have enough pure drink water. What parasitic disease should be supposed? How to confirm the diagnosis?
Case No 2. A patient who recently came back from Africa complains of painful urination and pain in the lower part of the abdomen. Eggs were found in microscopy of urine sediment. The eggs were elongated, 150×60 micrometers in length had a spine on one of the ends. What is the species of the parasite?	Case № 5. There is a patient with symptoms of pneumonia. 4 months ago, he was on a business trip in Vladivostok, Russia where he often ate crawfish. The doctor supposed that pneumonia can be associated with helminths. What parasitic disease may cause the symptoms?
Case No 3. A patient consulted a physician with complaints of abdominal pain, diarrhea, and blood in the stool. The examination of the feces revealed elongated oval-shaped eggs $150 \times 70 \ \mu m$ in length with a lateral spine. Identify the parasite.	Case № 6. During endoscopic examination of the duodenum, a small yellowish helminth measuring 1 cm in length was found. What is the species of the parasite?
	Teacher's signature «»20

CONTENTS OF THE TOPIC 4. Strobila -1. General characteristics of the class Cestoda. 2. Features of the life cycles of trematodes. 3. Taenia saginata and Taenia solium: morphology, life cycle, routes of 5. Microtriches transmission, pathogenic action. Symptoms, diagnosis, and prevention of teaniais and cysticercosis. 4. Hymenolepis nana: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of hymenolepiasis. 6. Procercoid – 5. Echinococcus granulosus and Echinococcus multilocularis: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of cystic echinococcosis. 6. Diphyllobothrium latum: morphology, life cycle, routes of 7. Coracidium transmission, pathogenic action. Symptoms, diagnosis, and prevention of diphyllobothriasis. 7. Biological basis for the prevention of the diseases caused by tapeworms. 8. Oncosphere – **GLOSSARY** 1. Bothria – 9. Hydatid cyst -2. Scolex – 10. Cysticercosis -3. Proglottid –

Class № 09 (27). Topic: PHYLUM PLATHELMINTHES, CLASS CESTODA



Make a diagnosis in the following cases.

Case No 1. A 35-year-old man, a hunter by profession, complains of general malaise, abdominal pain, nausea, and the presence of parasite fragments in the stool. 9 flattened proglottids measuring 10×15 mm were found in stool specimens. The uterus of the parasite had 17 to 35 branches on each side. When interviewing the patient, it was found that he often eats dishes with raw or half-baked meat. What parasitic disease can be supposed?



Case No 2. A 45-year-old patient was admitted to a neurological department of a hospital complaining of frequent headaches and seizures. 5 years ago the patient had taeniasis. What parasitic disease can be supposed?

Case N_{2} **3.** A 5-year-old boy has abdominal pain and loss of appetite. In stool analysis, oval eggs about 45 microns in size were found. The oncosphere inside the egg has two thickenings at the opposite ends. What parasitic disease can be supposed?



Case No 4. Proglottids of a tapeworm were delivered to the laboratory. Microscopy reveals 7 to 12 lateral branches of the uterus on each side. Identify the parasite.



Case № 5. Patient G. was hospitalized with complaints of tightness of the right hypochondrium and pain. Palpation revealed considerable enlargement of the liver; an X-ray shown a cyst in the liver. What parasitic disease can be supposed in this case?

Case № 6. A patient, a professional fisherman, has complaints of weakness, nausea, bad appetite, and dull pains in the abdomen. Examination of the patient's feces revealed helminth fragments consisting of wide but short segments, with a dark rosette-like spot in the center of each segment. What parasitic disease can be supposed in this case?



Teacher's signature

20 « »

CONTENTS OF THE TOPIC	3. Buccal capsule –
 General characteristics of nematodes. Features of the life cycles of nematodes. Ascaris lumbricoides: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of ascariasis. Trichuris trichiura: morphology, life cycle, routes of transmission. 	4. Geohelminths –
pathogenic action. Symptoms, diagnosis, and prevention of trichuriasis.	5. Molting –
 <i>Enterootus vermicutaris</i>: morphology, me cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of enterobiasis. <i>Toxocara canis</i>: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of 	6. Filariform larva –
 toxocariasis. <i>Strongyloides stercoralis</i>: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of strongyloidiasis. 	7. Rabditiform larva –
 7. Ancylostoma duodenale and Necator americanus: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of ancylostomiasis. a. Diala in family fam	8. Enterobiasis –
8. Biological basis for the prevention of diseases caused by nematodes.	9. Larva migrans –
1. Esophageal bulb –	
	10. Autoinfection –
2. Cephalic alae –	

