

V.E. BUTVILOVSKY, V.V. GRIGOROVICH, V.V. DAVYDOV

# **MEDICAL BIOLOGY**

**METHODOLOGICAL RECOMMENDATIONS  
FOR STUDENTS  
STUDYING IN THE SPECIALITY «GENERAL MEDICINE»**

Minsk BSMU 2018

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ  
БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ  
КАФЕДРА БИОЛОГИИ

В.Э. Бутвиловский, В.В. Григорович, В.В. Давыдов

**МЕДИЦИНСКАЯ БИОЛОГИЯ  
МЕТОДИЧЕСКИЕ РЕКОМЕНДАЦИИ ДЛЯ СТУДЕНТОВ,  
ОБУЧАЮЩИХСЯ ПО СПЕЦИАЛЬНОСТИ «ЛЕЧЕБНОЕ ДЕЛО»**

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Минск БГМУ 2018

УДК 57 (075.8)–054.6  
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**Б 93**

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**В. Э. Бутвиловский, В. В. Григорович, В. В. Давыдов**

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## **MEDICAL BIOLOGY**

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Минск БГМУ 2018

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## **CRITERIA FOR ACADEMIC PROGRESS ASSESSMENT OF STUDENTS IN THE BELARUSIAN STATE MEDICAL UNIVERSITY**

### **10 (ten), passed:**

- comprehended, profound and full knowledge in 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, ability of efficient use of them for setting objectives and solving scientific and professional cases;
- remarkable ability for individual creative solution of problems in unconventional situations;
- 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 at practical and laboratory classes, active and creative participation in group discussions, high cultural level of solutions to questions.

### **9 (nine), passed:**

- comprehended, profound and full knowledge in 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;
- ability for individual creative solution of 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 at practical and laboratory classes, active and creative participation in group discussions, high cultural level of solutions to questions.

### **8 (eight), passed:**

- comprehended, profound and full knowledge in 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;
- ability for 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 at practical and laboratory classes, regular and active participation in group discussions, high cultural level of solutions to questions.

**7 (seven), passed:**

- comprehended, profound and full knowledge in 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;
- ability for 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 at practical and laboratory classes, participation in group discussions, high cultural level of solutions to questions.

**6 (six), passed:**

- full knowledge in 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;
- ability for 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 at practical and laboratory classes, periodic participation in group discussions, high cultural level of solutions to questions.

**5 (five), passed:**

- enough knowledge in the material of 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;
- ability for 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 at 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 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 commands of a lecturer, acceptable cultural level of solutions to questions.

**3 (three), not passed:**

- not enough knowledge in the material of educational program 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 of 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 at practical and laboratory classes un, low cultural level of solutions to questions.

**2 (two), not passed:**

- very low knowledge in the material of educational program 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 at practical and laboratory classes un, 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.

**CRITERIA OF KNOWLEDGE ASSESSMENT FOR COMPUTER TESTS**

<b>Points</b>	<b>Grade</b>	<b>Points</b>	<b>Grade</b>
96–100	— «10»	53–62	— «5»
91–95	— «9»	44–52	— «4»
83–90	— «8»	33–43	— «3»
73–82	— «7»	20–32	— «2»
63–72	— «6»	0–19	— «1»

**CRITERIA OF KNOWLEDGE ASSESSMENT FOR WRITTEN TESTS**

<b>Points</b>	<b>Grade</b>	<b>Points</b>	<b>Grade</b>
94–100	— «10»	49–55	— «5»
83–93	— «9»	42–48	— «4»
73–82	— «8»	26–41	— «3»
63–72	— «7»	11–25	— «2»
56–62	— «6»	0–10	— «1»

**Class 1. THE ROLE OF BIOLOGY IN MEDICAL EDUCATION.  
METHODS USED TO INVESTIGATE CELLS**

**Purpose of the practice:** to learn the role of Biology in medical education, peculiarities of human being as a biological and social object; to learn basic methods used for cell investigation.

**CONTENTS OF THE TOPIC**

1. Human being as a biological and social object.
2. Role of Biology in medical education. Significance of Biology for pharmaceutical education.
3. Subject matter, tasks and methods of cytology.
4. Light microscopy.

**BASIC TERMS AND CONCEPTS**

**Isotopic labeling (autoradiography)** — technique based on tracking the passage of a substance labeled with an isotope.

**Life** — functioning of open systems which decrease the internal entropy and are based on work of DNA and proteins.

**Cell** — a membrane-bound structure which is the least structural and functional unit of living matter.

**X-ray crystallography** — a technique used for determining the molecular structure of a crystal based on diffraction of X-rays.

**Microsurgery of cells** — a technique allowing to remove and transplant organelles of the cell.

**Metabolism** — complex of chemical transformations sustaining the life of an organism.

**Taxonomy of Homo sapiens** — position of human being in biological classification: phylum Chordates, subphylum Vertebrates, class Mammals, subclass Placentals, order Primates, suborder Anthropoids, family of Hominids, genus Homo, species Homo sapiens.

**Cytology** — science that deals with structure and functioning of cells.

### **Directions for use of a microscope (low-powered magnification (7 x 8))**

1. Put the microscope on a table (at the distance approximately equal to palm width from the edge of the table). Column should be directed towards you and the mirror towards the light source.

2. Turn the coarse adjustment knob to set the objective lens to the level 2–3 cm above the surface of the stage.

3. Turn and set the objective lens with low magnification (8×) towards the aperture of the stage. It should click when fixed properly.

4. Put the condenser to the middle position and open the diaphragm completely.

5. Look at the ocular lens and turn mirror surface to the light source for even illumination of the field of vision.

6. Put a micropreparation on the stage. Its side with the cover glass should be directed towards the objective lens.

7. Look at the stage, but not at the ocular lens, and lower the objective lens (turning the coarse adjustment knob) to the level 0.5 cm above the surface of the micropreparation.

8. Start looking at the ocular lens and turn coarse adjustment knob slowly until clear image of the object appears (the focal distance of the 8× objective lens is ~1 cm).

9. Study the object. Move the micropreparation manually.

#### **Notes:**

The cover glass is sometimes dirty with dust and fingerprints. It is recommended to clean it with a tissue before using.

The focal distance of the 8× objective lens is approximately 1 cm. If you have lost the image and pass this distance, then you have to repeat steps 7 and 8.

If the object is too small and is not seen at low magnification, then adjust the microscope to the edge of the cover glass. Having obtained a clear image of the glass surface, move it and search for the object.

### **Directions for work with a high-powered magnification (7 x 40)**

1. Move the area of the micropreparation you need to see with high magnification to the center of the field of vision.
2. Turn and set the objective lens with high magnification (40×) instead of the current lens. It should click when fixed properly.
3. Put the condenser to the upper position to increase illumination. Look at the stage, but not at the ocular lens and carefully lower the objective lens (with coarse adjustment knob) until it touches the surface of the cover glass.
4. Looking at the ocular lens and slightly turn the coarse adjustment knob until object's outlines appear (the focal distance of 40× objective is approximately 1–2 mm).
5. Use the fine adjustment knob for getting better image.
6. Study the needed area of the micropreparation.

