MEDICAL BIOLOGY

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

Minsk BSMU 2024

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»

3-е издание

Минск БГМУ 2024

УДК 57:61(076.5)(075.8)-054.6
ББК 28.0я73
М42

Рекомендовано Научно-методическим советом университета
в качестве практикума 21.02.2024 г., протокол № 14

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Р е ц е н з е н т ы: канд. мед. наук, доц. О. Н. Ринейская; каф. общей химии

Медицинская биология = Medical Biology : практикум для студентов, М42 обучающихся на английском языке по специальности «Лечебное дело» / В. В. Григорович [и др.]. – 3-е изд. – Минск : БГМУ, 2024. – 111 с.

ISBN 978-985-21-1513-1.

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.

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ISBN 978-985-21-1513-1

PLAN OF THE COURSE

1st semester

Name _____ Group _____

Week number	Topic
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**

PLAN OF THE COURSE

2nd semester

Name _____ Group _____

Week number	Topic
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 OF STUDENTS IN THE BELARUSIAN STATE MEDICAL UNIVERSITY

The decree of the **Ministry of education of the Republic of Belarus** № 53 from 29.05.2012 «Rules for attestation of students, cadets, listeners for mastering the content of educational programs of higher education»

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;

the ability for individual creative solutions to problems in unconventional situations of the discipline;

full 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; regular active individual work in practical and laboratory classes, active and creative participation in group discussions, and a high cultural level of solutions to questions.

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 and analytically estimate them;

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;

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 use them for solving typical professional cases;

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;

inability to use scientific terminology, presentation of answers to with serious 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

1. The nature of life, and the role of proteins and nucleic acids in the organization of living systems.
2. Organization levels of living matter.
3. The cell theory.
4. Prokaryotes and eukaryotes.
5. Human as a biological and social being.
6. The role of biology in medical education.
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.

GLOSSARY

1. Life –

2. Biopolymer –

3. Bacteriophage (phage) –

4. Virion –

5. Capsid –

6. Differential centrifugation –

7. Autoradiography –

8. Cell culture –

9. Histochemistry –

10. Fluorescent dye –

11. Resolving power of a microscope –

12. Eukaryotes –

13. Prokaryotes –

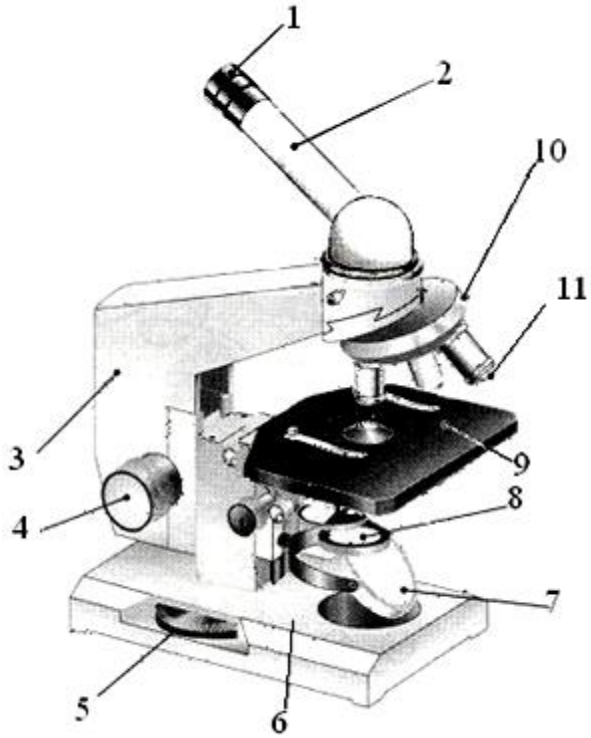


Fig. 1. The microscope «BIOLAM»:
1 – ocular lens; 2 – draw tube; 3 – arm; 4 – coarse adjustment knob; 5 – fine adjustment knob; 6 – base; 7 – mirror; 8 – condenser, diaphragm, and lens filter; 9 – stage; 10 – revolving nosepiece; 11 – objective lens

Task 1. Label the pictures:

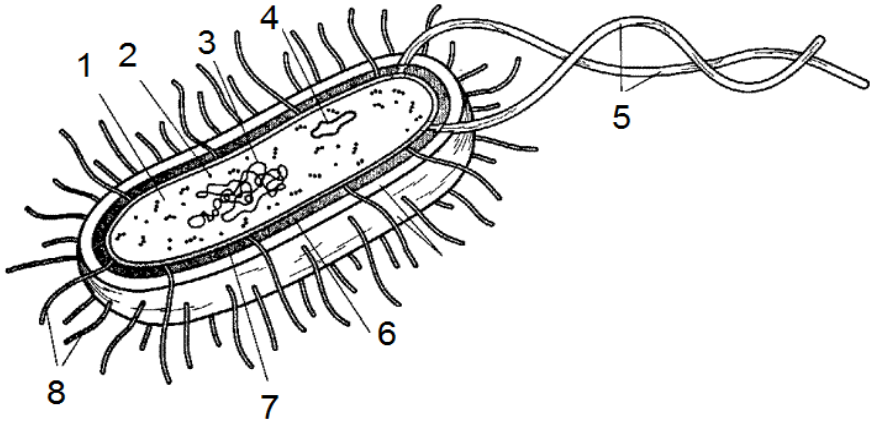


Fig. 2. Diagram of bacterium:

1 –

2 –

3 –

4 –

5 –

6 –

7 –

8 –

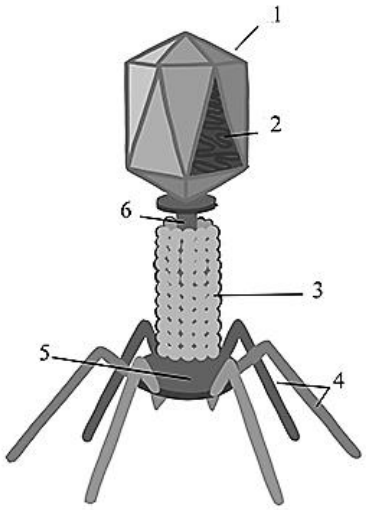


Fig. 3. Diagram of bacteriophage:

1 –

2 –

3 –

4 –

5 –

6 –

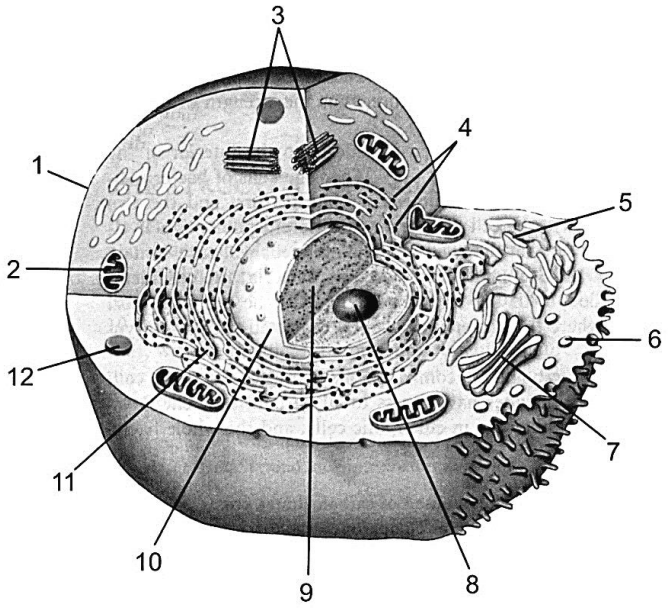


Fig. 4. Diagram of animal cell:

1 –

2 –

3 –

4 –

5 –

6 –

7 –

8 –

9 –

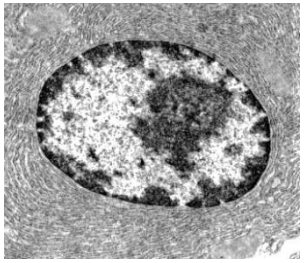
10 –

11 –

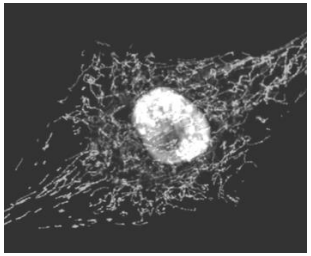
12 –

Task 2. Find the type of microscopy corresponding to each photograph.

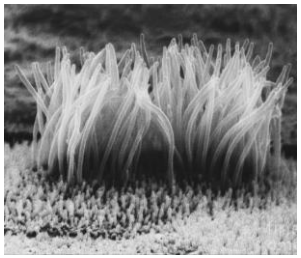
A – Common light microscopy;
B – Fluorescent microscopy;
C – Transmission electron microscopy (TEM);
D – Scanning electron microscopy (SEM).



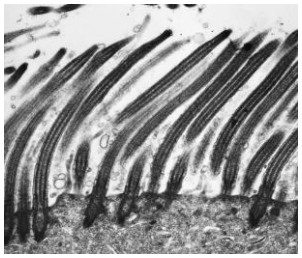
1. Nucleus



2. Nucleus and mitochondria

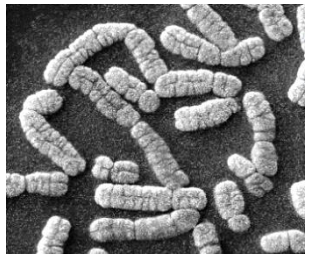


3. Cilia



4. Cilia

5. Anaphase



6. Chromosomes

1	2	3	4	5	6

Task 3. Find the description corresponding to the techniques.

Technique	Description
1 – removal of cell organelles and their transplantation to other cells 2 – tracking of chemical compounds in the metabolic pathways of the cell 3 – separation of cellular components by a centrifuge 4 – obtaining the cell image based on the usage of visible light rays 5 – assessment of the chemical composition of cells and chemical reactions occurring in them 6 – locating cell macromolecules using specific dyes or antibodies bound with dyes 7 – determination of spatial arrangement and physical properties of atoms in biological molecules 8 – analysis of biological objects stained with the dyes which fluoresce when exposed to light 9 – growing cells of multicellular organisms on nutrient media under sterile conditions 10 – obtaining the images of the cell components based on the usage of electrons as a source of illumination 11 – obtaining a tridimensional image of the surface of a biological object	A. Light microscopy B. Transmission electron microscopy C. Differential centrifugation D. Histochemistry and immunohistochemistry E. X-ray crystallography F. Cell culture G. Cell microsurgery H. Scanning electron microscopy I. Biochemical methods J. Isotopic labeling K. Fluorescent microscopy

1	2	3	4	5	6	7	8	9	10	11

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

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 (+/-)		

Teacher's signature
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Class № 2. Topic: STRUCTURAL AND FUNCTIONAL ORGANIZATION OF THE CELL

CONTENTS OF THE TOPIC

1. The structure of the plasma membrane.
2. Transport across the membrane: passive transport (simple diffusion, facilitated diffusion, osmosis), active transport, endocytosis, exocytosis.
3. Cytosol. Cytoskeleton: microtubules, intermediate filaments, microfilaments.
4. Intracellular transport of substances.
5. Assimilation. Ribosomes.
6. Endomembrane system (nuclear envelope, endoplasmic reticulum, Golgi body, lysosomes, peroxisomes, endosomes, vesicles).
7. Dissimilation. Mitochondria.
8. Lysosomal and peroxisomal disorders.

GLOSSARY

1. **Antiport –**
2. **Anabolism –**
3. **Glycolysis –**
4. **Concentration gradient –**
5. **Dictyosome –**
6. **Dynein –**
7. **Osmosis –**
8. **Peptidoglycan –**
9. **Pili –**
10. **Plasma membrane –**
11. **Simple diffusion –**
12. **Cytosol –**
13. **Endocytosis –**

Task 1. Label the diagrams.

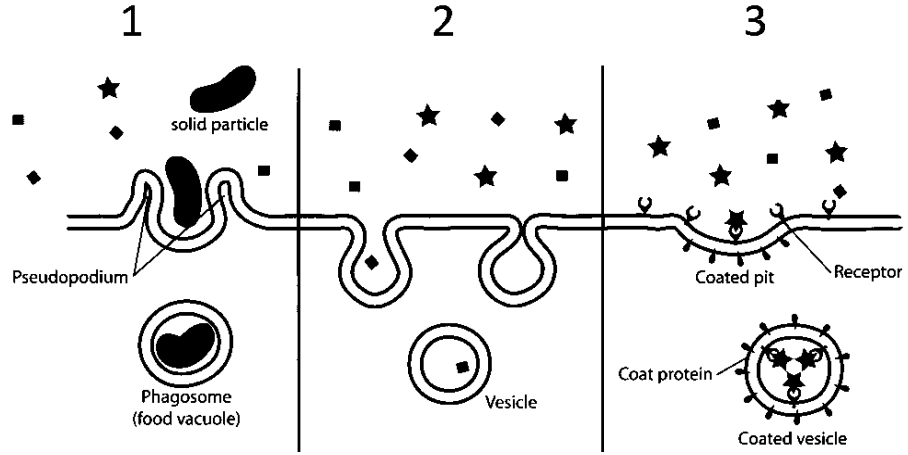
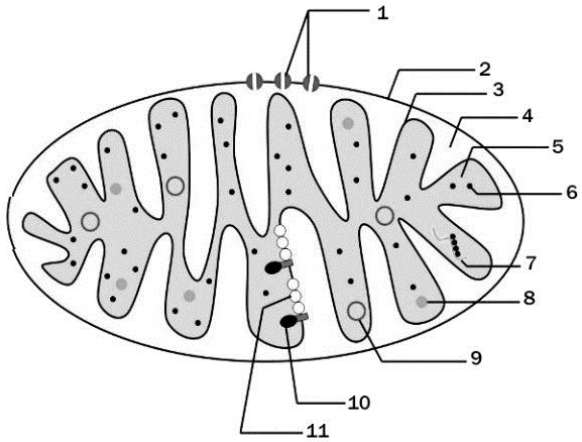


Fig. 1. Bulk transport across the cell membrane:

1 –
2 –
3 –



1 –
2 –
3 –
4 –
5 –
6 –
7 –
8 –
9 –
10 –
11 –

Fig. 2. Mitochondrion

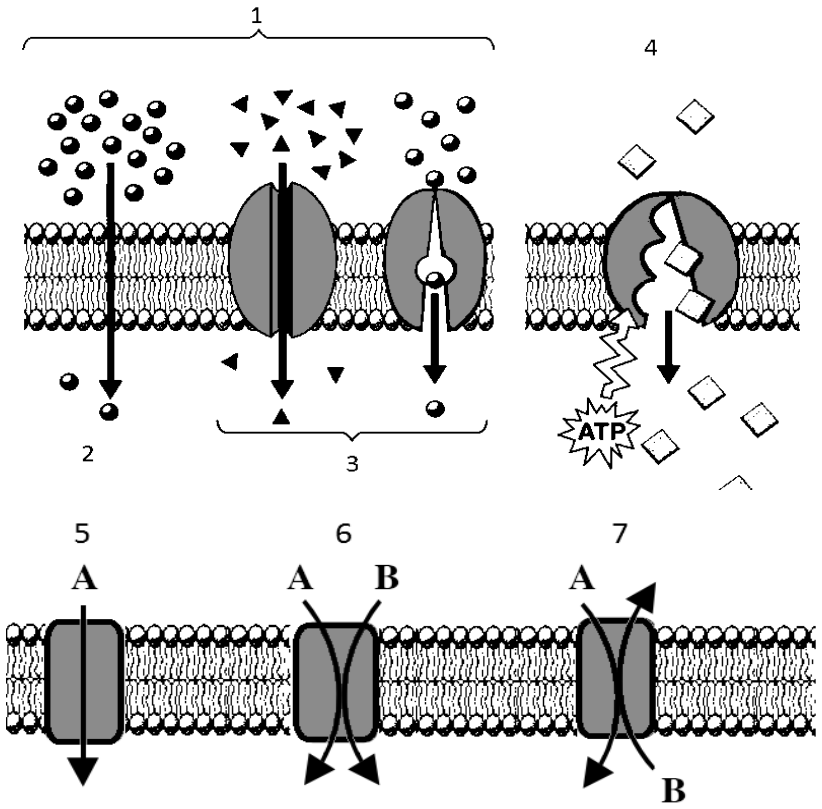


Fig. 3. Transport across the membrane:

1 –
2 –
3 –
4 –
5 –
6 –
7 –

Task 2. Label the TEMs of different organelles.

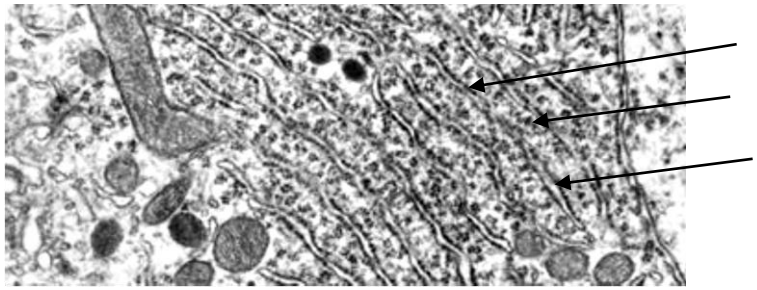


Fig. 4. Rough ER in the cells of the cerebellar cortex:
1 – membrane; 2 – channel; 3 – ribosomes

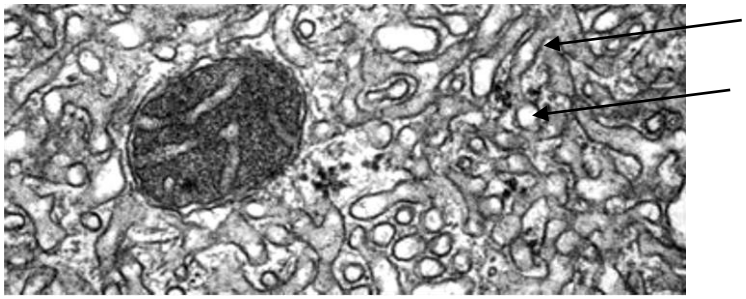


Fig. 5. Smooth ER in the cells of adrenal cortex:
1 – membrane; 2 – channel

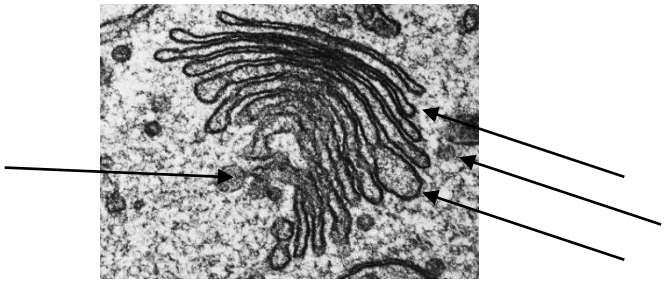


Fig. 6. Golgi apparatus:
1 – membrane; 2 – cisterna; 3 – lysosome; 4 – vesicle

Fig. 7. Mitochondrion:
1 – outer membrane; 2 – inner membrane; 3 – matrix;
4 – cristae; 5 – ribosomes

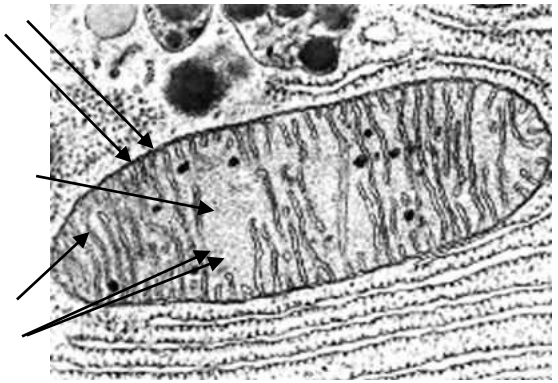


Fig. 8. Lysosomes in hepatic cells:
1 – mitochondrion;
2 – lysosome; 3 – cell membrane

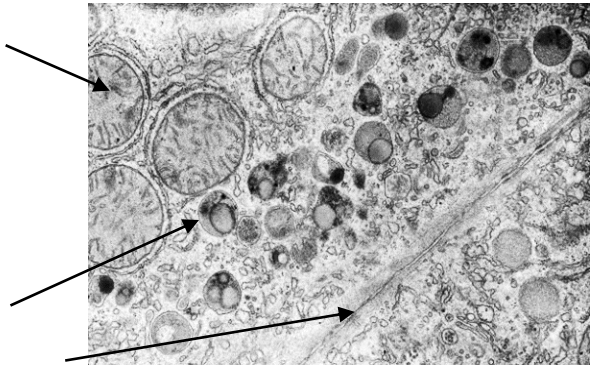
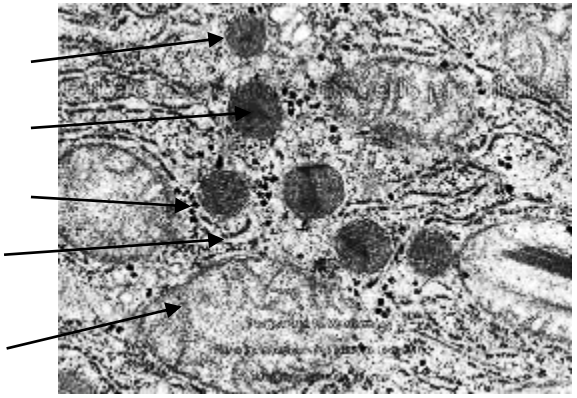


Fig. 9. Peroxisomes:
1 – mitochondrion;
2 – peroxisome;
3 – crystalized core of peroxisome; 4 – ER;
5 – ribosomes



Task 3. Label the diagram of plasma membrane.

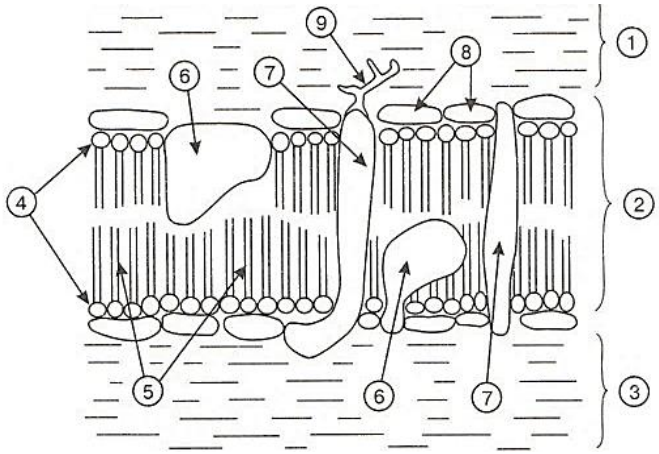


Fig. 10. The membrane of an animal cell:

1 –
2 –
3 –
4 –
5 –
6 –
7 –
8 –
9 –

Task 4. Answer the questions.