Class № 10 (28). Topic: PHYLUM NEMATODA (1)





CONTENTS OF THE TOPIC	4. Filariform larva –
1. Trichinella spiralis: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of trichinellosis.	
2. <i>Dirofilaria spp</i> .: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of dirofilariasis.	5. Microfilaria –
3. <i>Dracunculus medinensis</i> : morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of dracunculiasis.	6. Onchocercoma –
 Filaria: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of filariasis. Biological basis for the prevention of diseases caused by nematodes. 	
GLOSSARY	7. Trichinellosis –
1. Muscle biopsy –	
	8. Filariasis –
2. Dracunculiasis –	
	9. Elephantiasis –
3. River blindness –	

Class № 11 (29). Topic: PHYLUM NEMATODA (2)



Task 2. Make a diagnosis in the following cases. Case № 1. Six villagers apply to the infectious hospital with complaints of muscular pain, fever, weakness, and edema of the eyelids and face. There was eosinophilia in a blood test. A few weeks ago they ate the meat of a wild boar. Next days they had nausea, fever, and diarrhea, but these symptoms subsided within a week. What disease can be supposed?	Case № 3. A resident of Togo, Africa complains of burning pain in the right foot and a blister with a turbid content. The patient's family uses water from a lake. What disease can be supposed?
Case № 2. A patient from West Africa came to the hospital with complaints of itching in the thighs, shins, eyelids, eye pain, photophobia, and visual impairment. Examination of his legs revealed six subcutaneous nodules 1–3 cm in diameter. The patient had been sick for 5 months. He lives in the countryside near a river, the banks of which are overgrown with bushes. There is a lot of biting insects near the river. What disease can be suspected?	Case № 4. A patient was admitted to the hospital with complaints of a long-lasting lesion on the left leg. Examination revealed elephantiasis of both extremities. What parasites may cause this disease? How to confirm the diagnosis?

Class № 12 (30). Topic: PHYLUM ARTHROPODA, CLASS ARACHNIDA, ORDER ACARI

CONTENTS OF THE TOPIC	5. Nymph –
 General characteristics and systematics of the phylum Arthropoda. General characteristics and taxonomy of the class Arachnida. Ticks of the genera <i>Ixodidae</i>, <i>Argasidae</i>, and <i>Gamasidae</i> as vectors of human pathogens. Peculiarities of morphology, biology, mechanism of pathogen transmission of ticks. Mites of the genera <i>Sarcoptidae</i>, <i>Tyrogliphidae</i>, and <i>Demodecidae</i> as human pathogens. Peculiarities of morphology, biology, and 	6. Imago – 7. Mite –
 5. Doctrine of E. N. Pavlovsky of natural focality of parasitic diseases. Characteristics of natural foci. 	
GLOSSARY	8. Demodicosis –
1. Vector-borne disease –	
2. Natural focal disease –	9. Biological vector –
	10. Tick-borne encephalitis –
3. Scutum –	
	11. Scabies –
4. Capitulum –	



Task 3. Make a diagnosis in the following cases. Case № 1. Tourists traveling through Central Asia spent the night in caves, and in the morning, they found traces of bites on the skin of the exposed surfaces of their hands: dark red spots, bumps, surrounded by bruises. The spots were very itchy and several days later, ulcers formed. Examination of the cave revealed grayish-brown ticks, their bodies were oval and had no scutum. What family do the ticks belong to?	Case № 3. During the work in a grain warehouse, the workers complained about inflammation of the skin of their hands, and neck, with itching. What mite may cause these symptoms?
	Case № 4. A patient has itching between the fingers, wrists, and lower part of the abdomen. The affected area has a pimple-like skin rash. What parasitic disease can be supposed?
Case № 2. In the middle of August, a woman diagnosed with encephalitis (inflammation of the brain) was admitted to the hospital. The patient had not left her village for three years. Two weeks before the disease she had been picking mushrooms in the forest, and when she returned home, she found ticks on her body. What family of ticks did the patient find?	Case № 5. A woman complains of facial acne, redness of eyelids, sticking of eyelashes, and itching in the affected areas. Skin surface biopsy with microscopy revealed arthropods about 0.3–0.4 mm in size, with an elongated body and four pairs of limbs. Identify the parasite.
	Teacher's signature «»20