#### **Notes:**

The focal distance of the 8× objective lens is approximately 0,1–0,2 cm, so turn the fine adjustment knob slowly. If you need to focus once more than:

Look at the stage, but not at the ocular lens and carefully lower the objective lens (with coarse adjustment knob) until it touches the surface of the cover glass, repeat steps 4–6.

If the contrast of the object is low, then cover the diaphragm or lower the condenser.

### **Directions for work with oil-immersion objective LENS (7 x 90)**

1. Move the area which should be magnified to the center of the vision field. Increase the volume of light: the concave surface of the mirror should be used and the condenser should be in upper position.
2. Turn and set the objective lens into free (not fixed) position.
3. Put a drop of immersion oil on the surface of the cover glass.
4. Fix the objective lens above the micropreparation.
5. Find the clear image in the same way as in case of work with high-powered magnification.

#### **Practical work:**

**Task 1.** Read the name of the cytological technique and find the letter indicating the description which corresponds to this technique.

**Task 2.** Study the micropreparations «Onion peel», «Fly's wing», «Frog's epithelium», «Frog's erythrocytes», «Scales from the butterfly's wing».

## **Class 2. BIOLOGY OF THE CELL. FLOW OF SUBSTANCE AND ENERGY IN THE CELL**

**Purpose of the practice:** to study distinguishing features of prokaryotic and eukaryotic cells, anabolic system of the cell, to study catabolic system of the cell, to analyze electron-diffraction photographs

## CONTENTS OF THE TOPIC

1. The modern Cell Theory.
2. Difference between pro- and eukaryotic cells.
3. Structure of plasma membrane, its properties and functions. Transport of substances through the membrane.
4. Anabolic and catabolic systems of the cell.
5. Energy exchange in the cell. Characteristic of its stages.
6. Connection between flows of substances and energy in the cell

### BASIC TERMS AND CONCEPTS

**Glycocalyx** — receptor apparatus on membranes of animal cells.

**Glycolysis** — process of breaking down glucose without oxygen.

**Concentration gradient** — the difference of substance concentrations.

**Enzymes of oxidative phosphorylation** — are enzymes of mitochondria located on ATP-somes.

**Enzymes of tissue respiration** — enzymes of mitochondria located in cristae.

**Enzymes of Krebs cycle** — enzymes of mitochondria located in the matrix.

**Dictyosome** — system of flat disc-like cisterns formed by the membrane of the Golgi complex.

**Mesosomes** — ingrowths of plasma membrane which perform a role of membrane organelles in prokaryotic cells.

**Nucleoid** — genetic apparatus of prokaryotes.

**Plasma membrane** — bilipid layer with proteins and carbohydrates covering the cell.

**Peroxisomes** — organelles, where oxidation of amino acids occurs and hydrogen peroxide is formed.

#### **Practical work:**

**Task 1.** Solve the problem from the practical book.

**Task 2.** Study the electron-diffraction photographs of mitochondria, ER, Golgi complex, ATP-synthases and write indications.

### Class 3. FLOW OF GENETIC INFORMATION IN THE CELL

**Purpose of the practice:** to study the microscopic and submicroscopic structure of the cell nucleus, cell cycle and principles of interphase, types of cell division, to know how to write down the content of genetic material in different interphase periods and in different stages of mitosis and meiosis

## CONTENTS OF THE TOPIC

1. Structure and functions of nucleus.
2. Types of chromosomes. Structure of chromosomes. Rules of chromosomes.
3. Karyotype and idiogram. Classification of human chromosomes.
4. Mitotic and cell cycles. Interphase. Cause of mitosis.
5. Regulators of the cell cycle (cyclins and cyclin-dependent kinases).
6. Comparison of mitosis and meiosis (content of genetic material during different stages of division).

### BASIC TERMS AND CONCEPTS

**Bivalents** — two homologous chromosomes, connected to one another during the prophase of meiosis I.

**Karyolymph (nucleoplasm)** — the viscous liquid within the nucleus.

**Cell cycle** — a period from the appearance of the cell to its death or to the end of next division.

**Synapsis** — connection of homologous chromosomes during prophase of meiosis I leading to formation of a bivalent.

**Meiosis** — division of specialized somatic cells of gonads (gametocytes) resulting in formation of gametes.

**Mitotic cycle** — period of cell's life which includes preparation for division (interphase) and the division itself (mitosis).

**Telomeres** — terminal parts of chromosome arms.

**Centromere index (CI)** – length of the short chromosome arm divided by the entire length of the chromosome and expressed as percentage.

**Chiasmata** — crossings of chromatids of homologous chromosomes observed during synapsis.

**Chromatin** — a complex of DNA and histone proteins in the nucleus of the cell.

**Nuclear-cytoplasmic ratio** — is a physiologically and morphologically regular ratio of the volume of the nucleus to the volume of the cytoplasm.

#### **Practical work:**

**Task 1.** Study the diagram of a chromosome, and nucleus, write indications.

**Task 2.** Solve the problems from the practical book.

**Task 3.** Fill in the table and write the contents of genetic information for various stages of interphase, mitosis and meiosis

#### **Educational and research work (library-research papers)**

1. Amitosis.
2. Pathology of mitosis: mechanisms and medical significance.

## Class 4. ARRANGEMENT OF HEREDITARY MATERIAL (Part 1)

**Purpose of the practice:** to study molecular basis of a gene, its properties, to learn how to solve problems in DNA and RNA structure, replication, transcription, translation.

### CONTENTS OF THE TOPIC

1. Levels of DNA condensation (nucleosomal, supernucleosomal, chromatid, metaphase chromosome levels).
2. Structural-functional levels of genetic material (gene, chromosome, genome levels).
3. Properties of genes. Primary functions of genes: autosynthetic (replication) and heterosynthetic (protein biosynthesis).
4. The central dogma of molecular biology.

### BASIC TERMS AND CONCEPTS

**Gene** — a segment of DNA coding for a certain polypeptide (or RNA).

**Initiation** — the first stage of translation.

**Revertase** — the enzyme performing reverse transcription.

**Recon** — unit of recombination equal to one nucleotide pair.

**Supernucleosome** — the second level of DNA condensation.

**Stability of gene** — ability of gene to maintain its structure.

**Termination** — ending of the protein synthesis.

**Transcription** — creation of mRNA on DNA matrix in the nucleus.

**Cistron** — gene as a functional unit responsible for protein synthesis.

**Elongation** — the second step of translation which begins from formation of the first peptide bond and finishes with connection of the last amino acid to ate polypeptide