Question № 1. Do mitochondria take part in protein synthesis?

Question № 2. Adults do not grow. Do they need protein in food, or can it be substituted with equal calories of lipids and carbohydrates?

Question № 3. What properties of plasma membrane explain its capability of endocytosis?

Question № 4. How sodium-potassium pump works?

Question № 5. In case of storage diseases, cells accumulate some molecules, which would be digested in normal cells. The function of what organelle is missing in case of these diseases?

Task 5. Solve the problem.

Problem № 1. Leg muscles of a man spend approximately 24 kJ/min running. What is the mass of glucose required for 20 min of run? Muscles can produce 30 ATP from 1 glucose. The cell receives 30.5 kJ of energy when hydrolyzes 1 mole of ATP to ADP. The molar mass of glucose is 180 g/mole.

Teacher's signature
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Class № 3. Topic: STRUCTURAL ORGANIZATION OF THE GENOME

CONTENTS OF THE TOPIC

1. Evolution of the gene concept.
2. Evidence that DNA is the genetic material.
3. Structure and functions of DNA.
4. Genetic material of viruses and bacteria.
5. The structure and functions of the cell nucleus.
6. Gene, chromosome, and genome levels of eukaryotic genetic material.
7. DNA condensation. Remodeling of chromatin.
8. The structure of metaphase chromosomes. Euchromatin and heterochromatin. Types of chromosomes. Rules of chromosomes.
9. Karyotype and idiogram. Methods for studying the human karyotype. Classifications of human chromosomes.
10. Cytoplasmic inheritance.

GLOSSARY

1. Genome –

2. Karyotype –

3. Lamins –

4. Nucleoid –

5. Nucleotide –

6. Chromatin remodeling –

7. Nuclear localization signal –

8. Nuclear speckles –

9. Telomeres –

10. Transduction –

11. Centromere index (CI) –

12. Nucleolar organizer region –

13. Nucleosome –

14. Plasmagenes –

Task 1. Label the pictures.

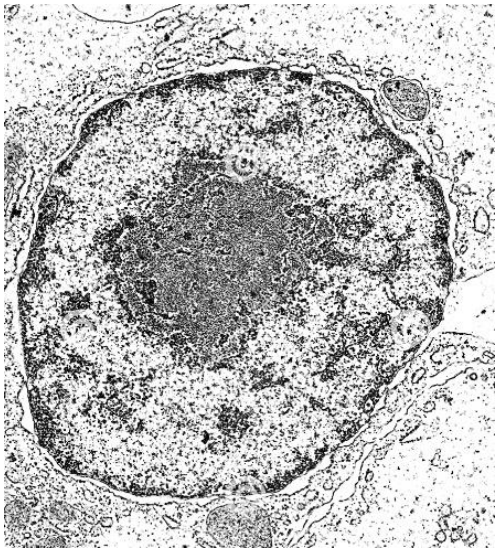

Fig. 1. TEM of the nucleus:
1 – outer membrane;
2 – inner membrane;
3 – intermembrane space;
4 – pore;
5 – karyoplasm;
6 – chromatin;
7 – nucleolus

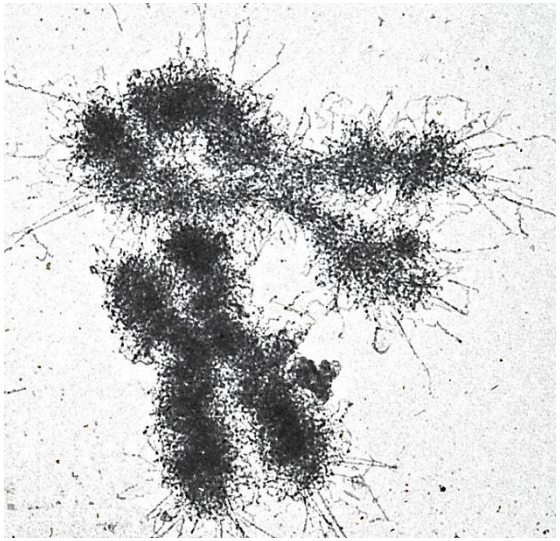

Fig. 2. TEM of human chromosomes:
1 – arm;
2 – centromere;
3 – chromatid;
4 – telomere

Task 2. Analyze the karyotype of the human and fill in the table.

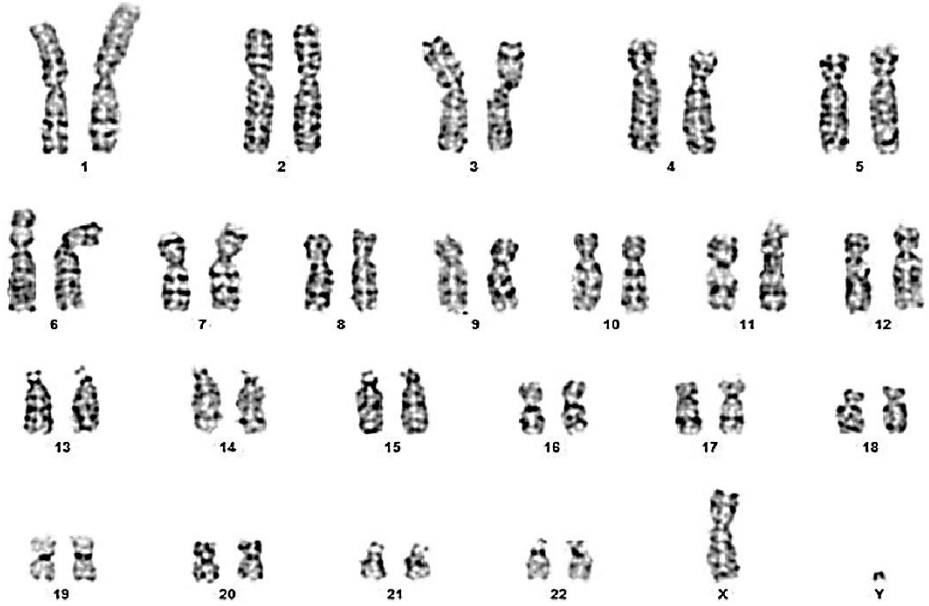

Fig. 3. Human karyotype

Groups	Morphology of chromosomes
A (1-3)	
B (4-5)	
C (6-12, X)	
D (13-15)	
E (16-18)	
F (19-20)	
G (21-22, Y)	

Task 3. Solve the problems.

Problem № 1. Write the complementary strands for the following ones:

a. CTGATCTGTATCAACTA

b. 3'ACTGATCTGTATCAACT5'

c. 5'GTACTAGCTAGCTAGCTAGCCAT3'

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 № 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 № 5. Adenine makes 16 %, guanine — 28 %, and thymine — 34 % of a DNA strand. Determine the percentage of pyrimidine bases in the complementary strand.

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 № 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 № 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?

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Class № 4. Topic: CELL CYCLE

CONTENTS OF THE TOPIC

1. Cell cycle. Interphase.
2. Semi-conservative mechanism of DNA replication. Replicon.
3. Cell cycle regulators (cyclins and cyclin-dependent kinases).
4. Types of cell division: mitosis, amitosis, endomitosis. Binary division of bacteria.
5. Mitosis: characteristics of phases, distribution of genetic material, biological significance.
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.

GLOSSARY

1. Apoptosis –

2. Bivalent –

3. Caspases –

4. Kinetochore –

5. Cohesins –

6. Crossing over –

7. Hayflick's limit –

8. Necrosis –

9. Primase –

10. Replisome –

11. Synaptonemal complex –

12. Topoisomerase –

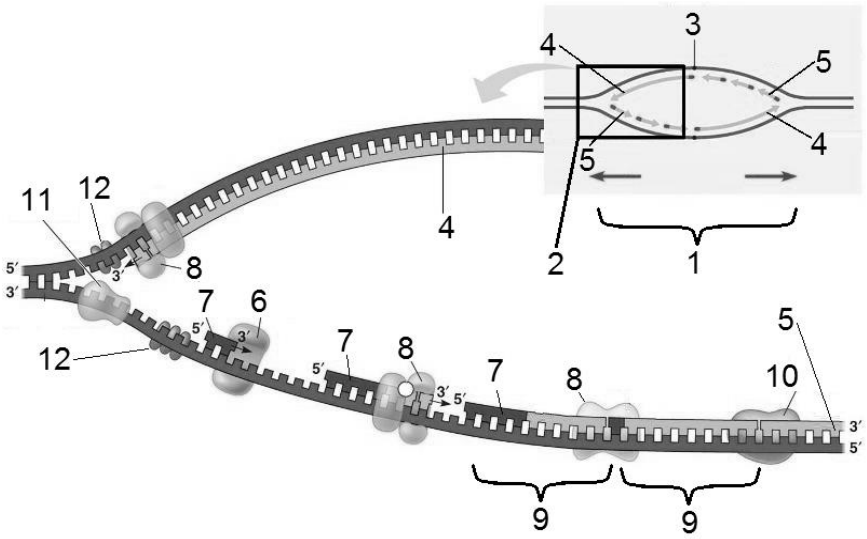
13. Origin of replication –

14. Okazaki fragment –

15. Chiasmata –

16. Cyclins –

Task 1. Write the labels for the diagram of the replication fork.



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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: **1.** Leptotene: **2.** Zygotene: **3.** Pachytene: **4.** Diplotene: **5.** Diakinesis:	A. Prophase:
S:	B. Metaphase:		B. Metaphase:
G_2:	C. Anaphase:		C. Anaphase:
	D. Telophase:		D. Telophase:
		B. Metaphase:	
		C. Anaphase:	
		D. Telophase:	

Task 4. Match the characteristics of proteins in the left column with their functions in the right one.

1. Form nuclear pore complex	A. Caspases
2. Form nucleosomes	B. Cyclins
3. Phosphorylate other proteins to activate or inactivate them	C. Cohesins
4. Take part in programmed cell death	D. Histones
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 chromosome	I. Synaptonemal complex

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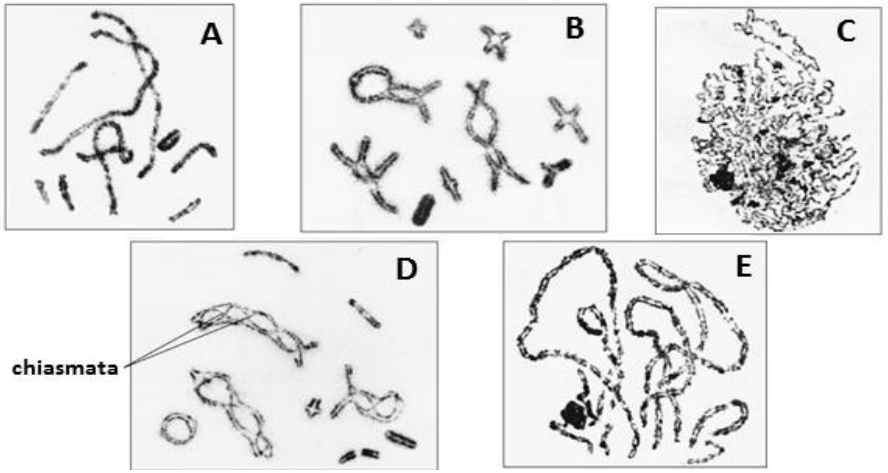
Task 5. Solve the case problems.

Case № 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 № 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 № 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

Task 6. Determine the stages of prophase I by their photographs.



	Phase	
A		Crossing over occurs
B		The maximal condensation of chromosomes is reached
C		Condensation of chromatin starts
D		Synaptonemal complex breaks down, chiasmata appear
E		Chromosomal synapsis starts

Task 7. Draw the cells undergoing different phases of mitosis.

Interphase	Prophase	Metaphase	Anaphase	Telophase

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

CONTENTS OF THE TOPIC

1. The Central Dogma of Molecular Biology.
2. The concept of the gene. Properties and functions of genes.
3. Ribonucleic acid, its types. The functions of RNA.
4. Genetic code and its properties.
5. Transcription. Transcription factors. Production of mRNA in eukaryotes: primary transcript and its processing.
6. Recognition. Translation: initiation, elongation, and termination.
7. Posttranslational modifications of proteins, folding of proteins. Chaperones.

GLOSSARY

1. Promoter –

2. Intron —

3. Spliceosome –

4. Terminator –

5. Poly-A tail –

6. Penetrance –

7. Transcription factors –

8. Degeneracy of genetic code –

9. Aminoacyl-tRNA synthetase –

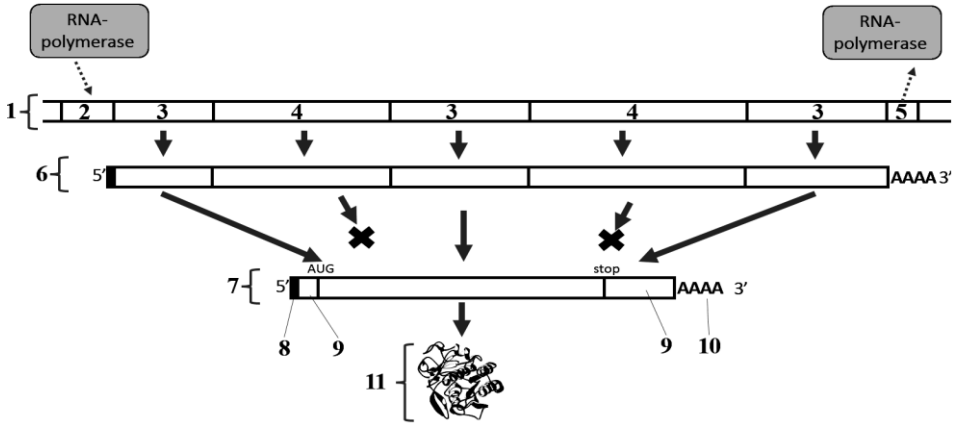
10. Capping –

11. Protein folding –

12. Chaperone –

13. Proteasome –

Task 1. Label the diagram of gene expression.



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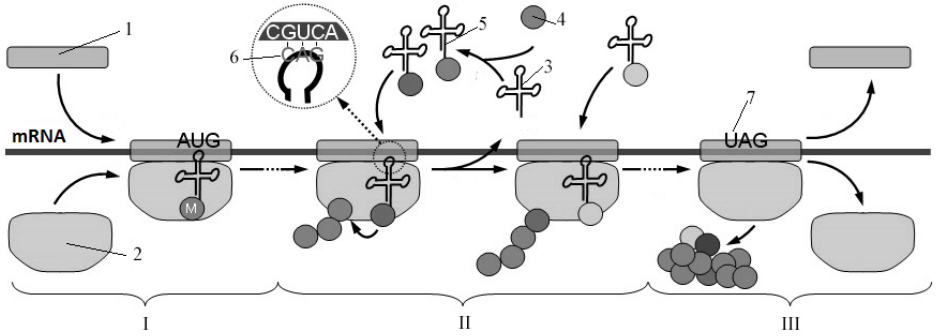
Task 2. Label the diagram of gene translation.



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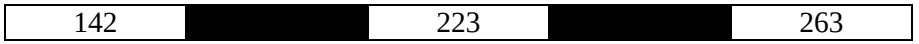
Task 3. Solve the problems.

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 № 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 № 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 № 4. Here is a diagram showing the exons (white) and introns (black) of the *HBB* gene encoding β-globin, a subunit of human hemoglobin. The numbers indicate the lengths of introns and exons in base pairs.



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 № 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 № 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?

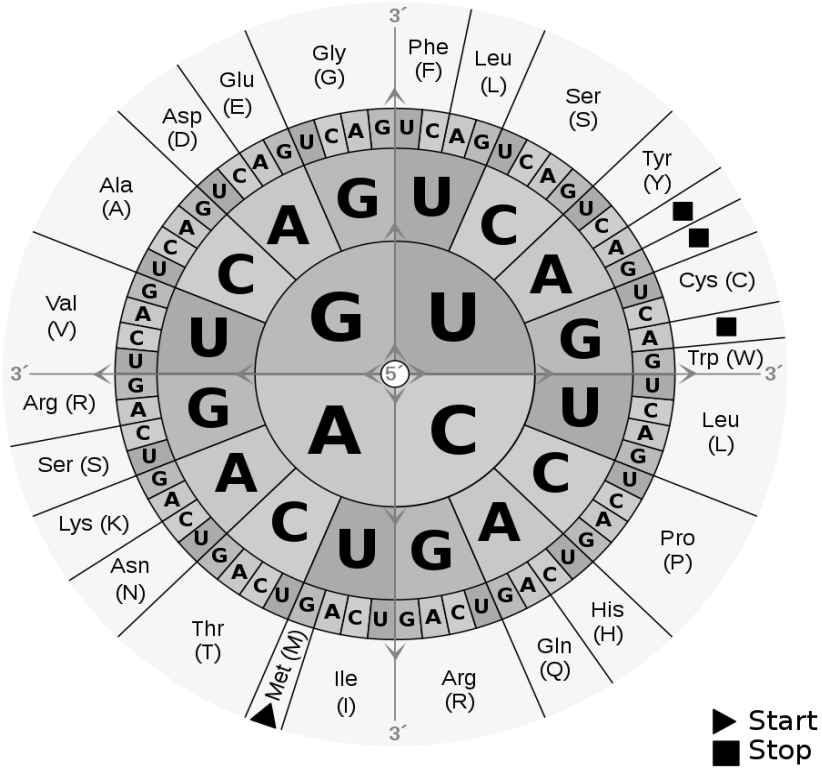


Fig. 1. Genetic code: mRNA codons and amino acids they code for

Problem № 7. A fragment of the sense DNA strand has the following nucleotide sequence: 5'ATGGAGGCTCTAGGTACCAGT3'.
A) Find the nucleotide sequence of the antisense strand.
B) Find the mRNA fragment transcribed from this DNA (the template for mRNA is the antisense strand).
C) Label the DNA ends (3' or 5').
D) Find the amino acid sequence of the protein encoded by this DNA fragment.

The coding (sense) strand:
5' A T G G A G G C T C T A G G T A C C A G T 3'

A)

B)

D)

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Class № 6. Topic: REGULATION OF GENE EXPRESSION

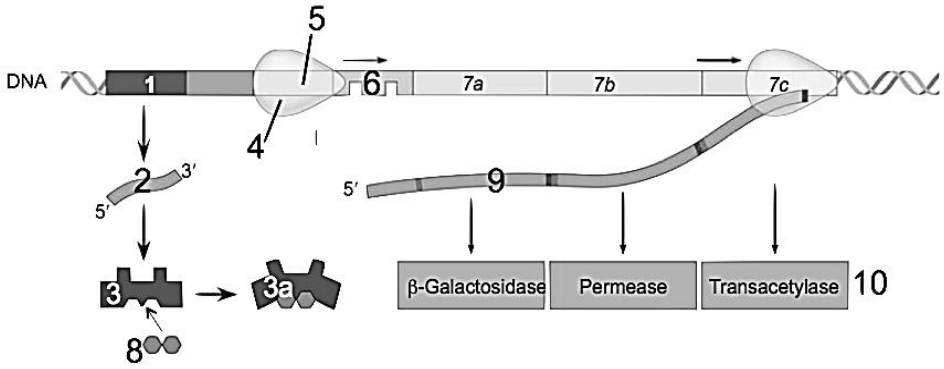
CONTENTS OF THE TOPIC

1. Human genome: protein-coding genes, RNA genes, non-coding sequences (repeats, introns, junk DNA). DNA transposons and retrotransposons. Transcriptome. Proteome. Metabolome.
2. Genome redundancy, its significance.
3. Projects Human genome, ENCODE, Roadmap.
4. Classification of genes (structural and functional genes, housekeeping, and tissue-specific genes).
5. Operon. Lac- and trp-operons. Polycistronic RNA.
6. Regulation of transcription in eukaryotes: preinitiation complex. Enhancers, silencers.
7. Epigenetics: histone modifications, cytosine methylation, CpG-islands.
8. Regulation of gene expression by non-coding RNAs.

GLOSSARY

1. **Gene expression –**
2. **Retrotransposon –**
3. **Single nucleotide polymorphism –**
4. **DNA methylation –**
5. **Housekeeping genes –**
6. **Chromatin remodeling –**
7. **Satellite DNA –**
8. **Enhancer –**
9. **Epigenetics –**
10. **Proteomics –**
11. **RNA interference –**
12. **Common transcription factors –**
13. **CpG-island –**

Task 1. Label the diagram of lac-operon.



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Task 2. Choose the term for each definition.

1. The specific structure of epigenetic modifications presents in the cell at a certain period.	A. Proteome
2. Qualitative and quantitative set of all low-molecular-weight molecules present in the cell.	B. Methylome
3. The entire sequence of DNA that characterizes a species, organism, or specific cell type	C. Genome
4. The entire set of proteins expressed in a given cell type or organism, at a given time under given conditions.	D. Epigenome
5. The specific set of transcripts (RNA molecules) present in cells of a particular type	E. Metabolome
6. A specific pattern of DNA methylation presents at a particular time in the genome or a particular cell type.	F. Transcriptome

1	2	3	4	5	6

Task 3. Put "+" to the factors that mosly promote gene expression and "–" to those that suppress it.

1. Removal of nucleosomes from the promoter	
2. Interaction of microRNA (as part of RISC) with mRNA	
3. Histone acetylation	
4. Deletion of poly-A tail of mRNA	
5. Histone methylation	
6. Interaction of the preinitiation complex with an enhancer	
7. Methylation of cytosine in the promoter of a gene	
8. Interaction of the preinitiation complex with a silencer	
9. Introduction of double-stranded RNA with gene sequence into the cell	

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 № 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 № 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?

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 № 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.