CONTENTS OF THE TOPIC 5. Chagas disease – 1. General characteristics and taxonomy of the class Insecta. 2. Lice. Morphology and biology of lice. Lice are pathogens and vectors of human diseases. Control of lice. 6. Tungiasis – 3. Fleas. Morphology and biology of fleas. Medical significance of fleas. Control of fleas. 4. Cockroaches. Morphology and biology of cockroaches. Medical significance of fleas. Control of cockroaches. 7. Incomplete metamorphosis -5. Bedbugs. Morphology and biology of bedbugs. Medical significance of fleas. Control of bedbugs. 6. Control of arthropods. Prevention of diseases caused and transmitted by arthropods. 8. Complete metamorphosis – GLOSSARY 1. Mechanical vector – 9. Chitin – 2. Insecticide – 10. Molting – 3. Pediculosis – 11. Piercing and sucking insects – 4. Pthiriasis –

Class № 13 (31). Topic: PHYLUM ARTHROPODA, CLASS INSECTA (1)



Task 2. Label the diagrams.



Fig. 1. Mouthparts of *Blattella germanica:* 1 – upper lip; 2 – upper jaw; 3 – lower lip; 4 – lower jaw



Fig. 2. Life cycle of the *Tunga penetrans:* 1 – eggs; 2 – adult; 3 – larva; 4 – pupa; 5 – female in the skin.

Task 3. Make a diagnosis in the following cases. Case № 1. Tourists traveling in the Altai Mountains, at one of the stops were bitten by small wingless insects, which have flattened sides of the body and a very long last pair of legs. Identify the insects. What is their medical significance?	Case № 3. A 9-year-old boy complains of severe itching in the scalp. Examination of his head revealed coarsening and pigmentation of the skin. What disease should the boy be tested for?
Case Nº 2. A 25-year-old woman traveled to Kenya and Uganda for three months. Upon returning, she noticed a painful lesion on her left big toe. She visited her primary care physician. While applying pressure to the region during the examination, eggs appeared to exude from the lesion. Eggs were sent to Microbiology for diagnostic assistance. The eggs measure on average 600 micrometers in length. Identify the parasite.	Case Nº 4. A student living in a rented room complains of insects biting him at night. On examining his bed, he found oval, dorsoventrally flattened brown insects up to several millimeters in length in the seams of the mattress and the folds of the bedding. Assuming that these insects might be vectors of disease, he consulted a physician. Identify the insects. What diseases does it ransmit?
	Teacher's signature

«____»____

Class № 14 (32). Topic: PHYLUM ARTHROPODA, CLASS INSECTA (2)

CONTENTS OF THE TOPIC	5. Repellents –
 Peculiarities of morphology and biology of the insects of the order Diptera. Gnat: blackflies (<i>Simuliidae</i>), biting midges (<i>Ceratopogonidae</i>), sand flies (<i>Phlebotominae</i>), and horse-flies (<i>Tabanidae</i>). Mosquitoes of genera <i>Culex</i>, <i>Anopheles</i> and <i>Aedes</i>: morphological and biological peculiarities and the medical significance 	6. Chrysalis –
 4. Flies: house fly (<i>Musca domestica</i>), stable fly (<i>Stomoxys calcitrans</i>), tsetse fly (<i>Glossina palpalis</i>), spotted flesh fly (<i>Wohlfahrtia magnifica</i>), their morphology, biology, and the medical significance. 	7. Insecticides –
 5. Botflies (<i>Oestridae</i>): morphology, biology, and the medical significance. 6. Control of dipterans and prevention of diseases they transmit and cause. 	8. Biological vector –
1. Diptera –	
	9. Botfly –
2. Gnat –	10. Blackfly –
3. Myiasis –	11. Sleeping sickness –
4. Sandfly –	







Task 2. Write the letters corresponding to the mosquitoes of the genera Anopheles and Culex/Aedes to the second and third rows of the table.



 Task 4. Make a diagnosis in the following cases. Case № 1. What insects of the order <i>Diptera</i> are the intermediate hosts and biological vectors of <i>Loa loa</i>? What is their taxonomy? 	Case № 4. What filaria can be transmitted by the mosquitoes of the genera Culex and Aedes?
 Case № 2. An outbreak of bacterial dysentery was registered in a village in the Minsk region in the summer. What insects of the order <i>Diptera</i> can contribute to the spread of the pathogens of the disease? Case № 3. There is a patient with African trypanosomiasis. What is the pathogen of the disease? How the patient was infected? 	Case № 5. A 30-year-old stable worker sought medical attention at a local health center for a painful bump with cellulitis on the side of her neck. The bump failed to go away with antibiotics, and when the wound was drained, the 3.5 mm long object pictured below was produced. What is the name of the disease caused by the parasite?
	Teacher's signature «»20