### Practical work:

**Task 1.** Solve the problems from the practical book.

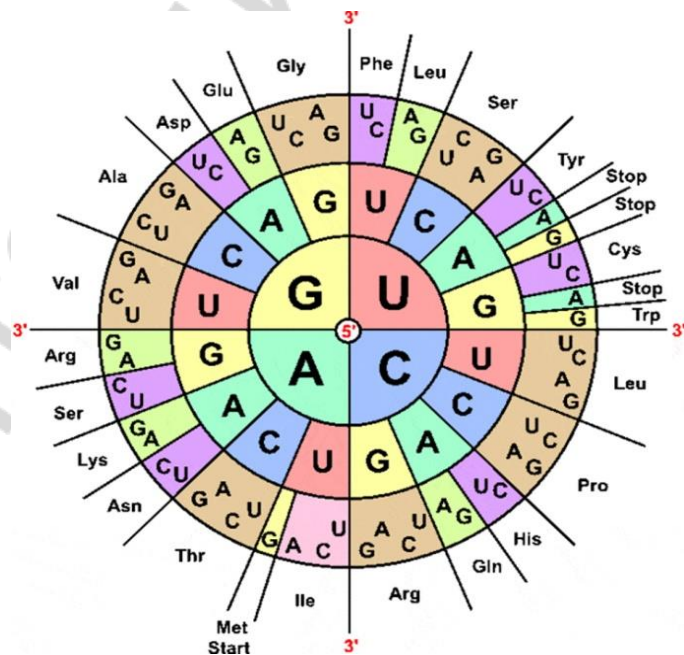


Fig. 1. Genetic code

## **Class 5. ARRANGEMENT OF HEREDITARY MATERIAL (Part 2)**

**Purpose of the practice:** to study properties of genes and their classification, principles of cytoplasmic heredity, regulation of gene functioning; learn how to solve typical problems concerning regulation of gene functioning.

### **CONTENTS OF THE TOPIC**

1. Classification of genes (structural and functional, unique, repeated sequences, transposons).
2. Regulation of transcription in prokaryotes (F. Jacob, J. Monod) and eukaryotes (G.P. Georgiev).
3. Cytoplasmic inheritance.

### **BASIC TERMS AND CONCEPTS**

**Operator** — functional element of operon that the repressor attaches to.

**Inductor** — substance that binds a certain protein-repressor.

**Intron** — non-informative fragment of structural genes in eukaryotes.

**Operon** — a transcription unit of prokaryotes.

**Promoter** — a site of an operon recognized by RNA-polymerase.

**RNA processing** — formation of mRNA including removal non-informative parts, splicing of exons, capping and polyadenylation.

**Pseudocyttoplasmic inheritance** — inheritance of traits caused by foreign DNA present in the cell.

**Repressor** — protein encoded by a regulatory gene for blocking the operator.

**Splicing** — reactions that combine and bind fragments of pre-mRNA to form the mRNA.

**Transcripton** — a transcription unit of eukaryotes.

**Transposon** — mobile genetic elements able to move within the genome.

**Exon** — informative part of structural genes of eukaryotes.

### **Practical work**

**Task 1.** Write indications for the diagrams of operon and transcripton.

**Task 2.** Solve the problems from the practical book

### **Educational and research work (library-research papers)**

1. Cytoplasmic inheritance

## **Class 6. GENETIC ENGINEERING**

**Purpose of the practice:** To study the principles of genetic engineering and organism cloning, to know how to solve problems in the context of genetic engineering.

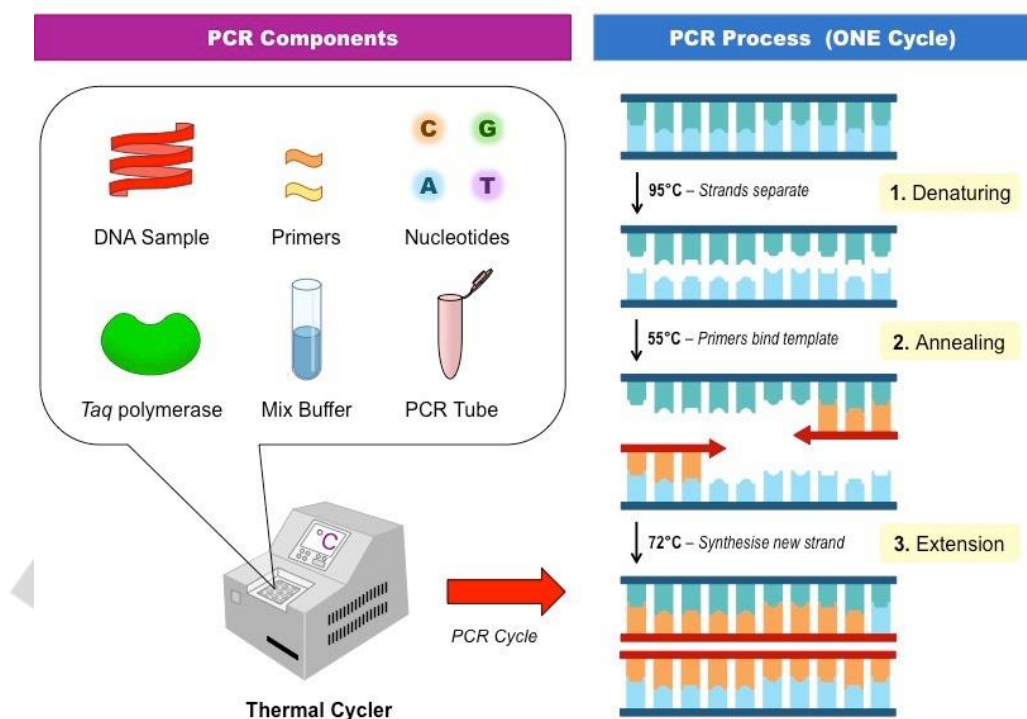
## CONTENTS OF THE TOPIC

1. Genetic engineering as a science.
2. Obtaining genetic material: techniques. Restriction endonucleases.
3. Insertion of DNA fragments into a vector molecule. Vectors.
4. Incorporation of the recombinant DNA into a recipient cell.
5. Techniques used in genetic engineering and biotechnology: polymerase chain reaction, southern blot, DNA fingerprinting.

*Table 1*

**Some restriction endonucleases**

#	Enzyme	Recognition site and cleavage points
1.	<b>Bal I</b>	$5' - TGG   CCA - 3'$ $3' - ACC   GGT - 5'$
2.	<b>Bam H I</b>	$5' - G   GATCC - 3'$ $3' - CCTAG   G - 5'$
3.	<b>Eco R I</b>	$5' - G   AATTC - 3'$ $3' - CTTAA   G - 5'$
4.	<b>Hind III</b>	$5' - A   AGCTT - 3'$ $3' - TTCGA   A - 5'$
5.	<b>Sal I</b>	$5' - G   TCGAC - 3'$ $3' - CAGCT   G - 5'$
6.	<b>Xba I</b>	$5' - T   CTAGA - 3'$ $3' - AGATC   T - 5'$





### **Polymerase chain reaction**

– **Denaturation:** the mixture of reagents is heated up to 90 °C. During 15 sec hydrogen bonds between DNA strands break and two single-strand molecules are formed.

– **Annealing:** the temperature is lowered to +50 °C. Primers connect to the complementary region of the DNA sample. This stage requires about 30 sec.

– **Elongation (or extension, polymerization)** the reaction is heated again to 70 °C. At this temperature the Taq-polymerase assembles complementary strands moving from primers to the 5' end of the matrix. This process takes 90 sec.