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

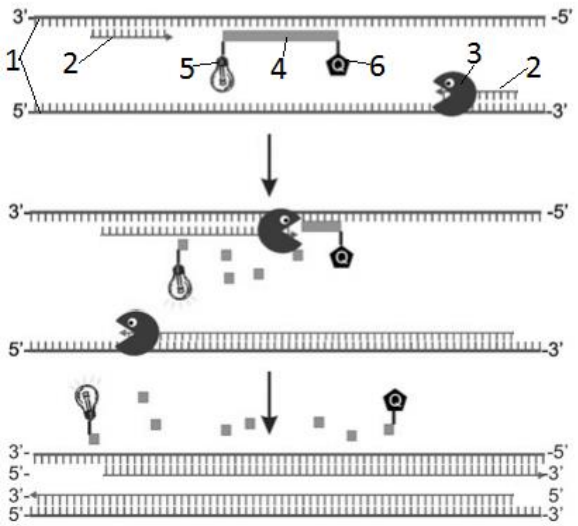
CONTENTS OF THE TOPIC

1. Methods of nucleic acids isolation.
2. DNA research methods: gel electrophoresis, restriction analysis, nucleic acid hybridization, DNA microarrays, PCR, sequencing.
3. PCR and its types: quantitative PCR, reverse transcription PCR, multiplex PCR.
4. Genome sequencing methods (Sanger sequencing, pyrosequencing, nanopore sequencing, bisulfite sequencing).

GLOSSARY

1. **Gel electrophoresis** –
2. **Restriction endonuclease** –
3. **DNA probe** –
4. **DNA sequencing** –
5. **Sanger sequencing** –
6. **Dideoxynucleotide** –
7. **Restriction analysis** –
8. **Nucleic acid hybridization** –
9. **Polymerase chain reaction** –
10. **DNA microarray** –
11. **Bisulfite sequencing** –
12. **Quantitative PCR** –
13. **Intercalating dye** –

Task 1. Label the diagram of quantitative PCR.



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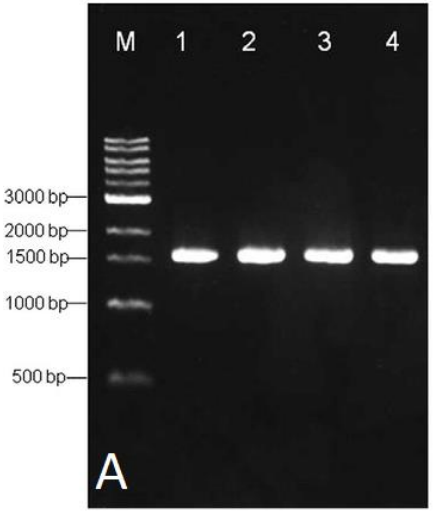
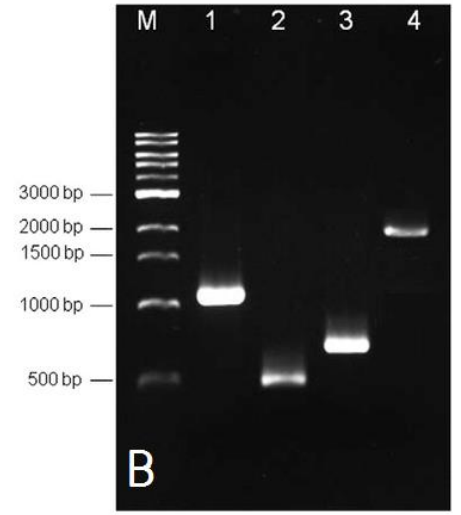
Task 2. Match the sequencing method with its characteristic (write the correct letter in the table): a) Sanger sequencing; b) pyrosequencing; c) nanopore sequencing; d) bisulfite sequencing.

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 № 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.





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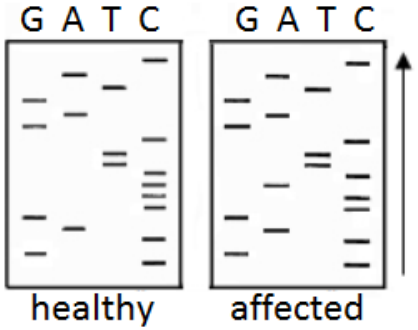
Problem № 2. Restriction endonuclease *Hind*III recognizes and cuts the site 5' AAGCTT3'. What is the chance of finding this nucleotide combination in a random DNA? What is the expected average length of the fragments formed when the DNA is cut by *Hind*III?

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 № 4. The gene *RHO* 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 *RHO* gene (bases encoding 21st-27th 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?

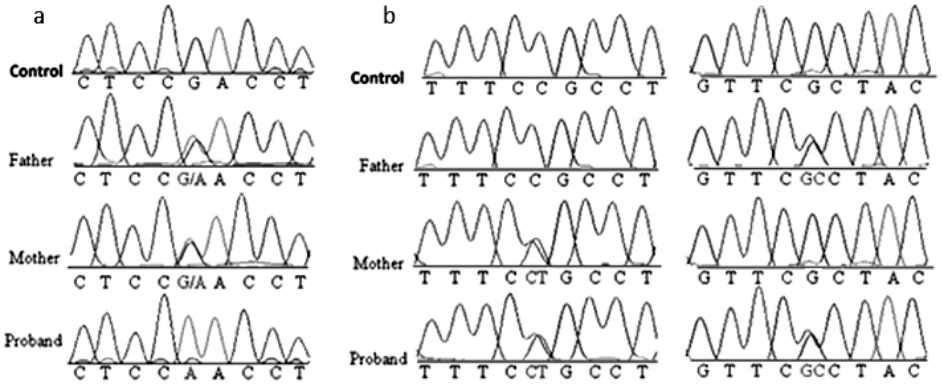


Problem № 5. Mutations in the *PAH* gene cause phenylketonuria. The disease is autosomal recessive (develops when the gene *PAH* is altered in both chromosomes). Here are the results of Sanger sequencing of the *PAH* gene for two families.

In family A, both parents have a c.728G>A mutation in exon 7, i.e., replacing the 728th 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.



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Class № 8. Topic: GENETIC ENGINEERING

CONTENTS OF THE TOPIC

1. Genetic engineering: goals, objectives, and stages.
2. Methods for obtaining genes for transgenesis.
3. Recombinant DNA. Construction of vectors, their types.
4. Introduction of recombinant DNA into a recipient cell. Selection of transformed cells. Selective and reporter genes.
5. Biotechnology, its importance for medicine. Genetically modified organisms. Food products containing GMOs.

GLOSSARY

1. **Vector –**
2. **Recombinant DNA –**
3. **Transgenesis –**
4. **Polylinker –**
5. **Reporter genes –**
6. **Selectable marker genes –**
7. **Shuttle vector –**
8. **Lipofection –**
9. **Electroporation –**
10. **Transformation –**
11. **Sticky ends –**
12. **DNA cloning –**
13. **Biolistics –**
14. **Phagemids –**

Task 1. Match the method of introducing recombinant DNA into a cell with its name:

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. Microinjection

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

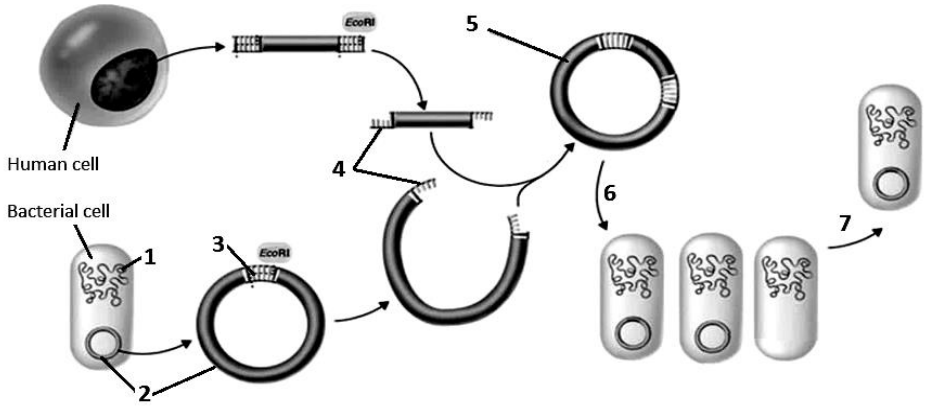

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Table 1

Some restriction endonucleases and their restriction sites

№	Restriction endonuclease	Restriction sites and cut points
1.	***Bal*I**	5'-TGG↓CCA–3' 3'-ACC↑GGT–5'
2.	***Bam*HI**	5'-G↓GATCC–3' 3'-CCTAG↑G–5'
3.	***Eco*RI**	5'-G↓AATTC–3' 3'-CTTAA↑G–5'
4.	***Hind*III**	5'-A↓AGCTT–3' 3'-TTCGA↑A–5'
5.	***Sal*I**	5'-G↓TCGAC–3' 3'-CAGCT↑G–5'
6.	***Xba*I**	5'-T↓CTAGA–3' 3'-AGATC↑T–5'
7.	***Hae*III**	5'-GG↓CC–3' 3'-CC↑GG–5'

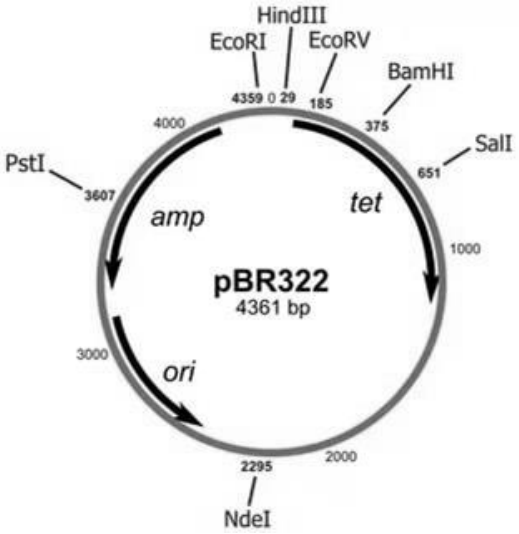
Task 3. Solve the problems.

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?

Problem № 2. The figure shows plasmid pBR322 with its restriction sites. Which of the following double-stranded DNA fragments can be inserted into the plasmid if only the endonucleases from table 1 are available? Why?



№ 1.

5'-CCGAATTCAGATGTAAGGCAATAGTGTGAATTCACA-3'
3'-GGCTTAAGTCTACATTCCGTTATCACACTTAAGTGT-5'

№ 2.

5'-CCTTAAGCTGAGGCTAAGGCAATAGAAGCAACACATG-3'
3'-GGAATTCGACTCCGATTCCGTTATCTTCGTTGTGTAC-5'

№ 3.

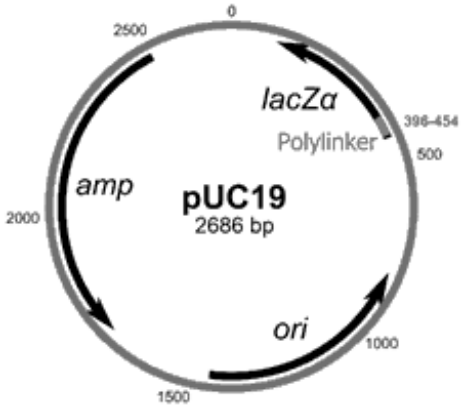
5'-AGGCCGATACCCGATACTCGACCGATACTGTAGGCCG-3'
3'-TCCGGCTATGGGCTATGAGCTGGCTATGACATCCGGC-5'

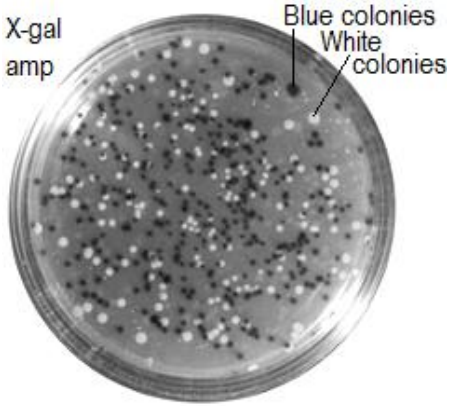
Problem № 3. The pUC19 plasmid contains:

- The gene for resistance to the antibiotic ampicillin (*amp*).
- The gene *lacZα,* allows bacteria to produce a blue substance from another substance called X-gal.
- Polylinker (a region containing multiple restriction sites) is located within the *lacZα* gene.

Cells transformed with recombinant pUC19-based DNA were seeded on a medium containing ampicillin and X-gal. White and blue colonies grew on the medium (each colony was a group of bacterial offspring of one cell).

1. What is the fate of bacteria that have not transformed (i.e. without pUC19)?
2. What is the fate of bacteria that have pUC19 but are without the desired gene?
3. Which color colonies were successfully genetically modified?





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Class № 9. Topic: OMIC TECHNOLOGIES IN MEDICINE

CONTENTS OF THE TOPIC

1. Internet databases containing information about nucleotide sequences, specialized online services, Blast, NCBI. Bioinformatics. Phylogenetic analysis.
2. Applications of genetic engineering in medicine: production of protein products, mono- and polyclonal antibodies, recombinant proteins, DNA probes.
3. Genome editing tools: CRISPR/Cas9, TALEN. Prospects for use in medicine and bioethical problems of genomic editing. Gene therapy.
4. Pharmacogenetics. Personalized medicine.
5. Molecular genetic markers of tumors. Cancer gene diagnostics.
6. Ways to diagnose hereditary gene diseases: direct sequencing, PCR, RFLP-, SSCP-analysis, DNA microarrays.

GLOSSARY

1. Monoclonal antibody –

2. Recombinant protein –

3. Personalized medicine –

4. Pharmacogenomics –

5. Variable regions of an antibody–

6. Gene therapy –

7. Cancer immunotherapy –

8. Personalized medicine –

9. CRISPR/Cas9 –

10. Hybridoma –

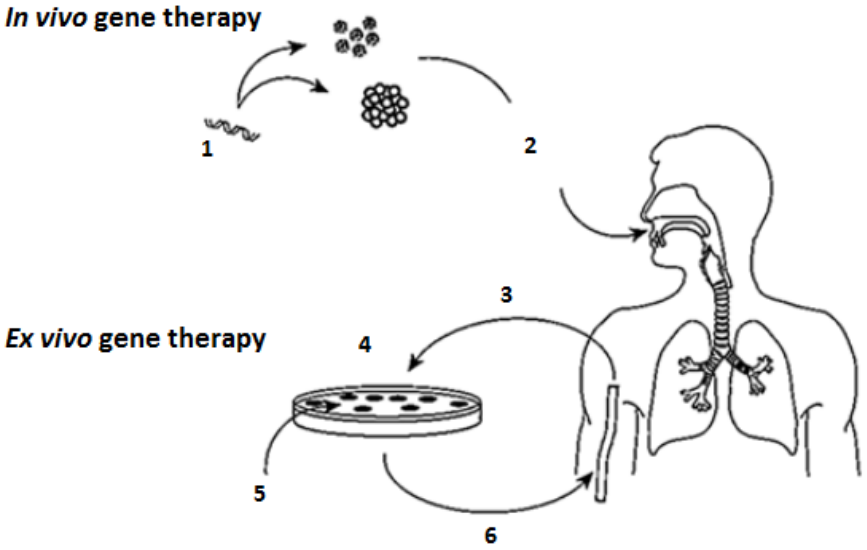
11. Vector vaccine –

12. Recombinant vaccine –

13. Biomarker –

14. Phylogenetic tree –

Task 1. Label the diagram.



1 –

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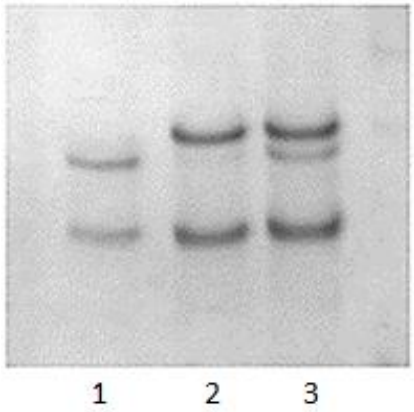
Task 2. Solve the problems.

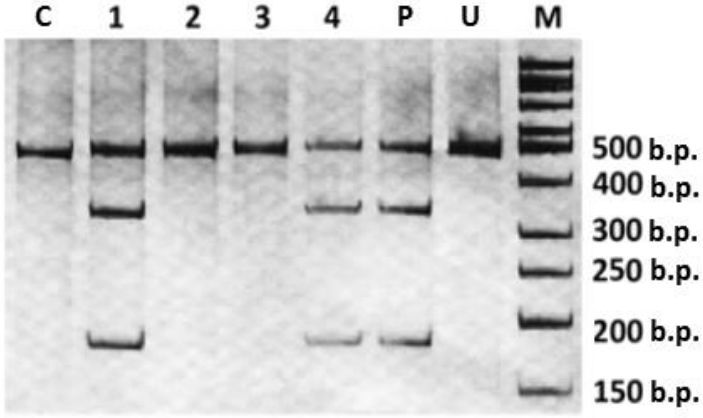
Problem № 1. Here is the SSCP of an exon for three different individuals. Two of them are homozygous for different mutations (i.e., they contain the same mutation in both copies of the gene).



What is the number of individual who has the mutations of both other individuals?

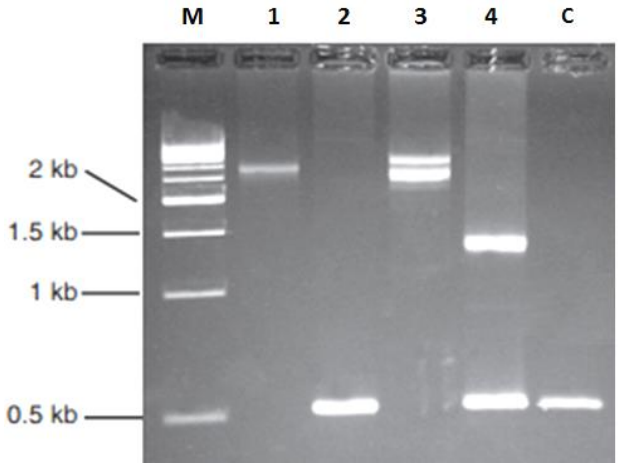
Problem № 2. A patient with oligodentia (absence of several teeth) was examined for mutations that might cause this condition. He was found to have a mutation in exon 2 of the MSX1 gene. His family members (parents and mother's parents) without oligodentia were also examined, for which the RFLP method 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 № 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).



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Class № 10. Topic: COLLOQUIUM № 1

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 and functions of the cell nucleus.
15. Gene, chromosome, and genome levels of eukaryotic genetic material.
16. DNA condensation. Remodeling of chromatin.
17. 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, amitosis, endomitosis. Binary division of bacteria. Mitosis: characteristics of phases, distribution of genetic material, biological significance. Meiosis as a type of mitosis: characteristic of phases, distribution of genetic material, biological significance.
24. Cell proliferation and cell death. Necrosis and apoptosis. Caspases.
25. The Central Dogma of Molecular Biology.
26. The concept of the gene. Properties and functions of genes.
27. Ribonucleic acid, its types, functions. Genetic code and its properties.
28. Transcription. Transcription factors. Production of mRNA / mRNA synthesis in eukaryotes: primary transcript and its processing.
29. Recognition. Translation: initiation, elongation, and termination.
30. Posttranslational proteins modifications, protein folding, chaperones.
31. 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.
32. Projects Human genome, ENCODE, Roadmap. Classification of genes.
33. Operon. Lac- and trp-operons. Polycistronic RNA. Regulation of transcription in eukaryotes: preinitiation complex. Enhancers, silencers.
34. Epigenetics: histone modifications, cytosine methylation, CpG-islands,
35. Regulation of gene expression by non-coding RNAs.
36. Methods of nucleic acids isolation.
37. 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).
38. Genetic engineering: goals, objectives, and stages. Methods for obtaining genes for transgenesis. Recombinant DNA. Construction of vectors, their types.
39. Introduction of recombinant DNA into a recipient cell. Selection of transformed cells. Selective and reporter genes.
40. Biotechnology, its importance for medicine. Genetically modified organisms. Food products containing GMOs.
41. Internet databases containing information about nucleotide sequences, specialized online services, Blast, NCBI. Bioinformatics. Phylogenetic analysis.
42. Applications of genetic engineering in medicine: production of protein products, mono- and polyclonal antibodies, recombinant proteins, DNA probes.
43. Genome editing tools: CRISPR/Cas 9, TALEN. Prospects for use in medicine and bioethical problems of genomic editing. Gene therapy.
44. Pharmacogenetics. Personalized medicine.
45. Molecular genetic markers of tumors. Cancer gene diagnostics.
46. Ways to diagnose hereditary gene diseases: direct sequencing, PCR, RFLP-, SSCP-analysis, DNA microarrays.

Class № 11. Topic: BASIC LAWS OF INHERITANCE

CONTENTS OF THE TOPIC

1. Genetics as a science.
2. Hybridological analysis.
3. Laws of inheritance in a monohybrid cross. Law of purity of gametes. Testcross. Backcrossing.
4. Laws of inheritance in polyhybrid cross.
5. Limitations of Mendel's laws. Pleiotropy.
6. Intraallelic gene interactions (complete and incomplete dominance, 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, polymeric gene action). Bombay blood group as an example of recessive epistasis in humans.

GLOSSARY

1. **Allele –**
2. **Complementation –**
3. **Superdominance –**
4. **Testcross –**
5. **Phenotype –**
6. **Polymeric gene action –**
7. **Codominance –**
8. **Genotype –**
9. **Backcrossing –**
10. **Epistasis –**
11. **Intraallelic interactions –**
12. **Allelic exclusion –**
13. **Pure lines –**

Task 1. Solve the problems.

Problem № 1. How many and what types of gametes could be formed by organisms with the following genotypes?

AaBbDd AAbbCCddRR

Problem № 2. A blue-eyed male married a brown-eyed female. Her father was blue-eyed and her mother was brown-eyed. It's known that the allele of brown eyes is dominant. What phenotypes of children could be expected in this family and what is their chance?

Problem № 3. In humans, brown eyes and dextrality (right-handedness) are determined by the dominant alleles of two different genes. The blue eyes and sinistrality (left-handedness) are determined by their recessive alleles. A browned-eyed right-hander man married a blue-eyed left-hander woman. What traits could be expected in children if the man is double-heterozygous?

Problem № 4. A woman has blood groups O, Rh-, MN. Her husband has groups AB, Rh+ (homozygote), and N. What combinations of blood groups can their children have?

Phenotype	Gene	Genotype
System AB0		
Group 0 (I)	I^0	I^0I^0
Group A (II)	I^A	I^AI^A, I^AI^0
Group B (III)	I^B	I^BI^B, I^BI^0
Group AB (IV)	$I^A + I^B$	$I^A I^B$
System MN		
Group M	L^M	L^ML^M
Group N	L^N	L^NL^N
Group MN	L^M+L^N	L^ML^N
System Rh		
Rh+	D	DD, Dd
Rh-	d	dd

Problem № 5. In humans, congenital deafness can be caused by recessive alleles of two different genes (**d** and **e**). Normal hearing requires dominant alleles of both the genes (**D** and **E**). There is a family where parents are deaf while all their seven children have normal hearing. What are the most probable genotypes of all members in this family?