	MICROPREPARATIONS	31. Cross section of Ascaris lumbricoides
1	Giardia duodenalis	32. Eggs of Ascaris lumbricoides
2	Trypanosoma brucei and Trypanosoma cruzi	33. Male and female <i>Trichuris trichiura</i>
3.	Leishmania spp.	34. Eggs of Trichuris trichiura
4.	Trichomonas vaginalis	35. Buccal capsule of <i>Necator americanus</i>
5.	Entamoeba histolytica	36. Buccal capsule of <i>Ancylostoma duodenale</i>
6.	Balantidium coli	37. Larva of <i>Trichinella spiralis</i>
7.	Toxoplasma gondii	38. Microfilaria
8.	Amoeboid-form trophozoite of <i>P. vivax</i>	39. Male and female <i>Enterobius vermicularis</i>
9.	Band-form trophozoite <i>P. malariae</i>	40. Eggs of <i>Enterobius vermicularis</i>
10.	Gametocyte of <i>P. falciparum</i>	41. Male and female ticks of the genus <i>Ixodes</i>
11.	Late trophozoite of <i>P. ovale</i>	42. Male and female ticks of the genus <i>Dermacentor</i>
12.	Fasciola hepatica	43. Argas persicus
13.	Eggs of Fasciola hepatica	44. Acarus siro
14.	Opisthorchis felineus	45. Sarcoptes scabiei
15.	Eggs of <i>Opisthorchis felineus</i>	46. <i>Demodex folliculorum</i>
16.	Eggs of schistosomes (S. haematobium, S. mansoni, S. japonicum)	47. Pediculus humanus
17.	Scolex of Taenia saginata	48. Pthirus pubis
18.	Scolex of Taenia solium	49. Pulex irritans
19.	Mature proglottid of <i>Taenia saginata</i>	50. Mouthparts of <i>Blattella germanica</i>
20.	Mature proglottid of <i>Taenia solium</i>	51. Eggs of mosquito of the genus <i>Culex</i>
21.	Gravid proglottid of <i>Taenia saginata</i>	52. Eggs of mosquito of the genus <i>Anopheles</i>
22.	Gravid proglottid of <i>Taenia solium</i>	53. Larva of mosquito of the genus <i>Culex</i>
23.	Eggs of <i>Taenia spp</i> .	54. Larva of mosquito of the genus Aniopheles
24.	Hymenolepis nana	55. Pupa of mosquito of the genus <i>Culex</i>
25.	Eggs of Hymenolepis nana	56. Pupa of mosquito of the genus <i>Anopheles</i>
26.	Echinococcus granulosus	57. Head of the female mosquito of the genus <i>Culex</i>
27.	Proglottids of <i>Diphyllobothrium latum</i>	58. Head of the male mosquito of the genus <i>Anopheles</i>
28.	Scolex cross-section of <i>Diphyllobothrium latum</i>	59. Head of the female mosquito of the genus <i>Culex</i>
29.	Eggs of Diphyllobothrium latum	60. Head of the male mosquito of the genus <i>Anopheles</i>
30.	Ascaris lumbricoides	