As a result, DNA duplicates many times. During 20 cycles the number of DNA copies reaches to 106. At the present day PCR is performed automatically in a thermocycler 10<sup>6</sup>.

### **BASIC TERMS AND CONCEPTS**

**Autoradiogram** — photographic film where spots corresponding to the marked DNA fractions are shown.

**Thermocycler** — a machine performing PCR.

**Vector** — a small autonomously replicated DNA molecule providing multiplication and/or work of an artificially inserted gene.

**DNA-probe** — a radioactively marked short single-strand DNA sequence able to bind certain DNA site.

**Sticky ends** — ends of DNA formed after cutting with restriction endonucleases which have complementary single-strand regions and able to join together.

**Liposomes** — vesicles surrounded by one or several membranes of lipids.

**Plasmids** — small autonomously replicated circular DNA molecules of bacterial genome.

**Polymerase chain reaction (PCR)** — technique used to amplify (make multiple copies) DNA or its fragment *in vitro*.

**Primers** — short (20–30 nucleotides) single-strand DNA fragments complementary to certain DNA site and serving as beginning for the new DNA strand during PCR.

**Recognition sites** — usually short DNA fragments recognized processed by DNA restriction enzymes.

**Transfection** — infection of cells with phages  $\lambda$ ,  $\psi$  X174 and T4.

**Blunt ends** — ends of DNA formed after cutting with restriction endonucleases which have no complementary single-strand regions.

### **Practical work**

**Task 1.** Solve the problems from the practical book.

**Task 2.** Write the indications for the picture "Insertion of a gene into a plasmid"

### **Educational and research work (library-research papers)**

1. Genetic engineering in biology and medicine

## **Class 7. COLLOQUIUM IN MOLECULAR BIOLOGY**

**Purpose of the practice:** to estimate student's knowledge in studied topics.

### **QUESTIONS FOR CONTROL**

1. Human being as a biological and social object.
2. Role of Biology in medical education. Significance of Biology for medical education.
3. Subject matter, tasks and methods of cytology.
4. Light microscopy.
5. The modern Cell Theory.
6. Difference between pro- and eukaryotic cells.
7. Structure of plasma membrane, its properties and functions. Transport of substances through the membrane.
8. Anabolic and catabolic systems of the cell.
9. Energy exchange in the cell. Characteristic of its stages.
10. Connection between flows of substances and energy in the cell.
11. Structure and functions of nucleus.
12. Types of chromosomes. Structure of chromosomes. Rules of chromosomes
13. Karyotype and idiogram. Classification of human chromosomes.
14. Mitotic and cell cycles. Interphase. Cause of mitosis.
15. Regulators of the cell cycle (cyclins and cyclin-dependent kinases).
16. Comparison of mitosis and meiosis (content of genetic material during different stages of division).
17. Classification of genes (structural and functional, unique, repeated sequences, transposons).
18. Regulation of transcription in prokaryotes (F. Jacob, J. Monod) and eukaryotes (G.P. Georgiev). Cytoplasmic inheritance.
19. Genetic engineering as a science.
20. Obtaining genetic material: techniques. Restriction endonucleases.
21. Insertion of DNA fragments into a vector molecule. Vectors.
22. Incorporation of the recombinant DNA into a recipient cell.
23. Polymerase chain reaction.
24. Southern blot.
25. DNA fingerprinting.

## **Class 8. GENE INTERACTIONS. GENETIC LINKAGE. GENETICS OF SEX**

**Purpose of the practice:** to study regularities of inheritance, interaction of genes, genetic linkage and genetics of sex. To learn how to solve problems based on these phenomena.

### **CONTENTS OF THE TOPIC**

1. Inheritance of blood groups: systems AB0, MN and Rh.
2. Non-allelic (inter-allelic) gene interactions.
3. Autosomal and gonosomal linkage groups.
4. Chromosome theory of inheritance.
5. Determination of sex in human and its disorders.
6. X-chromosome's sex chromatin. Mary F. Lyon's hypothesis of X-chromosome inactivation.
7. Sex chromosome disorders.

### **BASIC TERMS AND CONCEPTS**

**Crossover gametes** — gametes that contain chromatids that have undergone the crossing-over and exchanged certain alleles.

**Hemizygoty** — a state when an allele is single in diploid chromosome set as it is contained in a non-homologous (differential) region of X or Y chromosome of a person with heterogametic sex.

**True hermaphroditism** — a state of an organism associated with ability to produce both normal male and normal female gametes.

**Pseudohermaphroditism** — a state of an organism associated with mismatch of primary and secondary sex characters.

**Complementation** — non-allelic interaction in which a gene complements the action of another non-allelic gene and they both determine development of a character.

**Polymeria** — non-allelic gene interaction of several gene pairs in which the number of their dominant alleles defines development or degree of a character.

**Recombinants** — organisms who got crossover gametes.

**Klinefelter syndrome** — a sex chromosome disorder caused by presence of an extra X-chromosome in a male karyotype.

**Androgen insensitivity syndrome** — development of female phenotype in a person having the genotype XY

**X trisomy** — a sex chromosome disorder caused by presence of an extra X-chromosome in a female karyotype.

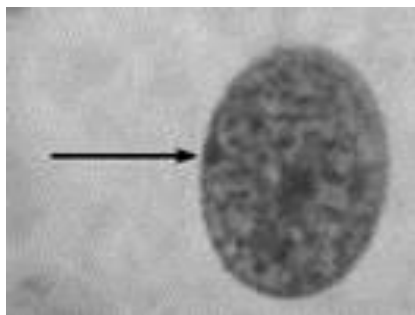
**Shereshevsky-turner syndrome** — a sex chromosome disorder caused by presence of only one X-chromosome in a karyotype.

**Physical determinants of sex** — morphological and physiological sex determinants of an organism.

**Epistasis** — type of non-allelic interactions in which an allele of a gene (dominant or recessive) suppresses the phenotypic effect of an allele of another gene.

### Technique of X-chromatin detection

Scraping of cheek mucous membrane is performed by a spatula disinfected with alcohol in order to take epithelial cells. The sample is taken to a glass and smeared. The smear is processed with 2–3 drops of aceto-orcein



Barr body

(1 gram of orcein is dissolved in 100 ml of boiling acetic acid; distilled water is then added to make up the volume to 200 ml) and covered with cover-slip. In 20–30 minutes excesses of dye are removed by a blotting paper and study micropreparation under the microscope. It is recommended to begin from low magnification to choose an area with one layer of well-stained cells. Interphase nuclei should be inspected. They are oval or spherical. The Barr

body sticks to the nuclear membrane and can be of different shape: oval, triangle, square and etc. Immersion objective lens can be used if necessary.

### Inheritance of blood groups in human:

Character	Gene	Genotype
<b>System ABO</b>		
Group O (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)	$I^A + I^B$	$I^A I^B$
<b>System MN</b>		
Group M	$L^M$	$L^ML^M$
Group N	$L^N$	$L^NL^N$
Group MN	$L^M + L^N$	$L^ML^N$
<b>System Rh</b>		
Rh+	D	DD, Dd
Rh-	d	dd

### Practical work

**Task 1.** Solve the problems from the practical book.

## Class 9. VARIATION

**Purpose of the practice:** to learn basic types of variation and their causes, their medical and biological significance; to know mechanisms of gene, chromosome and genome mutations, DNA repair and biological basis of oncogenesis.