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 № 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?

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

CONTENTS OF THE TOPIC

1. Experiments of T. Morgan. Complete and partial genetic linkage. Linkage groups.
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 Y linked traits.
6. Definition, differentiation, and redefinition of sex in ontogeny. Genetic regulation of gonadogenesis in humans.
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 morphological and civil sex changes.
9. X-inactivation. M. Lyon's hypothesis of female mosaicism by sex chromosomes.

GLOSSARY

1. **Linked genes –**
2. **Sex-linked genes –**
3. **Crossover gametes –**
4. **Chromosomal theory of sex determination –**
5. **Genetic map of chromosome –**
6. **Primary sexual characteristics –**
7. **Heterogametic sex –**
8. **Barr body –-**
9. **Mosaicism –**
10. **Androgen insensitivity syndrome –**
11. **Holandric traits –**
12. **Hemizygosity –**
13. **Genetic sex –**

Task 1. Solve the problems.

Problem № 1. Write the gametes and their percentages for Drosophila with the following genotypes (the distance between the linked genes is 28 cM).

1. male $\frac{A}{a}\ \frac{B}{b}$ 2. male $\frac{AB}{ab}$ 3. female $\frac{AB}{ab}$ 4. female $\frac{AB}{ab}\ \frac{D}{d}$

Problem № 2. The distance between the autosomal gene that determines the Lutheran antigens and the gene that determines the solubility of some blood proteins is 13 cM. What is the percentage of non-crossover gametes in a double-heterozygous human?

Problem № 3. What is the probability of giving birth to a recessive homozygous child in a family of people with the following genotypes? The distance between the genes A and B is 20 cM.

P: $\frac{AB}{ab}$ x $\frac{AB}{ab}$

G: ◯- % ◯- %

◯- % ◯- %

◯- % ◯- %

◯- % ◯- %

F1:

Answer:

Problem № 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 *AR* 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 *AR* gene? What does this gene encode?

Problem № 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?

Problem № 6. Hemophilia and color blindness are caused by the recessive alleles of two different genes (h and d). The genes are situated in the X chromosome at a distance of 10 cM. A woman whose father had both the diseases and mother had no such recessive alleles married a healthy man. What is the probability of giving birth to a child: 1) with both diseases; 2) with one disease; 3) phenotypically healthy?

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Class № 13. Topic: VARIATION. MUTAGENESIS. CARCINOGENESIS

CONTENTS OF THE TOPIC

1. Variation and its types. Phenotypic plasticity.
2. Combinative variation.
3. Mutations. Causes of mutations: DNA copying errors, unequal crossing over, mutagens.
4. Physical, chemical, and biological mutagenic factors. Genetic hazards of environmental pollution by mutagens.
5. Classifications of mutations.
6. Stability and repair of genetic material.
7. Types of DNA repair. Excision repair, repair of double-stranded breaks. Photoreactivation. Role of repair disorders in human pathology.
8. Carcinogenesis. Oncogenes and tumor suppressor genes.

GLOSSARY

1. Mutation –

2. Unequal crossing over –

3. Reparation of genetic material –

4. Insertion –

5. Reading frameshift –

6. Phenocopies –

7. Anaphase lag –

8. Non-homologous end joining –

9. Oncogene –

10. Tumor suppressor genes –

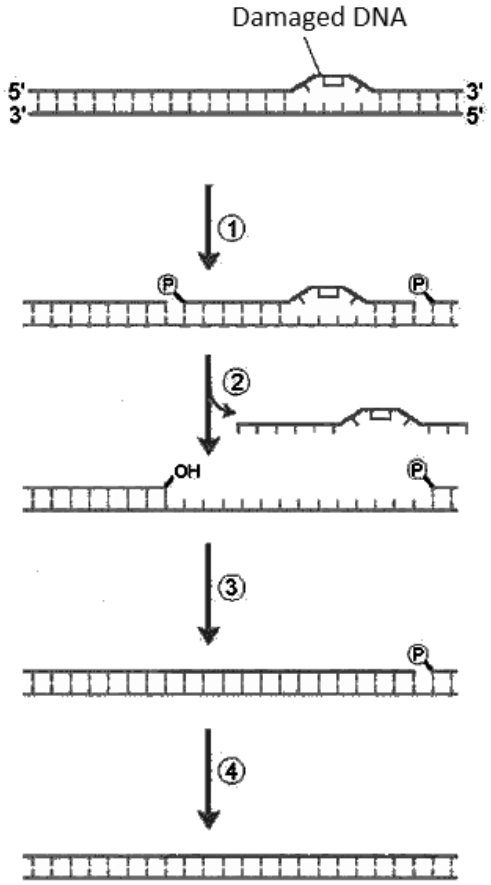
11. Reciprocal translocation –

12. Combinative variability –

13. Transversion –

14. Missense mutation –

Task 1. Label the figure of nucleotide excision repair and explain its mechanism.



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Task 2. Match the DNA repair mechanism with its name.

1. Error-prone mechanism for joining double-stranded breaks	A. Direct reversal
2. Single nucleotide is replaced	B. Nucleotide excision repair
3. Method by which pyrimidine dimers are eliminated in humans	C. Base excision repair
4. Damage is repaired without nucleotide replacement	D. Nonhomologous end joining
5. Repair involving proteins with endo- and exonuclease activity and subsequent filling in the gap in the DNA strand with DNA-polymerase	E. Reparation by homologous recombination
6. Use of the sequence of homologous chromosome or sister chromatid to repair double-stranded breaks	F. Mismatch repair

1	2	3	4	5	6

Task 3. Model changes of proteins in case of different point mutations.

Initial mRNA	5’AUGACCGACCCGAAAGGGACC3’
Peptide	
Silent mutation	5’AUGACCGACCC**C**AAAGGGACC3’
Peptide	
Missense mutation	5’AUG**C**CCGACCCGAAAGGGACC3’
Peptide	
Nonsense mutation	5’AUGACCGACCCG**U**AAGGGACC3’
Peptide	
Frameshift mutation	5’AUGACCGAC**G**CCGAAAGGGACC3’
Peptide	

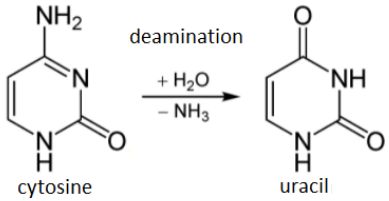
Task 4. Solve the problems.

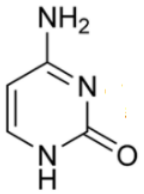
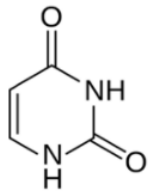
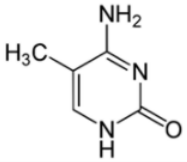
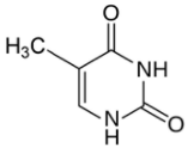
Problem № 1. Some cells of a person have a normal karyotype, others have 47 or 45 chromosomes. What is the name of this phenomenon? What is the mechanism of its origination?

Problem № 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?

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 are converted to uracil by spontaneous deamination. What is the consequence of deamination of methylated cytosine?



	
cytosine	uracil
	
5-methylcytosine	thymine

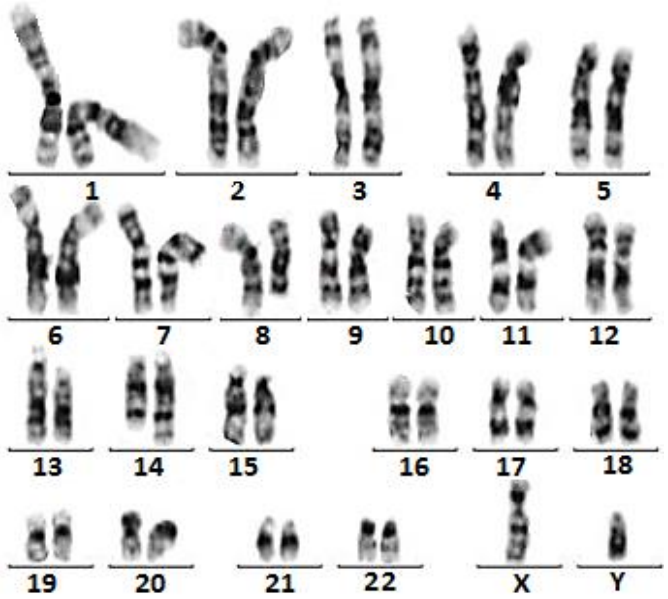
Problem № 5. Burkitt's lymphoma (cancer that develops from B-lymphocytes) is known to develop because of an increase in the activity of the *C-MYC* oncogene located in chromosome 8. The disease can be caused by several aberrations:

a) translocation of a q-arm fragment from chromosome 8 to the q-arm of chromosome 14;

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.

Is one of these mutations present in the chromosomes shown in the photograph? Explain your answer.



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Class № 14. Topic: POPULATION GENETICS

CONTENTS OF THE TOPIC

1. Population. Characteristics of a population. Gene pool.
2. Ideal population. Hardy–Weinberg equilibrium.
3. Factors disturbing Hardy–Weinberg equilibrium: natural selection, genetic drift, mutations, migration, non-random mating.
4. Human genetic polymorphism, its biological, medical, and social aspects. Distinctive features of the human population. Types of marriages. Inbreeding. Mating assortativity. Inbreeding coefficient.
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.

GLOSSARY

1. Population –

2. Gene pool –

3. Natural selection –

4. Genetic drift –

5. Immigration –

6. Founder effect –

7. Inbreeding –

8. Genetic load –

9. Inbreeding coefficient –

10. Assortative mating –

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 № 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 № 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 № 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 № 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?

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.

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Class № 15. Topic: HUMAN GENETICS

CONTENTS OF THE TOPIC

1. Humans as a specific object of genetic analysis.
2. Methods of human genetics: genealogical analysis, twin study, biochemical tests, molecular-genetic methods.
3. Methods of diagnosing human chromosomal diseases: standard karyotyping, SKY, FISH, and single-nucleotide polymorphism array karyotyping.
4. Rapid diagnostic methods: microbiological tests, detection of X- and Y-sex chromatin, biochemical tests, genetic dermatoglyphics.
5. Neonatal screening of monogenic disorders.

GLOSSARY

1. Karyotyping –

2. DNA probe –

3. Prenatal diagnosis –

4. Concordance of twins –

5. Rapid diagnostic methods –

6. Holzinger's formula –

7. Spectral karyotyping –

8. Pedigree –

9. Fluorescence in situ hybridization –

10. Screening –

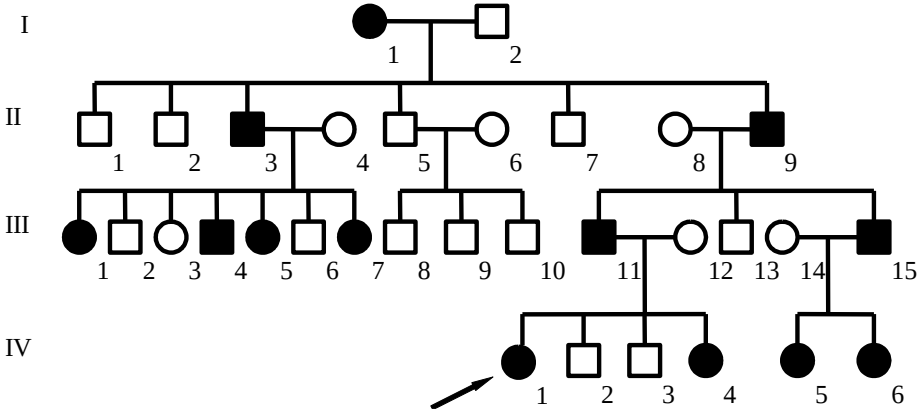
11. Propositus –

12. Single transverse palmar crease –

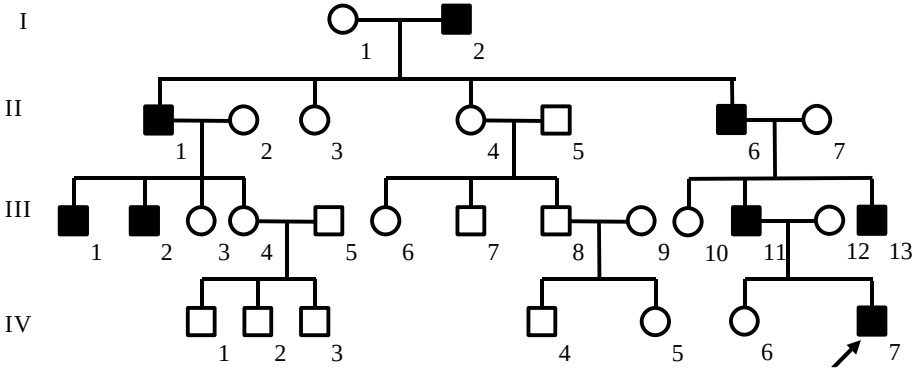
13. Medical Genetics –

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?



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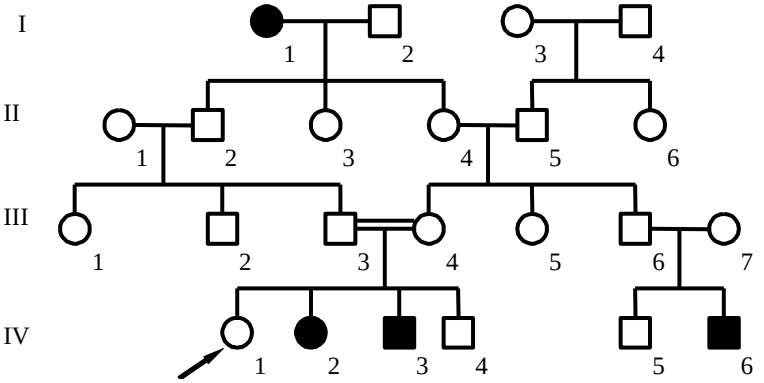

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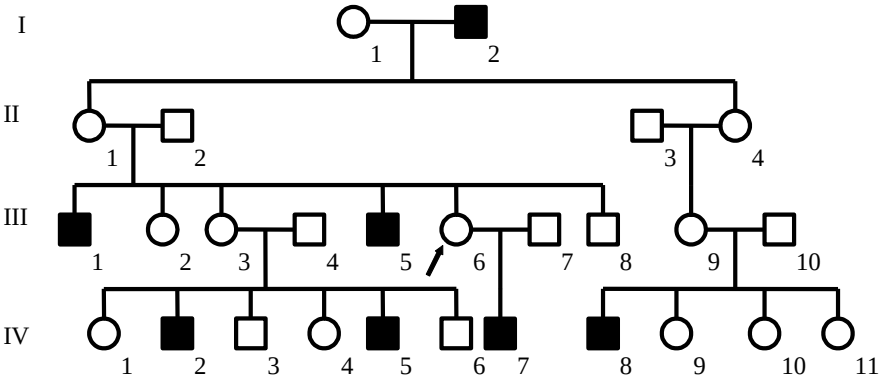
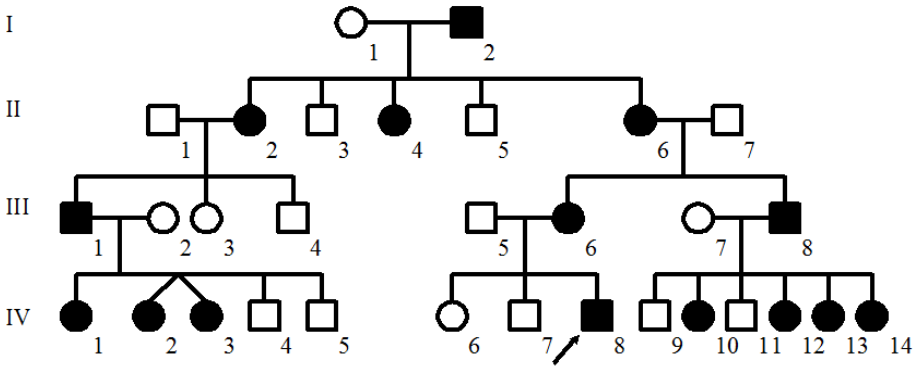


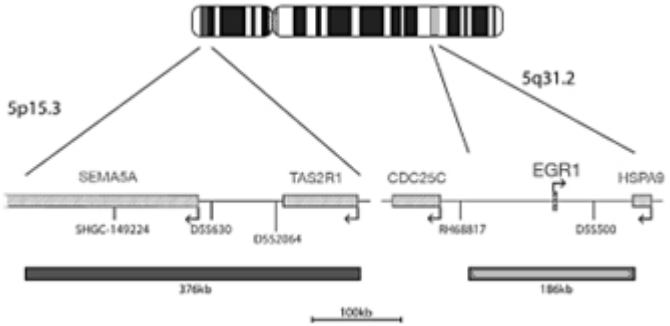
Problem № 5. What is the pattern of inheritance of the trait from the pedigree? What are the genotypes of all pedigree members?



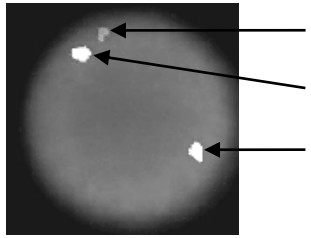
Problem № 6. The concordance of monozygotic and dizygotic twins in body mass is 80 % and 30 %. What is the degree of genetic determination of body mass? What is the influence of the environment on this trait?

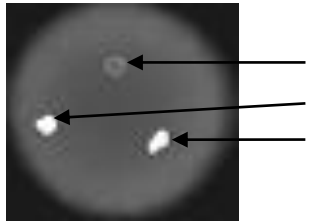
Problem № 7. To determine the degree of genetic determination of bronchial asthma, 44 pairs of monozygotic and 120 pairs of dizygotic twins were studied. Twenty-three pairs of monozygotic twins and six pairs of dizygotic twins were concordant. Estimate the role of hereditary and environmental factors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

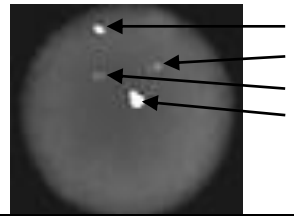
Problem № 8. FISH was used to detect a deletion in the long arm of the fifth chromosome. The signals from the probes to the p- and q-arms of this chromosome are green and red, respectively (in the black and white photo – white and gray).



Which cells of the following have a 5q deletion







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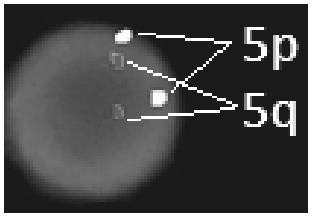

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Class № 16. Topic: HUMAN HEREDITARY DISORDERS

CONTENTS OF THE TOPIC

1. Etiology and pathogenesis of human hereditary diseases. Classification of human hereditary diseases.
2. Monogenic and polygenic diseases: disorders of amino acid, carbohydrate, lipid, nucleic acid, mineral metabolism, disorders of blood clotting, and hemoglobin structure.
3. Human chromosome disorders caused by changes in the structure and number of autosomes, full and partial monosomies and trisomies.
4. Mitochondrial diseases.
5. Multifactorial diseases.
6. Principles of treatment of human hereditary pathology.

GLOSSARY

1. Albinism –

2. Monogenic disorders –

3. Inborn errors of metabolism –

4. Chromosomal aberration –

5. Multifactorial disease–

6. Full trisomy –-

7. Mosaic trisomy –

8. Partial trisomy –

9. Kayser–Fleischer ring –

10. Tophus –

11. Muscle hypotonia –

12. Anemia –

13. Brushfield spots –

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 № 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?

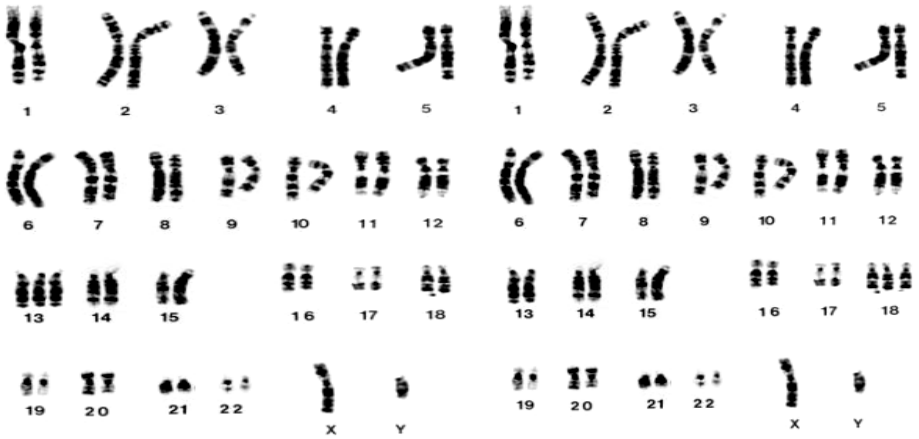
Case № 3. In the family of healthy parents who are second cousins, a full-term baby was born. The baby was breastfed by the mother. Gradually the child developed vomit and diarrhea, jaundice, liver and lien enlargement, failure to thrive, and cataract. The symptoms got stronger in course of time.
What 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 № 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 № 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?

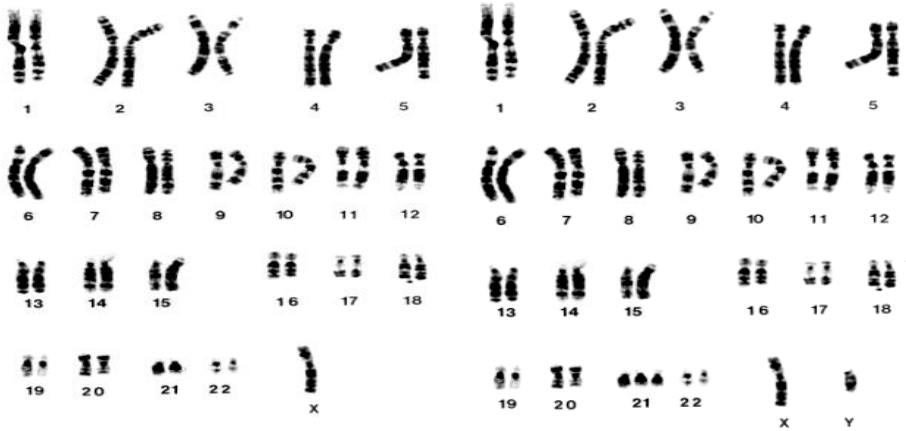
Case № 6. Identify the disorder:
The disorder occurs almost exclusively in males. Patients are normal at birth. Psychomotor delay becomes evident after several months. The disorder is characterized by neurological and behavioral abnormalities. There are symptoms of gout such as arthritis, and kidney 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. Identify a hereditary pathology based on the karyotype.