CONTENTS 15. Fasciola hepatica: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of fascioliasis. 1. Parasitism. Criteria for parasitism. Medical parasitology, its goals and 16. Opisthorchis felineus: morphology, life cycle, routes of transmission, objectives. Parasite-host system. Parasitic system. pathogenic action. Symptoms, diagnosis, and prevention of 2. Classification of parasites and their hosts. opisthorchiasis. 3. Transmission routes of parasites. 17. Paragonimus westermani: morphology, life cycle, routes of 4. Pathogenic action and specificity of parasites. transmission, pathogenic action. Symptoms, diagnosis, and prevention of 5. Morphophysiological and biological adaptations of parasites. paragonimiasis. 6. Response of the host organism to the introduction of parasites. 18. Schistosoma spp.: morphology, life cycle, routes of transmission, 7. Classification of parasitic diseases. pathogenic action. Symptoms, diagnosis, and prevention of 8. General characteristics of the kingdom Protista. schistosomiasis. 9. Life cycle of malaria pathogens (Plasmodium spp.). Species of 19. Cercarial dermatitis. plasmodia and their morphological characteristics in a thin blood smear. 20. Biological basis for the prevention of the diseases caused by flukes. Life cycle of plasmodia, the symptoms, and diagnosis of malaria. 21. General characteristics of the class Cestoda. Prevention of malaria. 22. Features of the life cycles of trematodes. 10. Toxoplasma gondii: morphology, life cycle, routes of transmission, 23. Taenia saginata and Taenia solium: morphology, life cycle, routes of pathogenic action. Diagnosis and prevention of toxoplasmosis. transmission, pathogenic action. Symptoms, diagnosis, and prevention of 11. Cryptosporidium parvum: morphology, life cycle, routes of teaniais and cysticercosis. transmission, pathogenic action. Diagnosis and prevention of 24. Hymenolepis nana: morphology, life cycle, routes of transmission, cryptosporidiosis. pathogenic action. Symptoms, diagnosis, and prevention of 13. Entamoeba histolytica. Morphology, life cycle, routes of transmission, hymenolepiasis. pathogenic action. Symptoms, diagnosis, and prevention of amebiasis. 25. Echinococcus granulosus and Echinococcus multilocularis: 14. Parasitic flagellates (Leishmania spp., Trypanosoma brucei, morphology, life cycle, routes of transmission, pathogenic action. Trypanosoma cruzi, Giardia duodenalis and Trichomonas vaginalis): Symptoms, diagnosis, and prevention of cystic echinococcosis. morphology, life cycle, routes of transmission, pathogenic action. 26. Diphyllobothrium latum: morphology, life cycle, routes of Symptoms, diagnosis, and prevention of the diseases caused by the parasites. transmission, pathogenic action. Symptoms, diagnosis, and prevention of 15. Balantidium coli: morphology, life cycle, routes of transmission, diphyllobothriasis. pathogenic action. Symptoms, diagnosis, and prevention of balantidiasis. 27. Biological basis for the prevention of the diseases caused by 12. Biological basis for the prevention of protozoal diseases. tapeworms. 13. General characteristic and classification of trematodes. 28. General characteristics of nematodes. Features of the life cycles of 14. Characteristics of the class Trematoda. Features of the life cycle of nematodes. trematodes.

Class № 16 (34). Topic: COLLOQUIUM № 4

 29. Ascaris lumbricoides: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of ascariasis. 30. Trichuris trichiura: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of trichuriasis. 31. Enterobius vermicularis: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of toxocariasis. 32. Toxocara canis: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of toxocariasis. 33. Strongyloides stercoralis: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of ancylostoma duodenale and Necator americanus: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of trichinellosi. 35. Biological basis for the prevention of diseases caused by nematodes. 36. Trichinella spiralis: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of dirofilariasis. 37. Dirofilaria spp.: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of dirofilariasis. 37. Dirofilaria spp.: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of dirofilariasis. 38. Dracunculus medinensis: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of filariasis. 39. Filaria: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of filariasis. 39. Filaria: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of filariasis. 39. Filaria: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of filariasis.	lites of the genera <i>Sarcoptidae, Tyrogliphidae,</i> and <i>Demodecidae</i> as n pathogens. Peculiarities of morphology, biology, and pathogenic of mites. octrine of E. N. Pavlovsky of natural focality of parasitic diseases. cteristics of natural foci. eneral characteristics and taxonomy of the class Insecta. ice. Morphology and biology of lice. Lice are pathogens and rs of human diseases. Control of lice. leas. Morphology and biology of fleas. Medical significance of Control of fleas. ockroaches. Morphology and biology of cockroaches. Medical icance of fleas. Control of cockroaches. edbugs. Morphology and biology of bedbugs. Medical significance as. Control of bedbugs. ontrol of bedbugs. ontrol of athropods. Prevention of diseases caused and transmitted hropods. eculiarities of morphology and biology of the insects of the order ra. nat: blackflies (<i>Simuliidae</i>), biting midges (<i>Ceratopogonidae</i>), sand <i>Phlebotominae</i>), and horse-flies (<i>Tabanidae</i>). Iosquitoes of genera <i>Culex</i> , <i>Anopheles</i> and <i>Aedes</i> : morphological iological peculiarities and the medical significance. lies: house fly (<i>Musca domestica</i>), stable fly (<i>Stomoxys calcitrans</i>), fly (<i>Glossina palpalis</i>), spotted flesh fly (<i>Wohlfahrtia magnifica</i>), norphology, biology, and the medical significance. otflies (<i>Oestridae</i>): morphology, biology, and the medical icance. ontrol of dipterans and prevention of diseases they transmit and
--	--

poisonous animals –
-poisonous animals –
ins –
ins –
hagins –
sins —
Task 1. Match the type of toxins in the left column with their effectsTasin the right column.right

3

4

1. Neurotoxins	A. Damaging cells and tissues
2. Cytotoxins	B. Impairing normal permeability of blood vessels

3. Hemorrhagins C. Affecting predominantly the nervous system

4. Hemolysins	D. Destroying erythrocytes

2

Task 2. Identify the type of primarily-toxic animal.