## CONTENTS OF THE TOPIC

1. Phenotypic variation. Reaction norm.
2. Genotypic variation and its types (combinative and mutational).  
Comparison of mutations and modifications.
3. Mutagenic factors, their classification and action.
4. Classification of mutations.
5. Gene, chromosome and genome mutations, their characteristics, biological and medical significance.
6. Stability and repair of genetic material, antimutagens.
7. Biological basis of oncogenesis.

### BASIC TERMS AND CONCEPTS

**Genocopies** — same phenotypic manifestation of different mutations.

**Deletions** — intrachromosomal mutations associated with a loss of a middle part of the chromosome.

**Duplications** — doubling of a chromosome part.

**Isochromosomes** — chromosomes originating from transverse division of chromosomes instead of longitudinal division of chromatids and consisting of two same arms.

**Inversion** — intrachromosomal mutations characterized by gene arrangement order impairment occurs.

**Oncogenesis** — a process of origination and development of tumor.

**Ring chromosome** — chromosomes formed when its telomere regions are deleted and the remaining ends connect to each other.

**Modifications** — changes of phenotype not caused by changes of the genotype.

**Reaction norm** — range of phenotypic variation.

**Reading frame shift** — a mutation of structural genes caused by insertion or deletion of nucleotides that move reading of nucleotides.

**Transgenations** — gene mutations.

**Translocations** — relocation of a chromosome region on another chromosome.

#### Practical work

**Task 1.** Study the photographs of mutations in drosophilae and draw the missing details.

**Task 2.** Solve the problems from the practical book.

### Class 10. FUNDAMENTALS OF HUMAN GENETICS (Part 1)

**Purpose of the practice:** to learn modern tasks of human genetics and its basic techniques; to learn how to solve problems with pedigree charts, estimating roles of heredity in environment in development of characters.

## CONTENTS OF THE TOPIC

1. Modern tasks of human genetics.
2. The human as an object of genetic investigations.
3. Classification of methods used in human genetics.
4. Genealogical analysis. Types of inheritance and their characteristics.
5. The method of twin study. Criteria determining zygoty of twins. Holzinger's formula.
6. Karyotyping.
7. Cultivation and hybridization of somatic cells.
8. Biochemical genetic tests.
9. Genetic analysis. The Human genome project

## BASIC TERMS AND CONCEPTS

**Dizygotic twins** — twins that developed from different zygotes at the same period.

**Monozygotic twins** — twins that developed from same zygote.

**DNA hybridization** — connection of DNA strands such as specimen and probe in case of their complementarity.

**Discordance** — percentage of twins who are different in a character.

**Concordance** — percentage of twins who both have the same character.

**DNA cloning** — making unlimited number of DNA copies for further usage.

**Proband** — a person from whom making a genealogy starts.

**Sequencing** — decoding the nucleotide sequence of DNA.

**Synkaryote** — a hybrid cell having chromosomes of both parental cells.

**Pedigree chart (genealogy)** — a genealogic map illustrating the proband with relatives and allowing to analyze inheritance of a gene in the family.

### Practical work

**Task 1.** Solve the problems from the practical book.

## Class 11. FUNDAMENTALS OF HUMAN GENETICS (Part 2)

**Purpose of the practice:** to learn techniques used in human genetics: modeling, population statistics, instant diagnostic tests and methods of prenatal diagnosis of hereditary disorders; to learn how to solve problems in Hardy-Weinberg principle.

## CONTENTS OF THE TOPIC

1. Mathematical and biological modeling. Vavilov's Law of Homologous Series.
2. Method of population statistic. The concept of population. Panmictic and non-panmictic populations.

3. Characteristic of human populations. Types of marriages. Genetic processes occurring in large populations. Hardy–Weinberg principle.

4. Factors impairing the equilibrium of genes and genotypes in populations (mutations, natural selection, population waves, isolation, migrations, genetic drift) and their characteristic.

5. Genetic load and its nature.

6. Methods of prenatal diagnosis of hereditary disorders and malformations.

7. Instant diagnosis tests (dermatoglyphics, microbiological, sex chromatin test, biochemical and chemical).

### **BASIC TERMS AND CONCEPTS**

**Amniocentesis** — method of prenatal diagnosis based on sampling amniotic fluid with fetal cells for further tests.

**$\alpha$ -fetoprotein** — protein contained in the amniotic fluid and blood serum of a pregnant woman.

**Demes** — are human populations where the number of individuals is 1500–4000.

**Genetic drift** — incidental fluctuations of genes' frequencies in small populations.

**Incest marriage** — marriage between family members or close relatives (such as brother and sister, parent and child) forbidden in most of cultures by law and religion.

**Panmixia** — random mating within a breeding population .

**Population** — group of individuals of same species having one whole genetic pool, capable of free crossing, inhabiting same territory for a long time and relatively isolated from other populations.

**Guthrie test** — microbiological tests for diagnosis of phenylketonuria in newborns.

**Ultrasonography** — diagnostic method using ultrasound for visualisation of fetus and embryonic membranes.

**Chorion biopsy** — method of prenatal diagnosis based on sampling chorion cilia for further tests.

#### **Practical work**

**Task 1.** Solve the problems from the practical book.

## **Class 12. HUMAN GENETIC AND CHROMOSOME DISORDERS**

**Purpose of the practice:** to study mechanisms of development, symptoms diagnostic methods of the most spread metabolic and chromosomal disorders, to be able to use the acquired knowledge for solution of cases.

### **CONTENTS OF THE TOPIC**

1. Gene mutations as a cause of metabolic diseases.

2. Characteristic of gene disorders of human (phenylketonuria, albinism, galactosemia hyperlipoproteinemia Lesch–Nyhan syndrome, Wilson–Konovalov disease, hemophilia, hemoglobinopathies).

3. Chromosome and genome mutations as a cause of human chromosome disorders.

4. Characteristics of human chromosome disorders (Patau, Edwards, Down, Cri-du-chat syndromes).

### **BASIC TERMS AND CONCEPTS**

**Hemophilia** — disease associated with impairment of blood coagulation.

**Microphthalmia** — malformation associated with reduced sizes of the eye-ball.

**Microcephaly** — malformation associated with reduced size of the brain.

**Monosomy** — mutation in which only one homologous chromosome is present in the karyotype instead of a pair.

**Syndactylia** — malformation associated in which phalanges of adjacent fingers fuse together.

**Trisomy** — mutation associated with presence of three homologous chromosome instead of two.

**Enzymopathy** — hereditary metabolic disorder caused by impairments in synthesis and functions of enzymes.

**Chromosome disorders** — complexes of congenital defects caused by the impairment of the structure and number of chromosomes.