A

B



C

D

A –

B –

C –

D –

Case № 8. A 45-year-old woman and her 50-year-old husband have got a full-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-behavioral development.

What disease can be supposed? Which methods should be used to confirm the diagnosis? What is the future viability prognosis for this child?

Task 2. What are the inheritance patterns of the following diseases?

1. Galactosemia
2. Lesch–Nyhan syndrome
3. Wilson disease
4. Hemophilia A
5. Sickle cell anemia
6. Oculocutaneous albinism
7. Phenylketonuria

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Class № 17. Topic: GENETIC COUNSELING. PRENATAL DIAGNOSIS

CONTENTS OF THE TOPIC

1. Genetic counseling and its tasks. Indications for directing a family to genetic counseling.
2. Stages of genetic counseling: clinical examination, risk calculation, evaluation of consequences, prognosis.
3. Genetic risk calculation. Laws of addition and multiplication, Bayes' theorem, calculation of posterior probability.
4. Prenatal diagnostic tests for hereditary disorders (alpha-fetoprotein evaluation, ultrasonography, chorionic villus sampling, amniocentesis, cordocentesis, and fetoscopy).
5. Moral and ethical aspects of prenatal diagnosis. Induced termination of pregnancy.
6. Ethical and legal problems of genetic consulting.

GLOSSARY

1. Prenatal diagnosis –

2. Medical genetic counseling –

3. Screening –

4. Indirect methods of prenatal diagnosis –

5. Invasive diagnostic tests –

6. Cordocentesis –

7. Amniocentesis –

8. Independent events –

9. Alpha-fetoprotein –

10. Ultrasonography –

11. Prior probability –

12. Posterior probability –

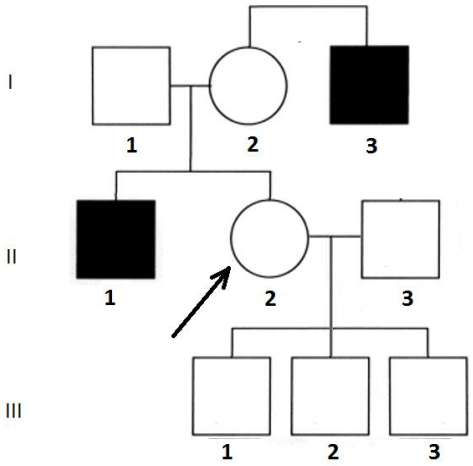
Task 1. Solve the problems.

Problem № 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 № 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?

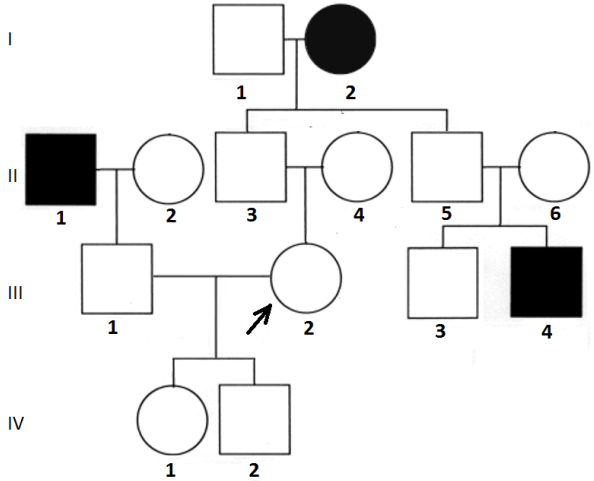
Problem № 3. The propositus is a boy having Duchenne muscular dystrophy. Proband's parents and two sisters are healthy. On the paternal side, two uncles, an aunt, a grandfather, and a grandmother were healthy. Two daughters of the uncle and the son of the aunt are healthy. On the mother's side, one of 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 the questions.



A. ***Prior probability*** that the propositus is a heterozygous carrier (probability of inheriting the X chromosome with the mutation from the mother)	
B. Prior probability that the propositus is NOT a heterozygous carrier	
C. Probability of giving birth to three healthy sons if the mother is a carrier of hemophilia	
D. Probability of giving birth to three healthy sons if the mother is NOT a carrier of hemophilia	
E. Total probability of giving birth to 3 healthy sons (A*C+B*D):	
F. *Posterior probability* of being a carrier(A*C)/ (A*C+B*D):	
G. Probability of hemophilia for the fourth son born by the propositus (based on the posterior probability):	

Problem № 5. Analyze the family. Determine the pattern of inheritance. Assuming that II-4 is not a carrier, calculate the probability that the propositus is a carrier of the recessive allele. Based on this probability, calculate the probability of having a sick child in the family of propositus.



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Class № 18. Topic: COLLOQUIUM № 2

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. Structure and functions of DNA. Genetic material of viruses and bacteria.
13. The structure and functions of the cell nucleus.
14. Gene, chromosome, and genome levels of eukaryotic genetic material.
15. DNA condensation. Remodeling of chromatin.
16. The structure of metaphase chromosomes. Euchromatin and heterochromatin. Types of chromosomes. Rules of chromosomes. Karyotype and idiogram. Methods for studying the human karyotype. Classifications of human chromosomes.
17. Cytoplasmic inheritance.
18. Cell cycle. Interphase.
19. Semi-conservative mechanism of DNA replication. Replicon.
20. Cell cycle regulators (cyclins and cyclin-dependent kinases).
21. Types of cell division: mitosis, amitosis, endomitosis. Binary division of bacteria.
22. Mitosis: characteristics of phases, distribution of genetic material, biological significance.
23. Meiosis as a type of mitosis: characteristic of phases, distribution of genetic material, biological significance.
24. Cell proliferation and cell death. Necrosis and apoptosis. Caspases.
25. The Central Dogma of Molecular Biology. The concept of the gene. Properties and functions of genes.
26. Ribonucleic acid, its types, functions. Genetic code and its properties.
27. Transcription. Transcription factors. Production of mRNA, mRNA synthesis in eukaryotes: primary transcript and its processing.
28. Recognition. Translation: initiation, elongation, and termination. Posttranslational proteins modifications, protein folding, chaperones.
29. Human genome: protein-coding genes, RNA genes, non-coding sequences (repeats, introns, junk DNA). DNA transposons and retrotransposons.
30. Transcriptome. Proteome. Metabolome. Genome redundancy, its significance.
31. Projects Human genome, ENCODE, Roadmap. Classification of genes.
32. Operon. Lac- and trp-operons. Polycistronic RNA. Regulation of transcription in eukaryotes: preinitiation complex. Enhancers, silencers.
33. Epigenetics: histone modifications, cytosine methylation, CpG-islands, regulation of gene expression by non-coding RNAs.
34. Methods of nucleic acids isolation.
35. DNA research methods: gel electrophoresis, restriction analysis, nucleic acid hybridization, DNA microarrays.
36. PCR and its types: quantitative PCR, reverse transcription PCR, multiplex PCR.
37. Genome sequencing methods (Sanger sequencing, pyrosequencing, nanopore sequencing, bisulfite sequencing).
38. Genetic engineering: goals, objectives, and stages. Methods for obtaining genes for transgenesis. Recombinant DNA. Construction of vectors, their types.
39. Introduction of recombinant DNA into a recipient cell. Selection of transformed cells. Selective and reporter genes.
40. Biotechnology, its importance for medicine. Genetically modified organisms. Food products containing GMOs.
41. Internet databases containing information about nucleotide sequences, specialized online services, Blast, NCBI. Bioinformatics. Phylogenetic analysis.

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

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

CONTENTS OF THE TOPIC

1. Reproduction is a universal property of living things. Forms of asexual reproduction.
2. Forms of sexual reproduction, biological significance. Lateral gene transfer. Hermaphroditism.
3. Ovogenesis and spermatogenesis in humans.
4. Regulation of gametogenesis in humans.
5. Morphological and functional characteristics of mature human gametes.
6. Insemination. Peculiarities of fertilization in humans.
7. Overcoming infertility in humans.
8. Implantation of an embryo, preimplantation diagnosis.

GLOSSARY

1. Pre-implantation genetic diagnosis –

2. Gynogenesis –

3. Gamete –

4. Insemination –

5. Hermaphrodites –

6. Asexual reproduction –

7. In vitro fertilization –

8. Infertility –

9. Zona pellucida –

10. Spermatogenesis –

11. Parthenogenesis –

12. Acrosome –

13. Lateral gene transfer –

Task 1. Label the diagrams.

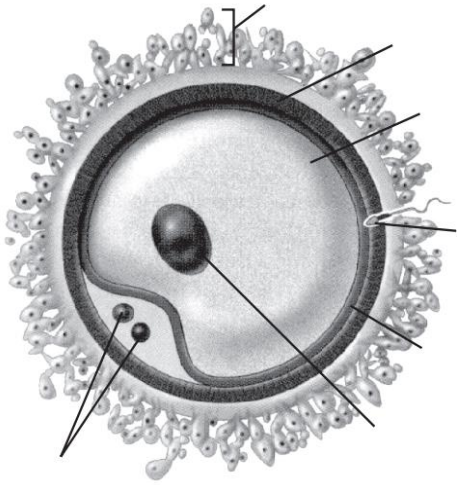

Fig. 1. Diagram of a human egg during fertilization:
1 – polar bodies; 2 – corona radiata; 3 – cytoplasm; 4 – membrane;
5 – zona pellucida; 6 – nucleus; 7 – spermatozoon

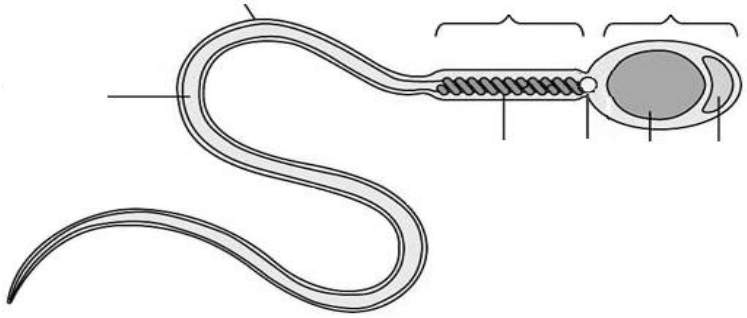

Fig. 2. Diagram of human sperm:
1 – head; 2 – middle piece; 3 – membrane; 4 – acrosome; 5 – nucleus;
6 – mitochondria; 7 – flagellum; 8 – centrosome

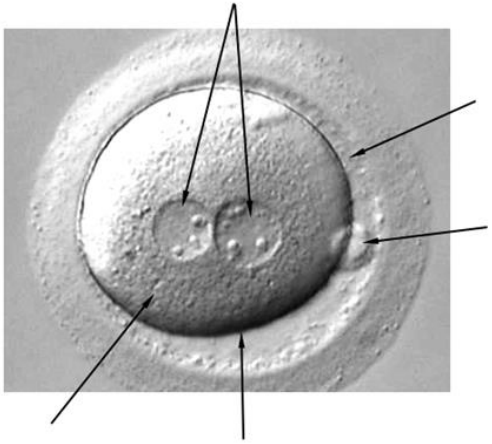

Fig. 3. Zygote of human:
1 – polar body; 2 – zona pellucida; 3 – pronuclei; 4 – membrane; 5 – cytoplasm

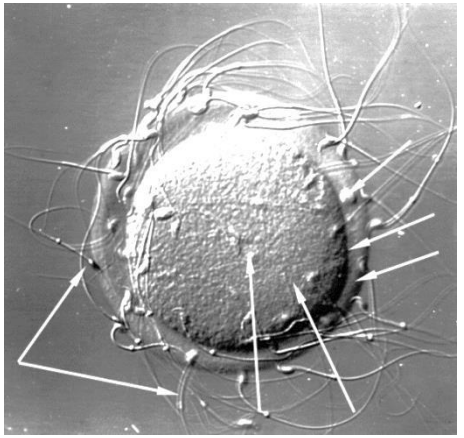

Fig. 4. Fertilization of the mouse egg cell in vitro:
1 – polar body; 2 – zona pellucida; 3 – pronucleus; 4 – membrane;
5 – cytoplasm; 6 – spermatozoa

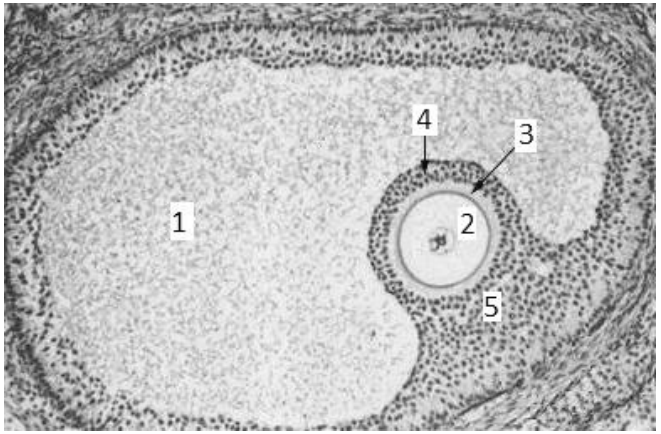

Fig. 5. Graafian follicle:
– secondary ovocyte;
– cumulus oophorus;
– corona radiate;
– follicular cavity;
– zona pellucida

Task 2. Solve the problems.

Problem № 1. In the case of parthenogenesis unfertilized ovum gives rise to a new organism. Why can't a spermatozoon do the same?

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 № 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?

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

CONTENTS OF THE TOPIC

1. Ontogenesis. Periodization of prenatal ontogenesis.
2. Prezygotic period. Prenatal period: zygote, cleavage, gastrulation, histogenesis, and organogenesis.
3. Extraembryonic membranes of chordates.
4. Regulation of embryonic development.
5. Critical periods of human intrauterine development, teratogenic factors.
6. Genomic imprinting. Diseases of genomic imprinting.

GLOSSARY

1. Prenatal ontogenesis –

2. Blastomere –

3. Cleavage –

4. Blastocyst –

5. Teratology –

6. Gastrulation –

7. Germ layers –

8. Amnion –

9. Neural tube –

10. Aplasia –

11. Extraembryonic membranes –

12. Trophoblast –

13. Hypoblast –

Task 1. Label the diagrams.

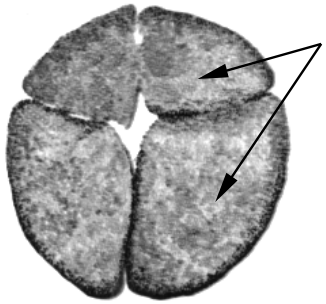


Fig. 1. Cleavage of frog's zygote:
1 – blastomeres

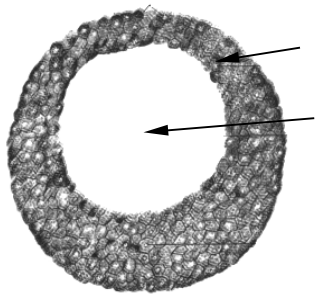


Fig. 2. Blastula of frog:
1 – blastomeres, 2 – blastocoel

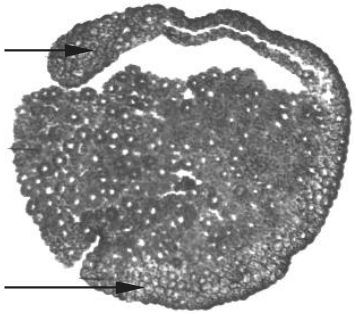


Fig. 3. Gastrula of frog:
1 – dorsal lip of blastopore;
2 – ventral lip of blastopore

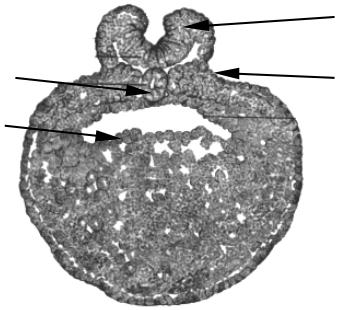
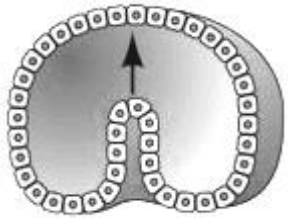
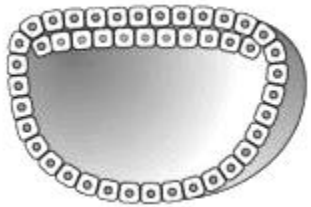


Fig. 4. Neurula of frog (7×8):
1 – ectoderm; 2 – neural fold;
3 – notochord; 4 – endoderm

Task 2. Write the names of the processes shown in the diagrams to the table.

	
1.	2.
	
3.	4.

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

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

A			B			C		

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

1. Participates in the feeding of the embryo; the first hematopoietic organ	A. Yolk sac
2. The outgrowth of the posterior region of the gut, participates in the formation of the placenta in mammals	B. Amnion
3. A sac with fluid that forms an aquatic environment for the embryo and fetus, protects it from drying out and injury	C. Chorion
4. External covering contacting with the mother's tissues; participates in formation of placenta	D. Allantois

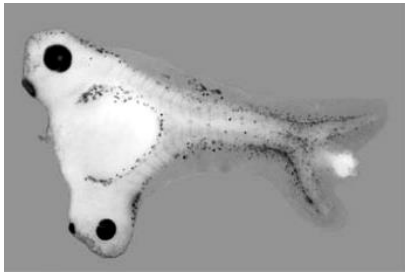
1	2	3	4

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

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?



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

CONTENTS OF THE TOPIC

1. Periods of postnatal ontogenesis.
2. Growth and development of the human body and its regulation. Acceleration.
3. Human constitution and habitus, their medical significance.
4. Critical periods of postnatal ontogenesis.
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.

GLOSSARY

1. Postnatal ontogenesis –

2. Ageing –

3. Habitus –

4. Clinical death –

5. Acceleration –

6. Resuscitation –

7. Euthanasia –

8. Biological age –

9. Gerontology –

10. Biological death –

11. Telomeres –

12. Valeology –

13. Neonate –

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

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

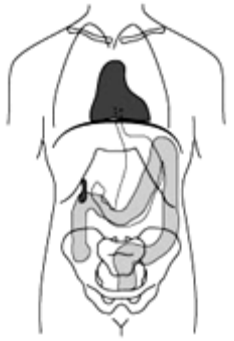
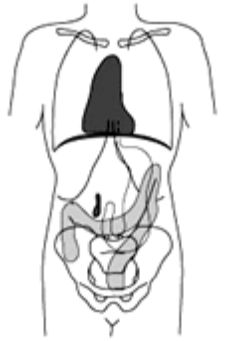
A			B			C			D		

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, translocations, chromosomal gains, losses, etc.	A. Mitochondrial Dysfunction
2. Shortening of terminal regions of chromosomes explains limited ability for division	B. Epigenetic Alterations
3. Anabolic signaling is associated with ageing	C. Telomere Attrition
4. Alterations in DNA methylation patterns, modifications of histones, chromatin remodeling	D. Altered Intercellular Communication
5. Changes in biogenesis, folding, trafficking, and degradation of proteins	E. Stem Cell Exhaustion
6. Alterations in the normal function of mitochondria	F, Genomic Instability
7. Phenomenon characterized by the cessation of cell division	G. Loss of Proteostasis
8. Decrease in the number of undifferentiated cells able to produce new specialized cells	H. Deregulated Nutrient-sensing
9. Changes in signals transmitted from cell to cell	I. Cellular Senescence

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?

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

CONTENTS OF THE TOPIC

1. Regeneration. Physiological regeneration as a mechanism for maintaining homeostasis. Classification of cells according to their regenerative ability.
2. Reparative regeneration.
3. Regulation of regeneration. Importance of regeneration for biology and medicine.
4. Regenerative medicine. Transplantation of organs and tissues, its 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.
7. Cultivation of cells and tissues outside the human body, tissue preservation. Stem cells. Cell lines in biological and medical experiments.
8. Artificial organs. Cultivation of human organs from animals and decellularization, therapeutic cloning, 3D-bioprinting.

GLOSSARY

1. Physiological regeneration –

2. Asymmetric division –

3. Stem cell –

4. Organ transplantation –

5. Organ donor –

6. Morphollaxis –

7. Epimorphosis –

8. Hypertrophy –

9. Hyperplasia –

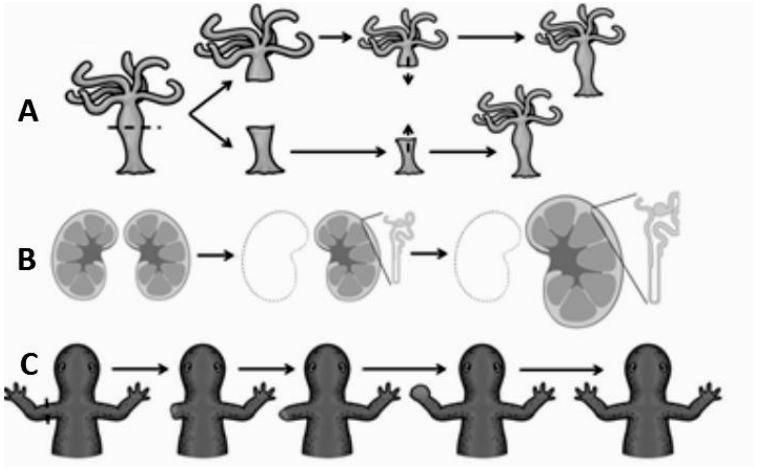
10. Orthotopic transplantation –

11. Heterotopic transplantation –

12. Tissue incompatibility –

13. Graft rejection –

Task 1. What types of regeneration are shown in the figure?



A –

B –

C –

Task 2. What is the importance of studying regeneration in species different from mammals for medicine?

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

1. Capable of differentiating into any cell type, including extraembryonic membranes	A. Totipotent
2. Capable of differentiating into any cell type, including cells from endoderm, mesoderm, or ectoderm	B. Multipotent
3. Capable of differentiating into several cell types	C. Unipotent
4. Capable of differentiating into only one cell type	D. Pluripotent

1	2	3	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	D. Isotransplantation

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?