1. Physalia		6. Pufferfish		
2. Black scorpions		7. Wasps		
3. Indian cobra		8. Some mollusks		
4. Moray eels		9. Orange-striped jellyfish		
5. Cocoa frog		10. African tree-frogs		
Actively-venomous	Actively-por	isonous	Passively-poisonous	

Task 3. Match the animal in the left column with the first aid in the right column.

1. Columbian cocoa	A. Remove parts of tentacles and striking threads			
frog	or sting from the skin, treat the affected sites with			
2. Karakurt	alcohol or solution of soda, symptomatic treatment			
3. Pufferfish	B. Sucking off the venom, injection of specific			
	antiserum, symptomatic treatment			
4. Physalia	C. Gastric lavage, vomiting, usage of saline			
	laxatives, symptomatic treatment			
5. Rattlesnake	D. Washing skin and eyes (if necessary) with			
6. Bee	water, symptomatic treatment			

1	2	3	4	5	6

Task 4. What is the name of the toxin the effect of which is shown in the figure?





LITERATURE

- 1. *Bekish, O.-Y. L.* Medical biology : textbook for student of higher educational establishments / O.-Y. L. Bekish. Vitebsk : VSMU Press, 2003. 346 p.
- 2. *Медицинская* генетика и паразитология для студентов, обучающихся по специальности «Лечебное дело» = Medical Genetics and Parasitology for students studying in the specialty "General Medicine" : учеб.-метод. пособие / В. Э. Бутвиловский [и др.]. Минск : БГМУ, 2018. 220 с.
- Медицинская биология для иностранных студентов 1-го года обучения = Medical biology for international students 1st year : курс лекций / В. Э. Бутвиловский [и др.]. 3-е изд. испр. и перераб. Минск : БГМУ, 2018. 68 с.
- Бутвиловский, В. Э. Медицинская биология для иностранных студентов, обучающихся по специальности «Лечебное дело» = Medical biology for international students studying "General medicine" : учеб.-метод. пособие / В. Э. Бутвиловский, В. В. Григорович, А. В. Бутвиловский. Минск : БГМУ, 2016. 224 с.
- 5. *Медицинская* биология и общая генетика : терминологический словарь для иностранных студентов / В. Э. Бутвиловский [и др.]. Минск : БГМУ, 2007. 55 с.
- 6. *Медицинская* биология и общая генетика : тесты / В. Э. Бутвиловский [и др.]. Минск : БГМУ, 2006. 228 с.
- 7. *Медицинская* биология и общая генетика : сб. задач / В. Э. Бутвиловский [и др.]. 2-е изд. Минск : БГМУ, 2010. 264 с.
- 8. *Медицинская* биология и общая генетика : учеб. / Р. Г. Заяц [и др.]. 2-е изд., испр. Минск : Выш. школа, 2012. 496 с.
- 9. *Частная* паразитология : учеб.-метод. пособие / В. Э. Бутвиловский [и др.]. Минск : БГМУ, 2007. 107 с.

Учебное издание

Григорович Виктор Васильевич Давыдов Владимир Витольдович Корбут Юлия Игоревна и др.

МЕДИЦИНСКАЯ БИОЛОГИЯ

MEDICAL BIOLOGY

Практикум для студентов, обучающихся на английском языке по специальности «Лечебное дело»

4-е издание, исправленное

Ответственный за выпуск В. В. Давыдов Переводчики В. В. Григорович, Ю. И. Корбут Компьютерная вёрстка Н. М. Федорцовой

Подписано в печать 28.03.25. Формат 60×84/8. Бумага писчая «Снегурочка». Ризография. Гарнитура «Times». Усл. печ. л. 13,02. Уч.-изд. л. 5,12. Тираж 181 экз. Заказ 208.

> Издатель и полиграфическое исполнение: учреждение образования «Белорусский государственный медицинский университет». Свидетельство о государственной регистрации издателя, изготовителя, распространителя печатных изданий № 1/187 от 24.11.2023. Ул. Ленинградская, 6, 220006, Минск.