**Ceruloplasmin** — the protein providing copper transport in the organism.

**Epicanthus** — skin fold of the upper eyelid covering the inner corner of the eye.

#### **Practical work**

**Task 1.** Solve the problems from the practical book.

### **Class 13. GENETIC COUNSELING**

**Purpose of the practice:** to study aims of genetic counseling, stages of making genetic prognosis and indications for direction to genetic counseling; to learn principles of therapy elaborated for treatment of hereditary disorders; to know how to use the acquired knowledge for solution of cases.

#### **CONTENTS OF THE TOPIC**

1. The aim and tasks of genetic counseling.
2. Stages of making genetic prognosis:
  - a) Determination of genetic risk;
  - b) Estimating the severity of medical and social consequences of the disorder;
  - c) Prenatal diagnostics.
3. Indications for direction of a family to genetic counseling.
4. Treatment principles of human hereditary disorders.



## BASIC TERMS AND CONCEPTS

**Mild genetic risk** — the probability of hereditary pathology in children up to 10 %.

**Medium genetic risk** — the probability of hereditary pathology in children up to 20 %.

**High genetic risk** — the probability of hereditary pathology in children over 20 %.

**Diet therapy** — treatment by a diet.

**Metabolic inhibition** — suppression of synthesis of the product which is not excreted from the organism.

**Gene therapy** — treatment using methods of genetic engineering.

**Substitution therapy** — injection metabolites which are not produced in the organism because of a pathology.

**Pathogenic therapy** — therapy that interrupts the development of the disorder but not eliminates its cause.

**Symptomatic therapy** — elimination of symptoms of a disorder without effect on its cause and mechanism of its development.

**Etiotropic therapy** — treatment that eliminates of the cause of the disease.

### Practical work

**Task 1.** Solve the problems from the practical book.

## 14. Class 14. COLLOQUIUM IN GENETICS

**Purpose of the practice:** to estimate student's knowledge in studied topics.

### QUESTIONS FOR CONTROL

1. Inheritance of blood groups: systems AB0, MN and Rh.
2. Non-allelic (inter-allelic) gene interactions.
3. Autosomal and gonosomal linkage groups.
4. Chromosome theory of inheritance.
5. Determination of sex in human and its disorders.
6. X-chromosome's sex chromatin. Mary F. Lyon's hypothesis of X-chromosome inactivation.
7. Sex chromosome disorders.
8. Phenotypic variation. Reaction norm.
9. Genotypic variation and its types (combinative and mutational). Comparison of mutations and modifications.
10. Mutagenic factors, their classification and action.
11. Classification of mutations.
12. Gene, chromosome and genome mutations, their characteristics, biological and medical significance.

13. Stability and repair of genetic material, antimutagens.
14. Biological basis of oncogenesis. Modern tasks of human genetics.
15. The human as an object of genetic investigations.
16. Classification of methods used in human genetics.
17. Genealogical analysis. Types of inheritance and their characteristics.
18. The method of twin study. Criteria determining zygoty of twins. Holzinger's formula.
19. Karyotyping.
20. Cultivation and hybridization of somatic cells.
21. Biochemical genetic tests.
22. Genetic analysis. The Human genome project.
23. Mathematical and biological modeling. Vavilov's Law of Homologous Series.
24. Method of population statistic. The concept of population. Panmictic and non-panmictic populations.
25. Characteristic of human populations. Types of marriages. Genetic processes occurring in large populations. Hardy–Weinberg principle.
26. Factors impairing the equilibrium of genes and genotypes in populations (mutations, natural selection, population waves, isolation, migrations, genetic drift) and their characteristic.
27. Genetic load and its nature.
28. Methods of prenatal diagnosis of hereditary disorders and malformations.
29. Instant diagnosis tests (dermatoglyphics, microbiological, sex chromatin test, biochemical and chemical).
30. Gene mutations as a cause of metabolic diseases.
31. Characteristic of gene disorders of human (phenylketonuria, albinism, galactosemia hyperlipoproteinemia Lesch–Nyhan syndrome, Wilson–Konovalov disease, hemophilia, hemoglobinopathies).
32. Chromosome and genome mutations as a cause of human chromosome disorders.
33. Characteristics of human chromosome disorders (Patau, Edwards, Down, Cri-du-chat syndromes).
34. The aim and tasks of genetic counseling.
35. Stages of making genetic prognosis: determination of genetic risk, estimating the severity of medical and social consequences of the disorder, prenatal diagnostics.
36. Indications for direction of a family to genetic counseling.
37. Treatment principles of human hereditary disorders.

## **Class 1 (15). REPRODUCTION OF LIVING MATTER**

**Purpose of the practice:** to study reproduction as essential property of living matter, its types; to study structure of sex cells gametogenesis and peculiarities of human reproduction.

### **CONTENTS OF THE TOPIC**

1. Reproduction as essential property of living matter.
2. Types of reproduction.
3. Gametogenesis (oogenesis and spermatogenesis).
4. Insemination and its types. Fertilization and its stages.
5. Biological peculiarities of human reproduction.

### **BASIC TERMS AND CONCEPTS**

**Acrosome** — modified Golgi complex of a spermatozoon providing its entrance into the ovum.

**Anisogamy** — form of sexual process in which gametes that fuse together are morphologically different.

**Gynogenesis** — type of sexual reproduction in which male and female pronuclei do not contact and only the female nucleus is used for the development of a zygote.

**Copulation** — sexual process in which genetic information of two unicellular organisms fuse.

**Oogenesis** — process of development and maturation of ova.

**Insemination** — processes providing contact of gametes.

**Sexual process** — exchange of genetic information between two cells or fusion of the genetic information of two cells which does not increase the number of individuals.

**Pronucleus** — nucleus of ova or spermatozoon before their fusion.

**Synkaryon** — nucleus of a zygote.

**Spermatogenesis** — process of spermatozoa development.

#### **Practical work**

**Task 1.** Study the micropreparations «Human spermatozoa», «Graafian follicle in the cat's ovary», «Fertilization of ascaris egg», «Karyogamy in ascaris egg cell».

**Task 2.** Solve the problems from the practical book.

## **Class 2 (16). FUNDAMENTALS OF ONTOGENESIS**

**Purpose of the practice:** to study periods of ontogenesis, its stages, critical periods and their nature, mechanisms providing realization of genetic information during development of embryo and fetus; to study periods of human postnatal ontogenesis, critical periods and their nature, growth types of tissues and organs, main theories explaining ageing; learn concepts of Gerontology, Geriatrics, acceleration and reanimation.

## CONTENTS OF THE TOPIC

1. Ontogenesis, its types and periods.
2. Characteristic of progenesis.
3. Stages of embryogenesis (cleavage, gastrulation, hysto- and organogenesis). Provisional organs of chordates. Peculiarities of embryonic development of human.
4. Realization of genetic information during prenatal ontogenesis. Mechanisms of embryogenesis and morphogenesis.
5. Critical periods of the ontogenesis. Teratogens.
6. Growth. Growth types of human tissues and organs. Acceleration.
7. Human constitution and habitus.
8. Ageing. Basic theories of ageing.
9. Clinical and biological death. Reanimation. Euthanasia

## BASIC TERMS AND CONCEPTS

**Acceleration** — speeding-up of physical and mental development of new generations of children and adolescents.

**Valeology** — a science that studies a healthy lifestyle and conditions for increasing the life span.

**Biological age** — the number of years a person looks.

**Chronological age** — age confirmed by documents.

**Critical periods** — periods of prenatal ontogenesis when the embryo or fetus is particularly sensitive to environmental factors.