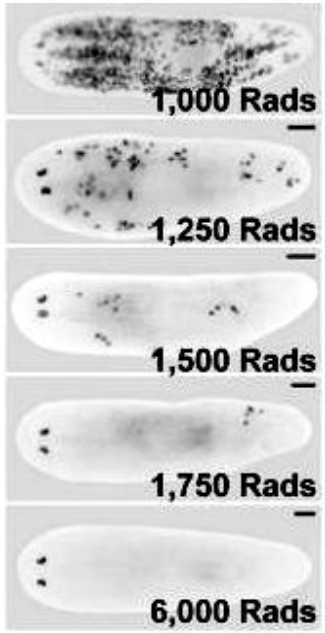


Fig. 1. Planaria that exposed to different doses of X-rays (1000–6000 rads). Neoblasts are visualized in the body of each worm, which allows estimating their number

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).

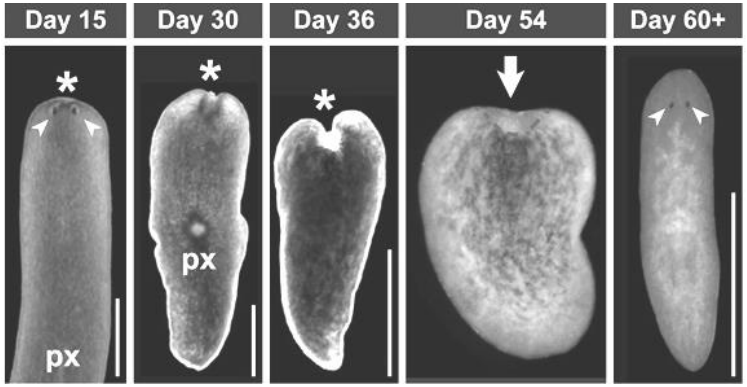


Fig. 2. Planarian exposed to a lethal dose of X-rays on days 15, 30, 36, 54, and after day 60. The asterisk marks the head end where the most intense tissue death begins, the arrow marks the blastema formed by regeneration of the lost body part, and the triangular arrows mark the eyes

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Class № 05 (23). Topic: GENERAL PARASITOLOGY

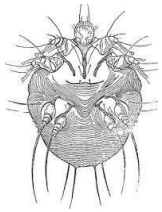
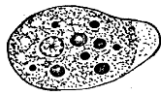
CONTENTS OF THE TOPIC

1. Parasitism. Criteria for parasitism. Medical parasitology, its goals and objectives.
2. Parasite-host system. Parasitic system.
3. Classification of parasites and their hosts.
4. Transmission routes of parasites.
5. Pathogenic action and specificity of parasites.
6. Morphophysiological and biological adaptations of parasites.
7. Response of the host organism to the introduction of parasites.
8. Classification of parasitic diseases.

GLOSSARY

1. **Symbiosis –**
2. **Parasite –**
3. **Host of a parasite –**
4. **Ectoparasite –**
5. **Temporary parasite –**
6. **Obligate parasite –**
7. **Molecular mimicry –**
8. **Definitive host –**
9. **Intermediate host –**
10. **Transmission route of a parasite –**
11. **Biological vector –**
12. **Pathogenicity**
13. **Host specificity –**

Task 1. Classify the parasites:

Parasite	Description	Based on interaction with the host:	Based on location in the host:	Based on duration of interaction with the host:
 *Sarcoptes scabiei*	Permanently resides in the outer layer of the skin. Infection occurs through direct contact with patients or their bedlinen, etc.			
 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			

Task 2. Study the life cycle of the tapeworm. Classify the hosts of this parasite according to its life cycle stage.

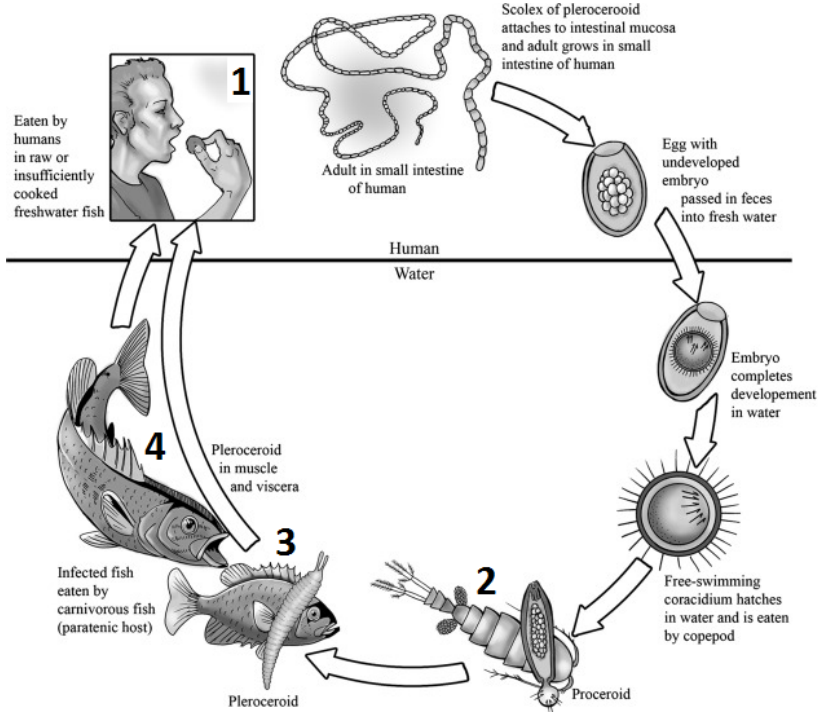
Fertilized eggs of the parasite are excreted from the **human body (1)** with feces. In the water, a larva (coracidium) hatches from the egg and is swallowed by a **freshwater crustacean (2)**.

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.



Which hosts are the organisms with the numbers?

1 –

2 –

3 –

4 –

Task 3. Match the transmission route of the parasite in the left column with its name in the right column:

1. Pathogens pass from the pregnant woman to the fetus during the period of intrauterine development	A. Contact
2. Pathogens are localized on the mucosa of the respiratory tract and pass to the susceptible organism through the air	B. Sexual
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. Vertical
4. Transmission of pathogens is mediated by blood-sucking arthropods	D. Respiratory
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
6. The pathogen is transmitted to the susceptible person during sexual intercourse	F. Iatrogenic
7. Infection occurs during medical procedures, such as blood transfusion	G. Vector-borne

1	2	3	4	5	6	7

Task 4. Fill in the table «Adaptations to parasitism».

Progressive morphological and physiological adaptations of parasites:
Regressive morphological and physiological adaptations of parasites:
Biological adaptations of parasites:

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

CONTENTS OF THE TOPIC

1. General characteristics of the kingdom Protista.
2. Life cycle of malaria pathogens (*Plasmodium spp*.). Species of plasmodia and their morphological characteristics in a thin blood smear.
3. Life cycle of plasmodia, symptoms, and diagnosis of malaria. Prevention of malaria.
4. *Toxoplasma gondii*: morphology, life cycle, routes of transmission, pathogenic action. Diagnosis and prevention of toxoplasmosis.
5. *Cryptosporidium parvum*: morphology, life cycle, routes of transmission, pathogenic action. Diagnosis and prevention of cryptosporidiosis.

GLOSSARY

1. Exoerythrocytic cycle –

2. Hypnozoites –

3. Sporozoite –

4. Merozoite –

5. Malaria –

6. Schizont –

7. Oocyst –

8. Tissue cyst –

9. Sporogony –

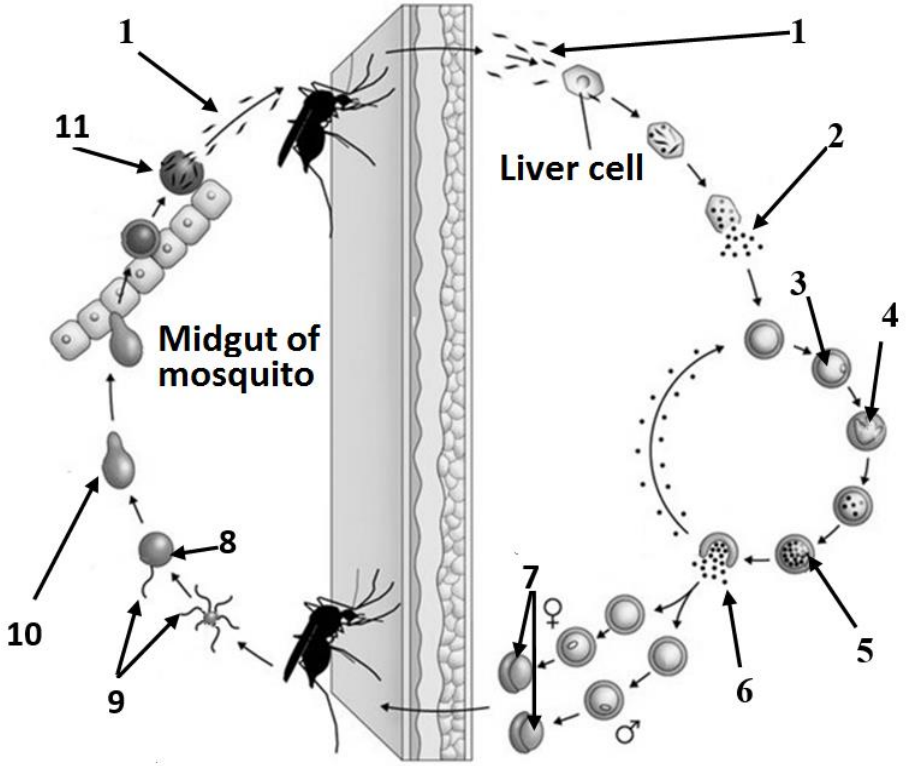
10. Congenital toxoplasmosis –

11. Cryptosporidiosis –

12. Schizogony –

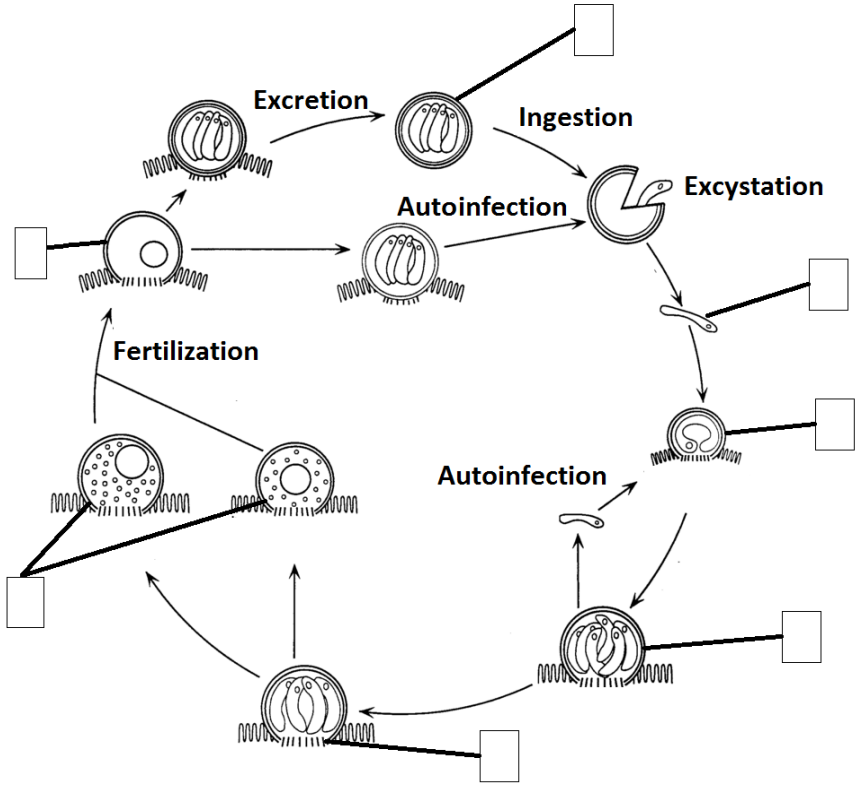
13. Biological vector –

Task 1. Label the diagram of Plasmodium life cycle.



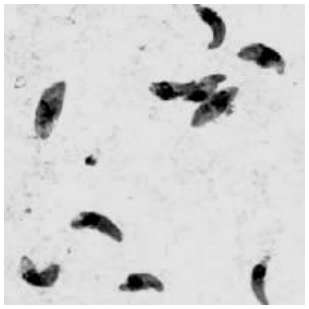
1. 7.
2. 8.
3. 9.
4. 10.
5. 11.
6.

Task 2. Label the diagram of *Cryptosporidium parvum* life cycle:

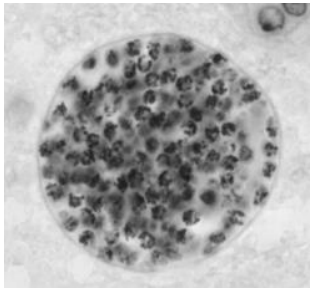


1 – oocyst; 2 – sporozoite; 3 – trophozoite; 4 – type I meront;
5 – type II meront; 6 – gametocytes; 7 – zygote

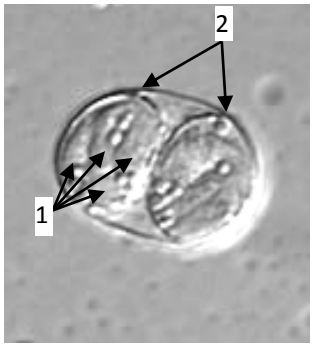
Task 3. Label the diagrams.



A



B



C

The Latin name of the parasite:

_____

A –

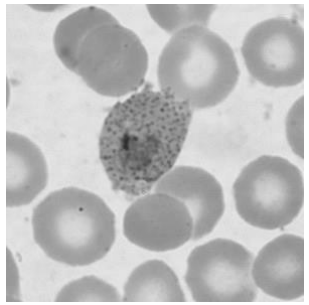
B –

C –

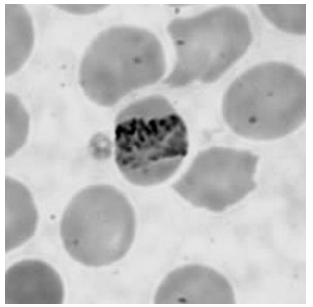
1 –

2 –

Task 4. What are the species of the parasites from the pictures?



1



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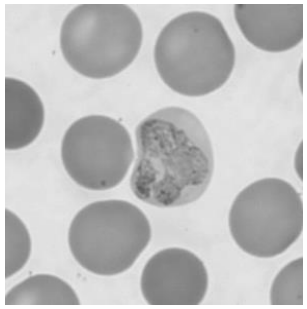

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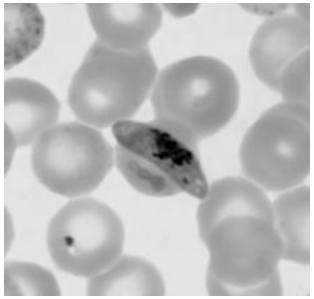

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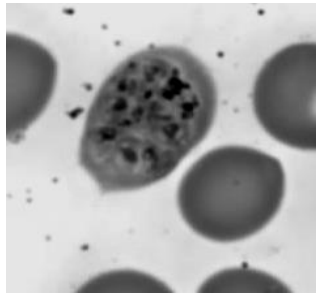

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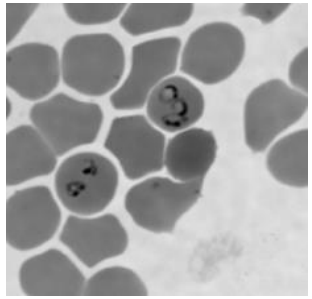

6

– Schizont of *Plasmodium ovale*

– Gametocyte of *Plasmodium falciparum*

– Trophozoite of *Plasmodium ovale*

– Band-form trophozoite *Plasmodium malariae*

– Ring-form trophozoite *Plasmodium falciparum*

– Amoeboid-form trophozoite of *Plasmodium vivax*

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 № 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 № 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 № 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?

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

CONTENTS OF THE TOPIC

1. *Entamoeba histolytica*. Morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of amebiasis.
2. Parasitic flagellates (*Leishmania spp*., *Trypanosoma brucei*, *Trypanosoma cruzi*, *Giardia duodenalis* and *Trichomonas vaginalis*): morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of the diseases caused by the parasites.
3. *Balantidium coli*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of balantidiasis.
4. Biological basis for the prevention of protozoal diseases.

GLOSSARY

1. Amoebiasis –

2. Chagas disease –

3. Visceral leishmaniasis –

4. Cutaneous leishmaniasis –

5. Pellicle –

6. Taxis –

7. African trypanosomiasis –

8. Trichomoniasis –

9. Undulating membrane –

10. Chagoma –

11. Amastigote –

12. Trypomastigote –

Task 1. Label the diagrams.

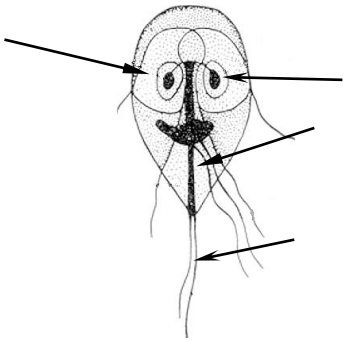

Fig. 1. Giardia duodenalis:
1 – nucleus; 2 – adhesive disk;
3 – axostyle; 4 – flagella

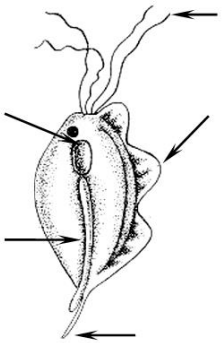

Fig. 2. Trichomonas vaginalis:
1 – nucleus; 2 – undulating membrane;
3 – flagella; 4 – axostyle; 5 – spine

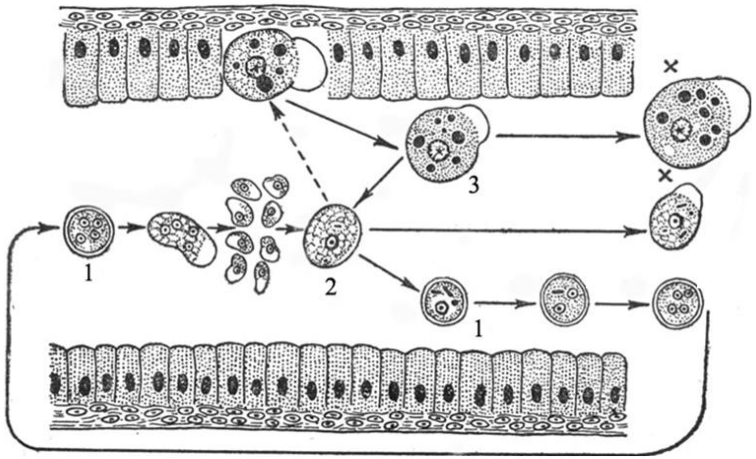

Fig. 3. The life cycle of *Entamoeba histolytica:*

1 –

2 –

3 –

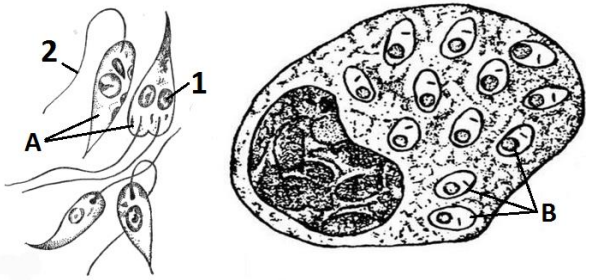

Fig. 4. Leishmania donovani:

A – 1 –

B – 2 –

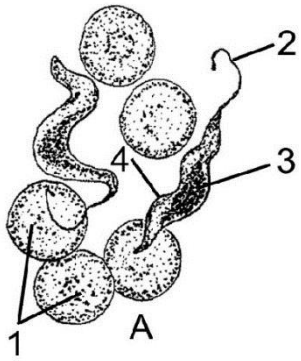

Fig. 5. Trypanosoma brucei:

1 –

2 –

3 –

4 –

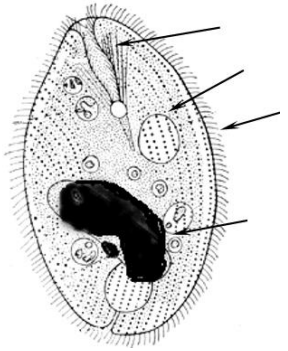

Fig. 6. Balantidium coli:
1 – cytostome; 2 – cilia; 3 – macronucleus;
4 – contractile vacuole

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 № 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 μm in size. What disease is confirmed by microscopy? What protists were found in the smear?

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 № 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 μm in size were found in stool specimens. What disease should be supposed?

Case № 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 № 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

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

CONTENTS OF THE TOPIC

1. General characteristic and classification of trematodes.
2. Characteristics of the class Trematoda. Features of the life cycle of trematodes.
3. *Fasciola hepatica*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of fascioliasis.
4. *Opisthorchis felineus*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of opisthorchiasis.
5. *Paragonimus westermani*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of paragonimiasis.
6. *Schistosoma spp.*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of schistosomiasis.
7. Cercarial dermatitis.
8. Biological basis for the prevention of the diseases caused by flukes.

GLOSSARY

1. Swimmer's itch –

2. Sporocyst –

3. Cercaria –

4. Fascioliasis –

5. Paragonimiasis–

6. Metacercaria –

7. Miracidium –

8. Gynecophoral canal –

9. Urogenital schistosomiasis –

10. Intestinal schistosomiasis –

11. Redia –

12. Tegument –

Task 1. Label the diagrams.