**Human habitus** — peculiarities of morphology, physiology, behavior in a definite time moment.

**Human constitution** — genetically conditioned peculiarities of human morphology, physiology and behavior

**Morphogenetic fields** — are fields formed by groups of cells which can respond to certain localized biochemical signals and develop into certain anatomical structures.

**Ontogenesis** — individual development of an organism from the moment of zygote formation till death.

**Progenesis** — period of formation and maturation of those parental gametes that formed a zygote.

**Geriatrics** — science that studies diseases of old people, peculiarities of their development, course, treatment and prophylaxis.

**Gerontology** — science about aging and old age

**Reanimation** — complex of actions performed to return a person to life from the state of a clinical death.

### Practical work

**Task 1.** Solve the problems from the practical book.

## Class 3 (17). EVOLUTION OF ORGAN SYSTEMS

**Purpose of the practice:** to study and learn the basic regularities of evolution of organ systems, correlation of the ontogenesis and phylogenesis; to comprehend phylogenetic basis of malformations occurring during prenatal development.

### CONTENTS OF THE TOPIC

1. Connection of the ontogenesis and phylogenesis, Biogenetic law, A. N. Sewertzoff's theory about phylembryogeneses.
2. Evolution of the nervous system.
3. Evolution of the cardiovascular system.
4. Evolution of the respiratory system.
5. Evolution of the digestive system.
6. Evolution of the urogenital system.
7. Ontophylogenetic etiology of malformations in the nervous, cardiovascular, respiratory, digestive and urogenital systems in the human.

### BASIC TERMS AND CONCEPT

**Anaboly** — development that follows ancestral pattern up to its last stage and then new stages are added.

**Archallaxis** — early deviation from ancestral developmental pattern that occurs simultaneously with formation of the organ anlage.

**Arterial cone** — pulsating muscular tube that starts from the ventricle and divides into a pulmocutaneous arteries, carotid arteries and aortal arches.

**Botallo duct** — duct functioning in fetus and connecting the pulmonary arteries with aorta.

**Venous sinus** — site where cava veins join the heart.

**Mesonephros** — excretory organ of fishes and amphibians.

**Metanephros** — kidney of terrestrial animals.

**Metanephric duct** — ureter of pelvic kidney.

**Sauropsidian brain** — brain where the integrating center is striate bodies.

**Ichthyopsidian brain** — brain where the integrating center is midbrain.

**Parallelism** — independent development of similar characters in closely related species in course of their evolution.

**Recapitulation** — appearance of ancestral characters in embryos during their ontogenesis.

**Phylembryogenesis** — embryonic reconstruction that is preserved in adults and have adaptive nature.

### Practical work

**Task 1.** Color the pictures «Heart evolution of lower vertebrates», «Heart evolution of higher vertebrates», «Development of the excretory and genital systems in vertebrates» and write indications.

**Task 2.** Solve the problems from the practical book.

## Class 4 (18). INTRODUCTION TO PARASITOLOGY

**Purpose of the practice:** to study parasitism as biological phenomenon, to learn classification of parasites and their hosts, interactions in the parasite-host system, adaptations of parasites, their pathogenic action and response of the host.

### CONTENTS OF THE TOPIC

1. Origin and age of parasitism. Criteria of parasitism.
2. Classification of parasites and their hosts.
3. The parasite–host system.
4. Transmission routes of parasites.
5. Adaptations to parasitism.
6. Pathogenic action and specificity of parasites.
7. Response of the host to parasitic invasion.
8. Biological basis of prophylaxis of parasitic diseases.

### BASIC TERMS AND CONCEPTS

**Invasions** — diseases caused by protozoans and helminthes.

**Infections** — diseases caused by viruses and bacteria.

**Hyperparasitism** — relations between parasites of different species when one parasite parasitizes the other parasite.

**Molecular mimicry** — similarity of parasite's antigens to host's antigens.

**Parasitocenosis** — all the parasites in the organism of a host.

**Parasite** — organism which is biologically adapted for life at the expense of another organism.

**Pathogenicity** — capability of the parasite to cause a disease.

**Symbiosis** — and kind of persistent interactions of organisms of different species.

**Specificity of the parasite** — historically formed adaptation degree of the parasite to its host.

**Invasive stage** — that life stage of the parasite which gets to the organism of the host to continue the life cycle.

#### Practical work

**Task 1.** Fill in the table: «Adaptations of parasites»:

## Class 5 (19). PHYLUM SARCOMASTIGOPHORA, CLASSES SARCODINA, ZOOMASTIGOTA

**Purpose of the practice:** to learn features of protists, peculiarities of their morphology and biology of parasitic Sarcodinae and Zoomastigotae which are pathogens of human diseases, their pathogenic action, methods of diagnosis and prophylaxis of diseases they cause.

## CONTENTS OF THE TOIC

1. General characteristic of the kingdom Protista.
2. Parasitic Sarcodinae: *Entamoeba histolytica*, *Entamoeba coli*, *Entamoeba gingivalis*. Life cycle of the *Entamoeba histolytica*, its pathogenic action; characteristic symptoms, diagnosis and prophylaxis of amoebiasis.
3. Parasitizing flagellates: *Leishmania*, *Trypanosoma*, *Lamblia* and *Trichomonas*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis.

### BASIC TERMS AND CONCEPTS

**Amoebiasis** — disease caused by *Entamoeba histolytica*.

**Chagas disease** — disease caused by *Trypanosoma cruzi*.

**Visceral leishmaniasis** — disease caused by *Leishmania donovani* and *Leishmania infantum*.

**Cutaneous leishmaniasis** — disease caused by *Leishmania tropica major* and *Leishmania tropica minor*.

**Lambliasis** — disease caused by *Lamblia intestinalis*.

**Pellicle** — elastic membrane covering a cell of a protozoan.

**Taxis** — oriented movement of a motile organism in response to an external stimulus.

**Sleeping sickness** — disease caused by *Trypanosoma brucei*.

**Trichomoniasis** — disease caused by *Trichomonas vaginalis*.

**Undulating membrane** — locomotor organelle of some protists consisting of fin-like fold of plasma membrane with flagellum.



***Lamblia intestinalis* (*Giardia lamblia*).**

**Phylum Sarcomastigophora, class**



**Zoomastigota.**

A pear-like shape, the body size is 10–18  $\mu\text{m}$ . 4 pairs of flagella, 2 supporting axes (axostyles) dividing the body into two symmetrical halves having per 1 nucleus and 1 adhesive disc.



***Trypanosoma brucei gambiense*. Phylum Sarcomastigophora, class Zoomastigota.**

The body is curved, has a flagellum going along the edge of the undulating membrane. The body length is 13–40  $\mu\text{m}$ . The protist feeds osmotically, multiplies by binary division.