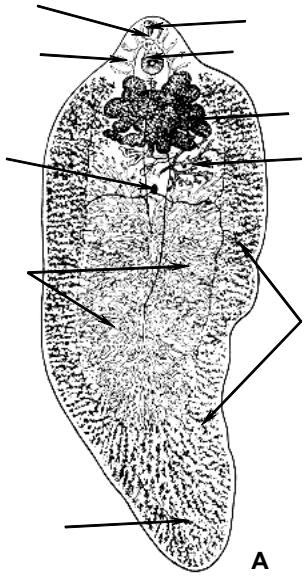


Fig. 1. Fasciola hepatica:
1 – oral sucker;
2 – ventral sucker;
3 – oesophagus;
4 – intestine;
5 – vitelline glands;
6 – uterus;
7 – ootype;
8 – ovary;
9 – testes;
10 – excretory duct

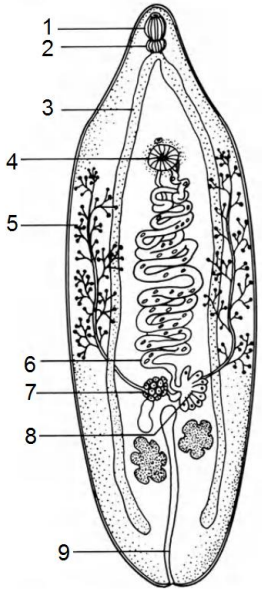
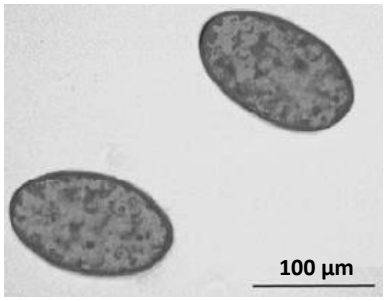
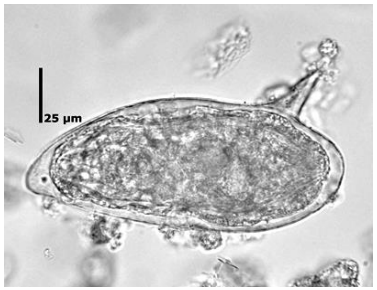


Fig. 2. Opisthorchis felineus:
1 –
2 –
3 –
4 –
5 –
6 –
7 –
8 –
9 –

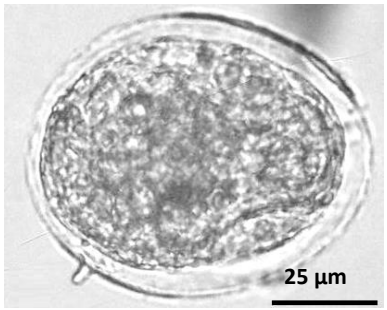
Task 2. Identify the parasites by their eggs:



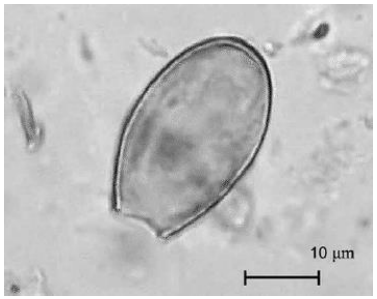
A



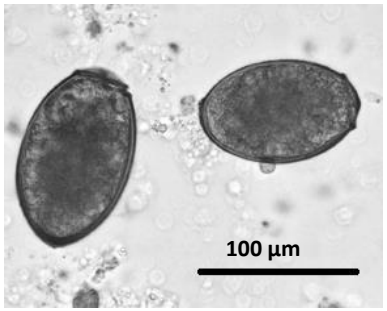
B



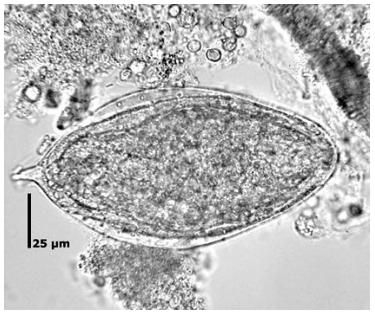
C



D



E



F

A –
B –
C –

D–
E –
F –

Task 3. Make a diagnosis in the following cases.

Case № 1. A patient with symptoms of pneumonia was examined for the presence of helminth eggs in his feces. Large (60 × 100 μm) oval yellow-brown eggs with a lid on one pole were found. Identify the parasite.

Case № 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 № 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 × 70 μm in length with a lateral spine. 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 № 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 № 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?

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

CONTENTS OF THE TOPIC

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 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.
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 transmission, pathogenic action. Symptoms, diagnosis, and prevention of diphyllobothriasis.
7. Biological basis for the prevention of the diseases caused by tapeworms.

GLOSSARY

1. **Bothria –**
2. **Scolex –**
3. **Proglottid –**
4. **Strobila –**
5. **Microtriches –**
6. **Procercoid –**
7. **Coracidium –**
8. **Oncosphere –**
9. **Hydatid cyst –**
10. **Cysticercosis –**

Task 1. Label the diagrams.

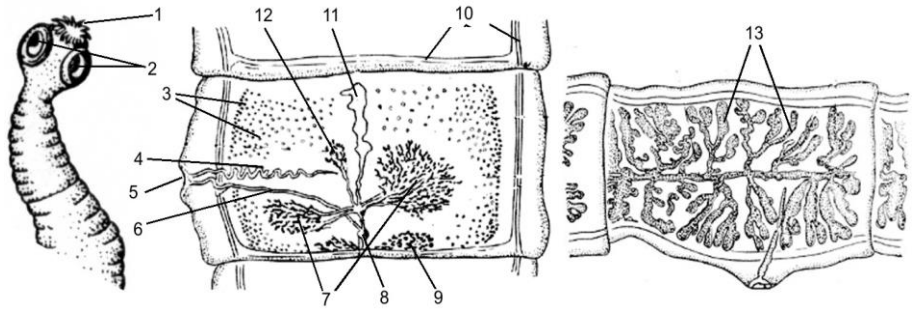


Fig. 1. Scolex, mature and gravid proglottids *Taenia solium:*

1 –
2 –
3 –
4 –
5 –
6 –
7 –
8 –
9 –
10 –
11, 13 –
12 –

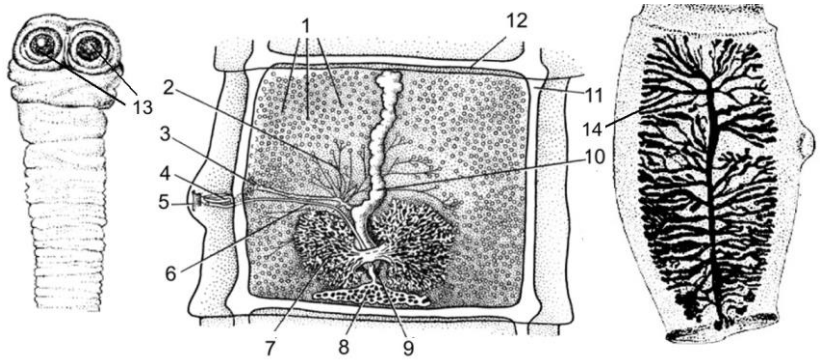


Fig. 2. Scolex, mature and gravid proglottids *Taenia saginata:*

1 –
2, 3 –
4 –
5 –
6 –
7 –
8 –
9 –
10, 14 –
11, 12 –
13 –

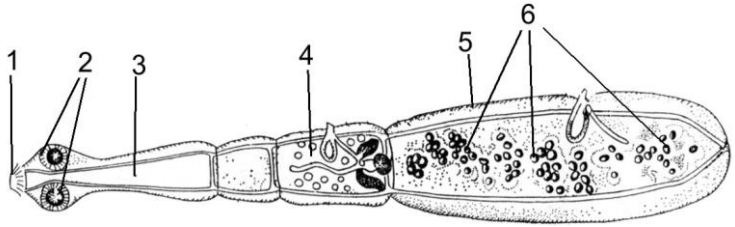


Fig. 3. Echinococcus granulosus:

1 –
2 –
3 –
4 –
5 –
6 –

Fig. 4. Hymenolepis nana :
1 – scolex; 2 – strobila

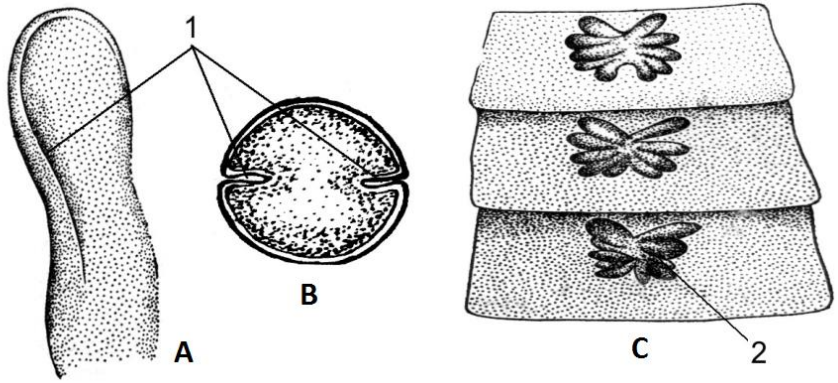
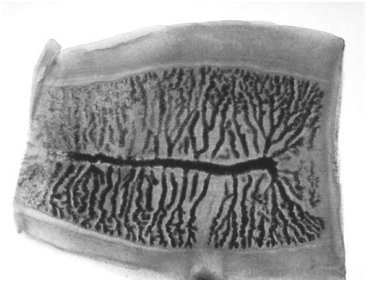


Fig. 5. Diphyllobothrium latum:
A – scolex; B – cross section of the scolex; B – proglottids;

1 –
2 –

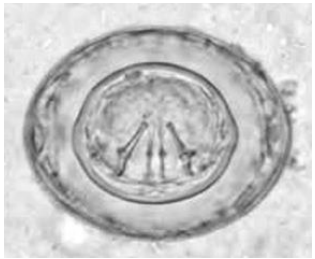
Make a diagnosis in the following cases.

Case № 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?

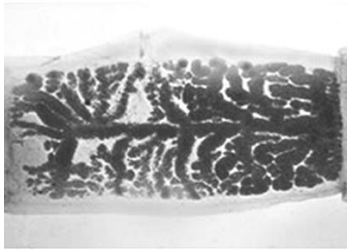


Case № 2. A 45-year-old patient was admitted to a neurological department of a hospital complaining of frequent headaches and seizures. 5 years ago the patient had taeniasis. What parasitic disease can be supposed?

Case № 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?

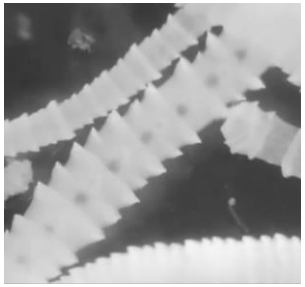


Case № 4. Proglottids of a tapeworm were delivered to the laboratory. Microscopy reveals 7 to 12 lateral branches of the uterus on each side. Identify the parasite.



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?



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

CONTENTS OF THE TOPIC

1. General characteristics of nematodes. Features of the life cycles of nematodes.
2. *Ascaris lumbricoides*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of ascariasis.
3. *Trichuris trichiura*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of trichuriasis.
4. *Enterobius vermicularis*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of enterobiasis.
5. *Toxocara canis*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of toxocariasis.
6. *Strongyloides stercoralis*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of ancylostomiasis.
7. *Ancylostoma duodenale* and *Necator americanus*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of strongyloidiasis.
8. Biological basis for the prevention of diseases caused by nematodes.

GLOSSARY

1. Esophageal bulb –

2. Cephalic alae –

3. Buccal capsule –

4. Geohelminths –

5. Molting –

6. Filariform larva –

7. Rabditiform larva –

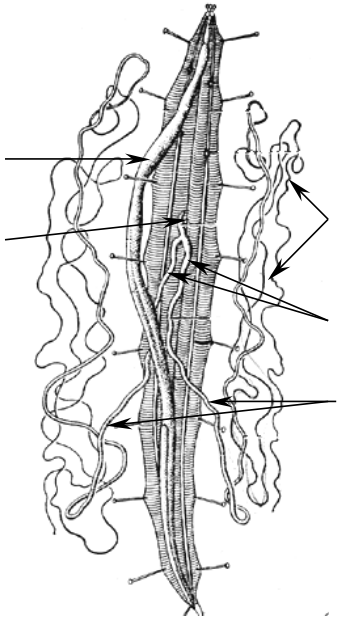
8. Enterobiasis –

9. Larva migrans –

10. Autoinfection –

Task 1. Label the diagrams.

Fig. 1. Dissected *Ascaris lumbricoides:*
1 – ovaries;
2 – oviducts;
3 – uteri;
4 – vagina;
5 – intestine



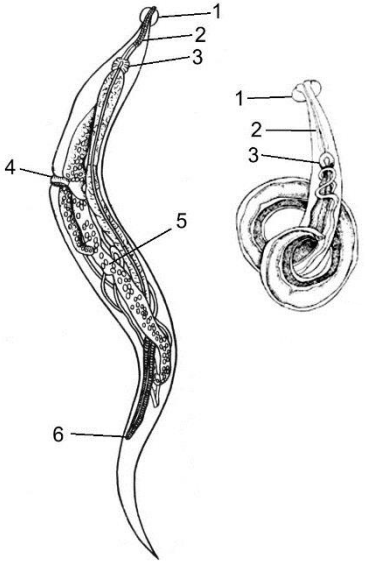
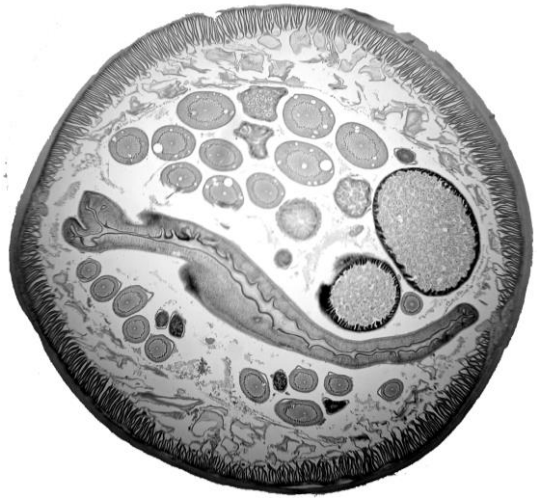


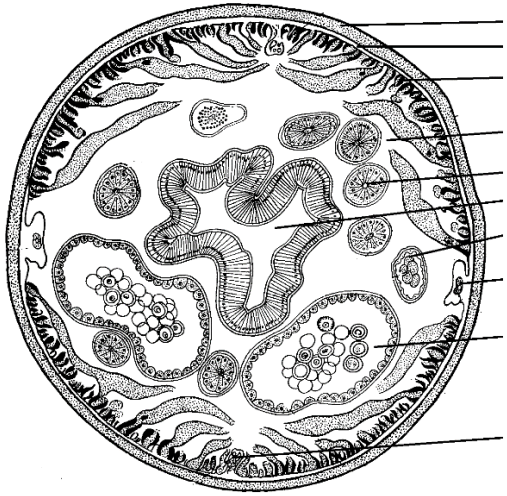
Fig. 2. Female and male *Enterobius vermicularis:*

1 –
2 –
3 –
4 –
5 –
6 –

Fig. 3. Female (A) and male (B) *Trichuris trichiura*:
1 –



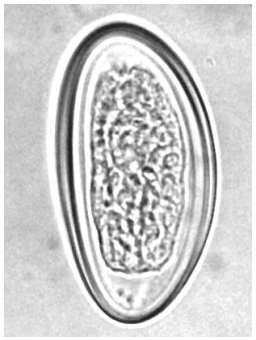
A



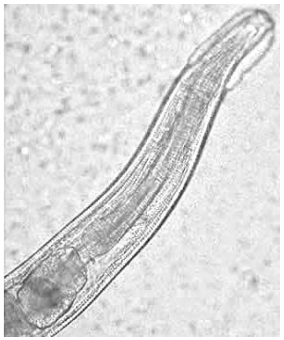
B

Fig. 4. Cross-section of *Ascaris lumbricoides:*
A – photograph; B – diagram;
1 – cuticle; 2 – hypodermis; 3 – muscle cells; 4 – body cavity;
5 – canal of the excretory system; 6 – nerves; 7 – lumen of the intestine;
8 – ovary; 9 – oviduct; 10 – uterus

Task 2. Identify the parasites and write their Latin names.



1. _____



2. _____

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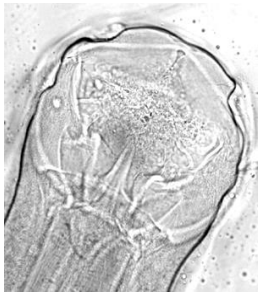
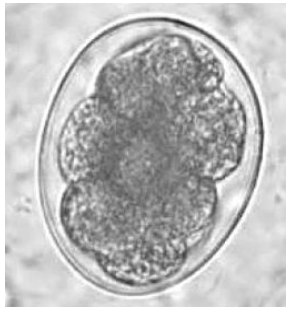
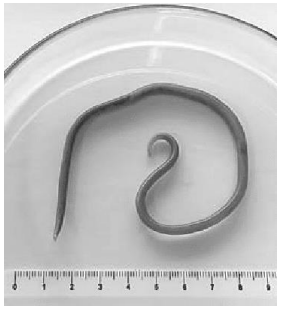


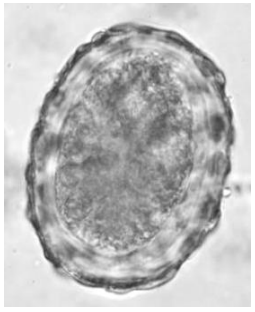
6. _____



7. _____



8. _____



9. _____

Task 3. Make a diagnosis in the following cases.

Case № 1. A 40-year-old man with symptoms of intestinal obstruction was hospitalized. During surgery, 9 white-pink worms, 22–38 cm long were found in the intestine. Identify the parasite.

Case № 2. A patient was admitted to the hospital complaining of epigastric pain, loss of appetite, and nausea. Laboratory examination revealed anemia, stool smear showed lemon-shaped eggs with plugs at the poles. The size of the eggs is about 50 μm. What disease can be suspected?

Case № 3. A woman found white helminths in the pants of her child and delivered them to the laboratory. The helminths are up to 1 cm long. Identify the parasite.

Case № 4. During the regular medical examination of kindergarten staff, eggs were found in stool samples of one of the kindergarteners. The eggs were 50–60 × 26–30 μm in size, colorless, oval, and slightly flattened on one side. What disease should be supposed?

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

CONTENTS OF THE TOPIC

1. T*richinella spiralis*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of trichinellosis.
2. *Dirofilaria spp*.: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of dirofilariasis.
3. *Dracunculus medinensis*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of dracunculiasis.
4. Filaria: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of filariasis.
5. Biological basis for the prevention of diseases caused by nematodes.

GLOSSARY

1. **Muscle biopsy –**
2. **Dracunculiasis –**
3. **River blindness –**
4. **Filariform larva –**
5. **Microfilaria –**
6. **Onchocercoma –**
7. **Trichinellosis –**
8. **Filariasis –**
9. **Elephantiasis –**

Task 1. Label the diagrams.

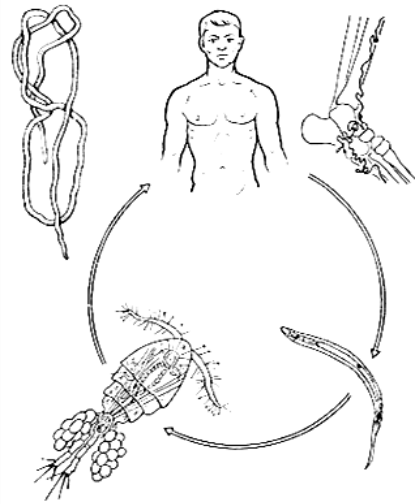


Fig. 1. The life cycle of *D. medinensis:*
1 – female worm;
2 – definitive host;
3 – D. medinensis in subcutaneous tissue;
4 – larva;
5 – intermediate host

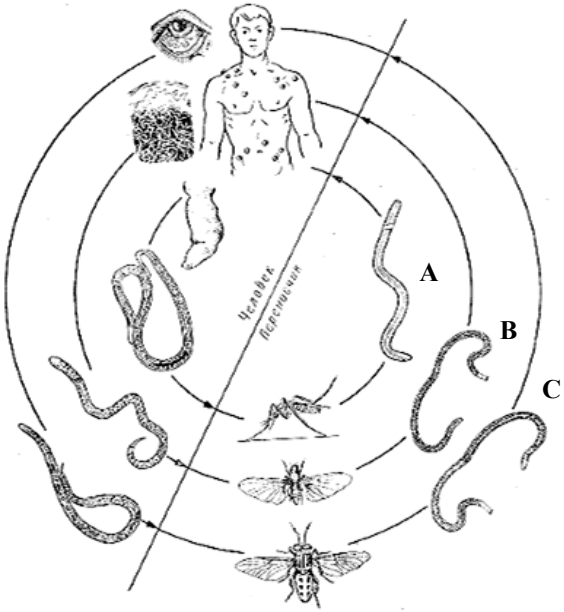
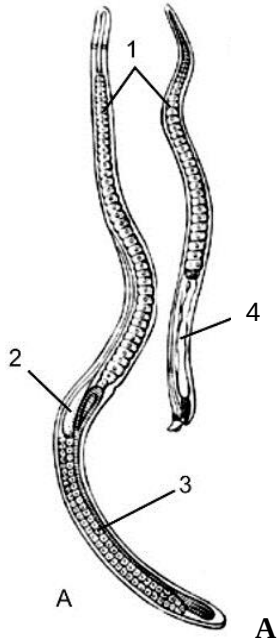


Fig. 2. The life cycle of filaria (write their Latin names):

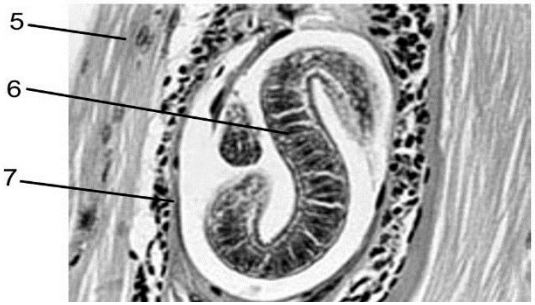
A –

B –

C –



A



B

Fig. 3. Trichinella spiralis:
A – adult worms; *B* – encapsulated larvae;

1 –

2 –

3 –

4 –

5 –

6 –

7 –

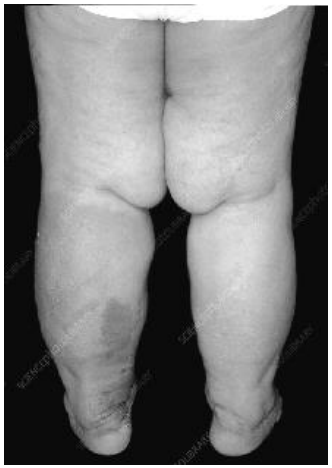
Task 2. Make a diagnosis in the following cases.

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 № 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 № 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 № 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?



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

CONTENTS OF THE TOPIC

1. General characteristics and systematics of the phylum Arthropoda.
2. General characteristics and taxonomy of the class Arachnida.
3. Ticks of the genera *Ixodidae*, *Argasidae,* and *Gamasidae* as vectors of human pathogens. Peculiarities of morphology, biology, mechanism of pathogen transmission of ticks.
4. Mites of the genera *Sarcoptidae*, *Tyrogliphidae,* and *Demodecidae* as human pathogens. Peculiarities of morphology, biology, and pathogenic action of mites.
5. Doctrine of E. N. Pavlovsky of natural focality of parasitic diseases. Characteristics of natural foci.

GLOSSARY

1. **Vector-borne disease –**
2. **Natural focal disease –**
3. **Scutum –**
4. **Capitulum –**
5. **Nymph –**
6. **Imago –**
7. **Mite –**
8. **Demodicosis –**
9. **Biological vector –**
10. **Tick-borne encephalitis –**
11. **Scabies –**

Task 1. Label the diagrams.

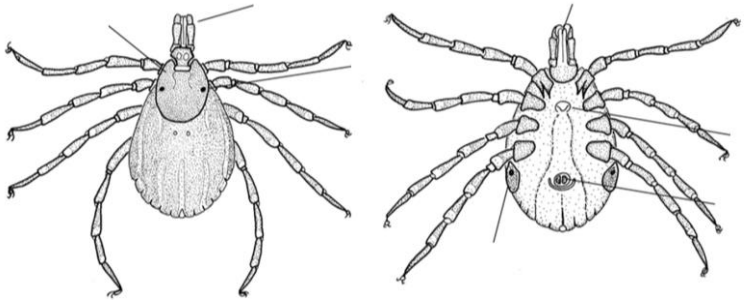


Fig. 1. Morphology of a female tick of the family *Ixodidae*:

1 – capitulum
2 – anus
3 – spiracle
4 – scutum
5 – eye
6 – genital opening

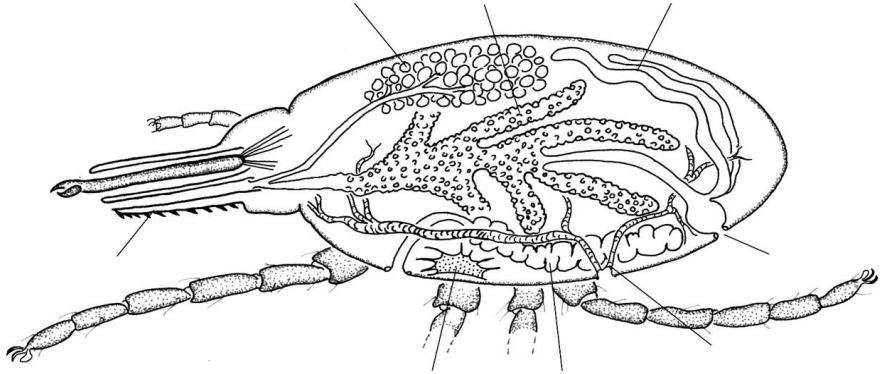
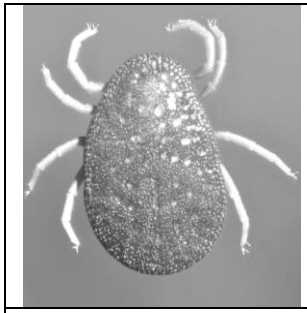
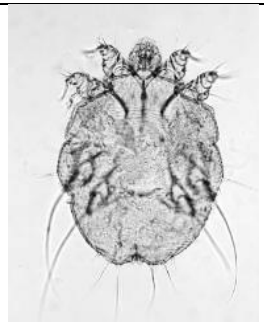
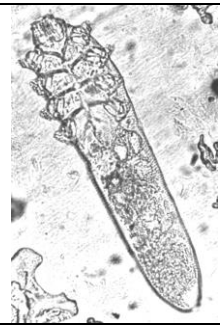


Fig. 2. Anatomy of a tick of the family *Ixodidae*

1 – salivary gland
2 – Malpighian tubule
3 – trachea
4 – capitulum
5 – synganglion of the nervous system
6 – anus
7 – gonad
8 – midgut

Task 2. Identify the parasites and write their Latin names in the table.

		
Species:	Genus:	Species:
		
Genus:	Species:	Species:

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 № 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 № 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 № 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.

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

CONTENTS OF THE TOPIC

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.
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.
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.

GLOSSARY

1. Mechanical vector –

2. Insecticide –

3. Pediculosis –

4. Pthiriasis –

5. Chagas disease –

6. Tungiasis –

7. Incomplete metamorphosis –

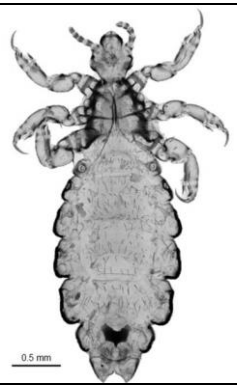
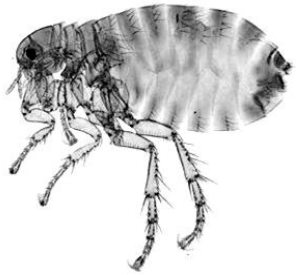
8. Complete metamorphosis –

9. Chitin –

10. Molting –

11. Piercing and sucking insects –

Task 1. Identify the parasite and write its Latin name in the table.

Task 2. Label the diagrams.

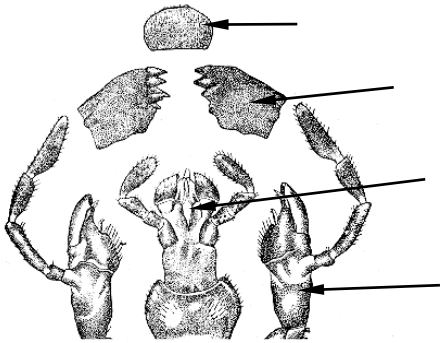


Fig. 1. Mouthparts of *Blattella germanica:*
1 – upper lip; 2 – upper jaw; 3 – lower lip; 4 – lower jaw

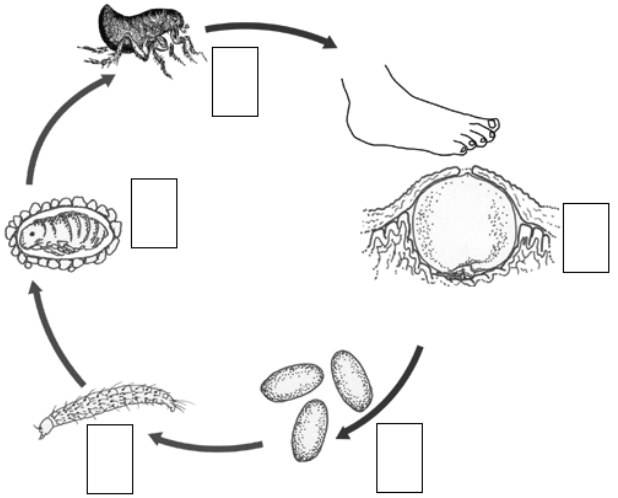
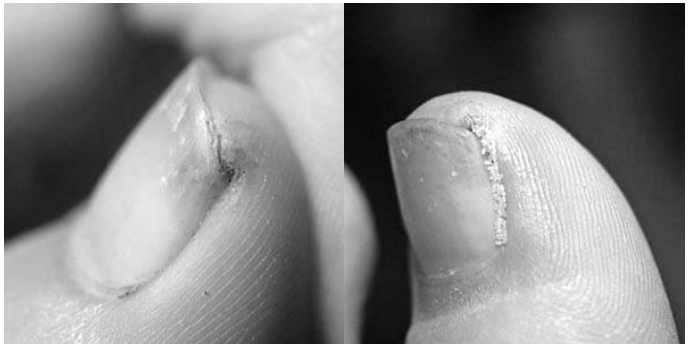


Fig. 2. Life cycle of the *Tunga penetrans:*
1 – eggs; 2 – adult; 3 – larva; 4 – pupa; 5 – female in the skin.

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 № 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 № 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 № 4. A student living in a rented room complains of insects biting him at night. On examining his bed, he found oval, flattened, dorsoventrally 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 transmit?

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

CONTENTS OF THE TOPIC

1. Peculiarities of morphology and biology of the insects of the order Diptera.
2. Gnat: blackflies (*Simuliidae*), biting midges (*Ceratopogonidae*), sand flies (*Phlebotominae*), and horse-flies (*Tabanidae*).
3. Mosquitoes of genera *Culex*, *Anopheles* and *Aedes*: morphological and biological peculiarities and the medical significance.
4. Flies: house fly (*Musca domestica*), stable fly (*Stomoxys calcitrans*), tsetse fly (*Glossina palpalis*), spotted flesh fly (*Wohlfahrtia magnifica*), their morphology, biology, and the medical significance.
5. Botflies (*Oestridae*): morphology, biology, and the medical significance.
6. Control of dipterans and prevention of diseases they transmit and cause.

GLOSSARY

1. Diptera –

2. Gnat –

3. Myiasis –

4. Sandfly –

5. Repellents –

6. Chrysalis –

7. Insecticides –

8. Biological vector –

9. Botfly –

10. Blackfly –

11. Sleeping sickness –

Task 1. Label the diagrams.

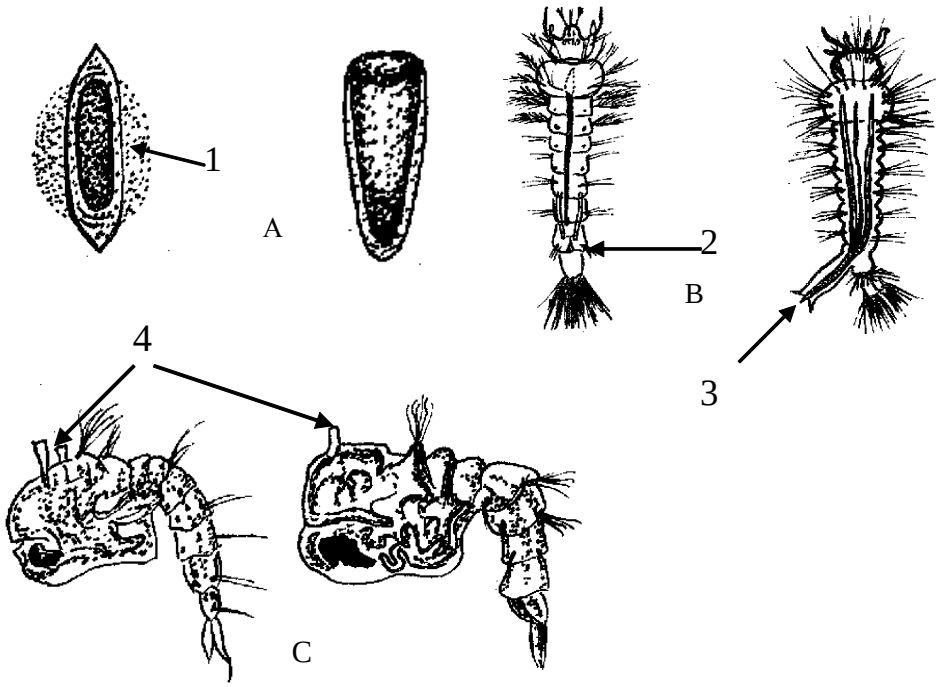


Fig. 1. Mosquitoes of the genera *Anopheles* (left) and *Culex* (right):

A –

B –

C –

1 –

2 –

3 –

4 –

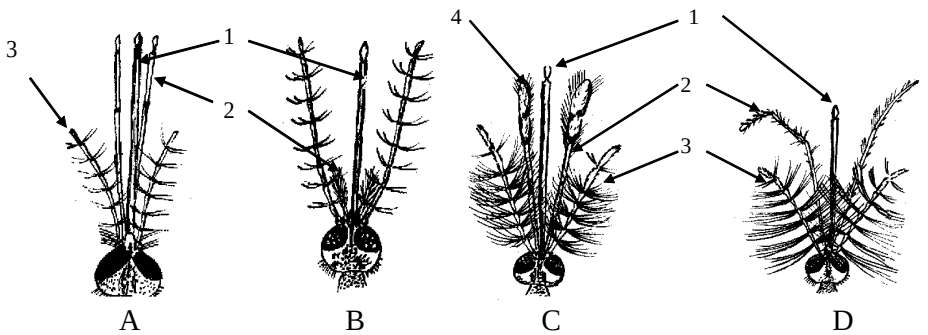
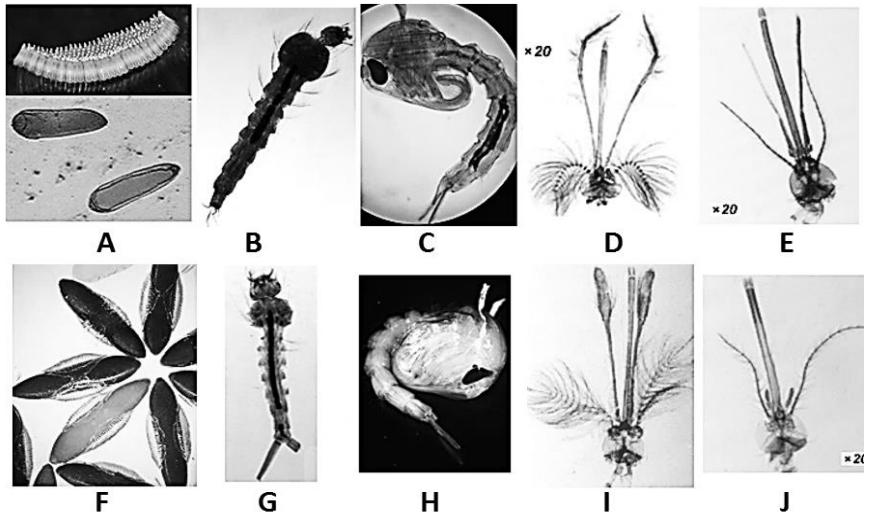


Fig. 2. Female mosquitoes of the genera Anopheles (A) and Culex (B); male mosquitoes of the genera Anopheles (C) and Culex (D):
1 – proboscis; 2 – palps; 3 – antennae; 4 – club-like thickenings of palps

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.



Genera	Answers
Anopheles	
Culex/Aedes	

Task 4. Make a diagnosis in the following cases.

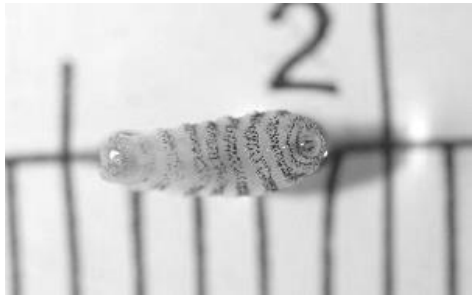
Case № 1. What insects of the order *Diptera* are the intermediate hosts and biological vectors of *Loa loa*? What is their taxonomy?

Case № 2. An outbreak of bacterial dysentery was registered in a village in theMinsk region in the summer. What insects of the order *Diptera* 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 № 4. What filaria can be transmitted by the mosquitoes of the genera Culex and Aedes?

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?



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Class № 15 (33). Topic: COLLOQUIUM № 3

MICROPREPARATIONS

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

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

CONTENTS

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

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 enterobiasis. 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 ancylostomiasis. 34. *Ancylostoma duodenale* and *Necator americanus*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of strongyloidiasis. 35. Biological basis for the prevention of diseases caused by nematodes. 36. T*richinella spiralis*: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of trichinellosis. 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 dracunculiasis. 39. Filaria: morphology, life cycle, routes of transmission, pathogenic action. Symptoms, diagnosis, and prevention of filariasis. 40. Biological basis for the prevention of diseases caused by nematodes. 41. General characteristics and systematics of the phylum Arthropoda. 42. General characteristics and taxonomy of the class Arachnida. 43. Ticks of the genera *Ixodidae*, *Argasidae,* and *Gamasidae* as vectors of human pathogens. Peculiarities of morphology, biology, mechanism of pathogen transmission of ticks.	44. Mites of the genera *Sarcoptidae*, *Tyrogliphidae,* and *Demodecidae* as human pathogens. Peculiarities of morphology, biology, and pathogenic action of mites. 45. Doctrine of E. N. Pavlovsky of natural focality of parasitic diseases. Characteristics of natural foci. 46. General characteristics and taxonomy of the class Insecta. 47. Lice. Morphology and biology of lice. Lice are pathogens and vectors of human diseases. Control of lice. 48. Fleas. Morphology and biology of fleas. Medical significance of fleas. Control of fleas. 49. Cockroaches. Morphology and biology of cockroaches. Medical significance of fleas. Control of cockroaches. 50. Bedbugs. Morphology and biology of bedbugs. Medical significance of fleas. Control of bedbugs. 51. Control of arthropods. Prevention of diseases caused and transmitted by arthropods. 52. Peculiarities of morphology and biology of the insects of the order Diptera. 53. Gnat: blackflies (*Simuliidae*), biting midges (*Ceratopogonidae*), sand flies (*Phlebotominae*), and horse-flies (*Tabanidae*). 54. Mosquitoes of genera *Culex*, *Anopheles* and *Aedes*: morphological and biological peculiarities and the medical significance. 55. Flies: house fly (*Musca domestica*), stable fly (*Stomoxys calcitrans*), tsetse fly (*Glossina palpalis*), spotted flesh fly (*Wohlfahrtia magnifica*), their morphology, biology, and the medical significance. 56. Botflies (*Oestridae*): morphology, biology, and the medical significance. 57. Control of dipterans and prevention of diseases they transmit and cause.

Class № 17 (35). Topic: POISONOUS AND VENOMOUS ORGANISMS

CONTENTS OF THE TOPIC

1. Poisonousness and venomousness as a universal phenomenon in living nature. Toxins, poisons and venoms.
2. Classification of poisonous and venomous animals.
3. Physiological characteristics of toxins produced by invertebrates (jellyfishes, spiders, hymenopterans). First aid and prevention of bites and poisoning.
4. Physiological characteristics of toxins produced by vertebrates (fishes, amphibians, reptiles). First aid and prevention of bites and poisoning.

GLOSSARY

1. Toxin –

2. Poison –

3. Venom –

4. Primarily-toxic animals –

5. Secondarily-toxic animals –

6. Actively-venomous animals –

7. Actively-poisonous animals –

8. Passively-poisonous animals –

9. Neurotoxins –

10. Cytotoxins –

11. Hemorrhagins –

12. Hemolysins –

Task 1. Match the type of toxins in the left column with their effects in the right column.

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

1	2	3	4

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

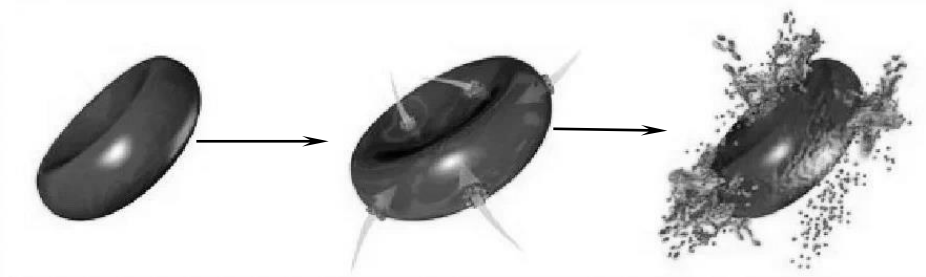
Actively-venomous	Actively-poisonous	Passively-poisonous

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

1. Columbian cocoa frog	A. Remove parts of tentacles and striking threads or sting from the skin, treat the affected sites with alcohol or solution of soda, symptomatic treatment
2. Karakurt	
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 water, symptomatic treatment
6. Bee	

1	2	3	4	5	6

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



Task 5. Label the diagrams:

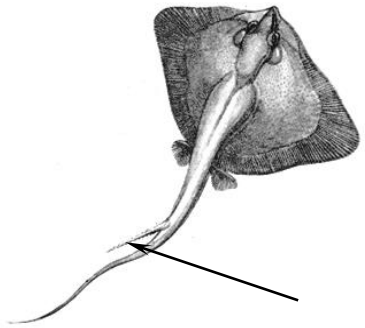


Fig. 1. Sting ray*:*
1 — stinger

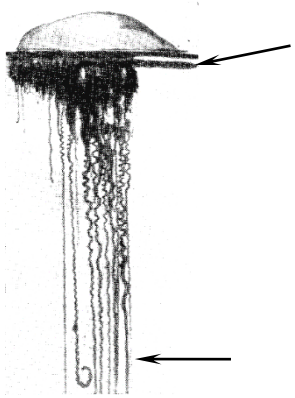


Fig. 2. Portuguese man-of-war:
1 — bell; 2 — tentacles

Fig. 3. Tarantula:
1 — chelicerae; 2 — pedipalps

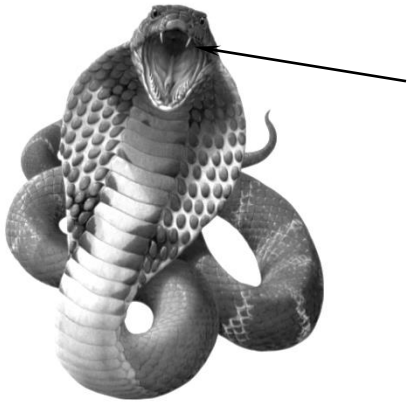


Fig. 4. Indian cobra:
1 — fangs

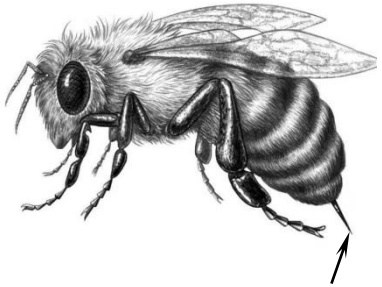


Fig. 5. Honey bee:
1 — sting

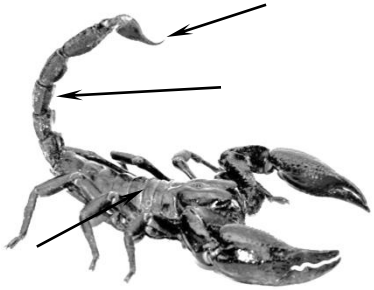


Fig. 6. Scorpion:
1 — cephalothorax, 2 — abdomen,
3 — sting

Teacher's signature
«____»_____20____

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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»

3-е издание

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

Подписано в печать 16.04.24. Формат 60×84/8. Бумага писчая «Снегурочка». Ризография. Гарнитура «Times».
Усл. печ. л. 13,02. Уч.-изд. л. 5,12. Тираж 180 экз. Заказ 179.

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.