	<p><b>Leishmania donovani. Phylum Sarcomastigophora, class Zoomastigota.</b> There are 2 forms: promastigote (has a flagellum deriving from kinetoplast, size is 10–20 <math>\mu\text{m}</math>) and amastigote (a nonflagellate rounded or oval, 3–5 <math>\mu\text{m}</math> in size).</p>
	<p><b>Trichomonas vaginalis. Phylum Sarcomastigophora, class Zoomastigota.</b> Oval shape of the cell, there is a spike on one end. Size — up to 30 micrometers. There are 5 flagella, one of them in the undulating membrane. There is axostyle in the center. Cytoplasm contains a nucleus and good vacuoles.</p>

### Practical work

**Task 1.** Study the life cycle of the dysenteric amoeba, write indications.

**Task 2.** Solve the problems from the practical book.

**Task 3.** Study the micropreparations: «Giardia», «Trichomonas», «Leishmania», «Trypanosoma», color them and write indications.

**Educational and research work (library-research papers)**

1. Free-living Amoebae.

## Class 6 (20). PHYLUM INFUSORIA, CLASS CILIATA. PHYLUM APICOMPLEXA, CLASS SPOROZOA

**Purpose of the practice:** to learn morphological and biological features of parasitic protists of classes Ciliata and Sporozoa, their life cycles, routes of transmission, their pathogenic action, methods of diagnosis and prophylaxis of diseases they cause.

### CONTENTS OF THE TOPIC

1. Characteristics of the classes Ciliata and Sporozoa.
2. *Balantidium coli*: route of transmission, pathogenic action, symptoms and diagnosis.
3. Life cycle of a malaria parasite. Types of malaria parasites, their appearance in a thin blood smear.
4. Route of transmission of malaria, pathogenic action of malaria parasites; symptoms and diagnosis of malaria.
5. *Toxoplasma gondii*: life cycle, route of transmission, pathogenic action, symptoms and diagnosis.
6. *Pneumocystis carinii*: life cycle, route of transmission, pathogenic action, symptoms and diagnosis.



## BASIC TERMS AND CONCEPTS

**Balantidiasis** — disease caused by *Balantidium coli*.

**Schizontic malaria** — malaria occurring when the invasive stage is an erythrocyte schizont.

**Merozoite** — vegetative stage in the life cycle of sporozoans.

**Merulation** — coming out of mature merozoites from erythrocytes into the blood plasma.

**Oocyst** — life stage of malaria parasite situated on the external surface of the mosquito's stomach and it containing sporozoites.

**Pseudocyst** — cyst in tissues that is formed as a result of accumulation of trophozoites of the toxoplasma in a cell.

**Gametogony** — development of plasmodium's gametes in the body of the intermediate host.

**Hypnozoites** — sporozoites of plasmodia that affect liver cells and continue their development only after some dormant period of time.

**Pneumocystosis** — disease caused by *Pneumocystis carinii*.

**Congenital toxoplasmosis** — disease caused by *Toxoplasma gondii* which affects fetus transplacentally.

**Schizogony** — asexual reproduction of sporozoans in which mother cell divides into multiple daughter cells.

**True cyst** — cyst formed as a result of copulation of gametes.

### Practical work

**Task 1.** Study the diagrams of life cycles of Plasmodiae and Toxoplasmae.

**Task 2.** Solve the problems from the practical book.

**Task 3.** Study the micropreparations: «*Toxoplasma*», «*Balantidium*», «Malaria parasites», draw the micropreparations.



### ***Balantidium coli*.**

#### **Phylum Infusoria, class Ciliata.**

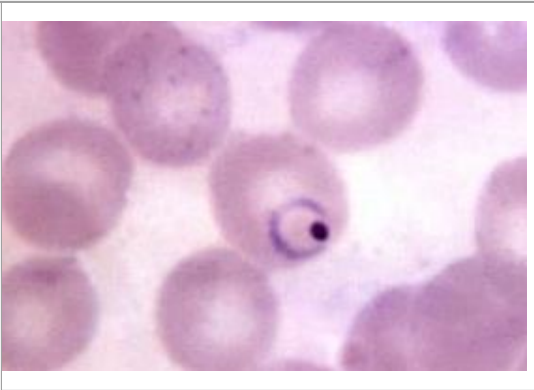
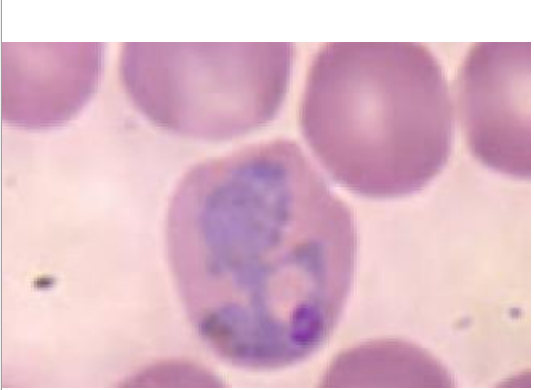
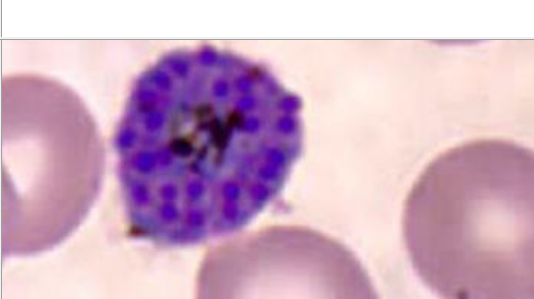
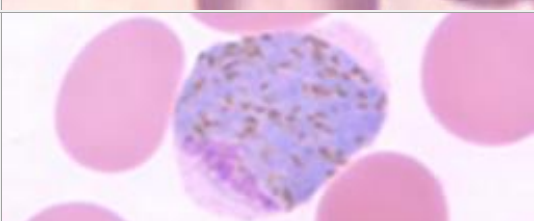
The cell is oval, sizes — 30–150 x 40–70  $\mu\text{m}$ . There is a peristome at the frontal end, which passes into a cytostome and a funnel-like cytopharynx. At the opposite side is a cytoproct. The macronucleus is bean-like or rod-like. There are 2 contractile vacuoles.



### ***Toxoplasma gondii* in a cell.**

#### **Phylum Apicomplexa, class Sporozoa.**

The trophozoite has a semilunar shape, sizes are 4–7 — 2–4  $\mu\text{m}$ . One of its ends is sharpened, the other one is rounded.

	<p><b>Ring stage Pl vivax.</b>  <b>Phylum Apicomplexa, class Sporozoa.</b>          At the start of development it is ring-shaped due to a big vacuole in the center which pushes the nucleus to the periphery. The cytoplasm is not pigmented. At this stage the plasmodium takes approximately <math>\frac{1}{3}</math> of the RBC volume. Sometimes 2–3 plasmodia are present in the same cell.</p>
	<p><b>Ameboid schizont Pl vivax.</b>  <b>Phylum Apicomplexa, class Sporozoa.</b>          Schizonts feed on hemoglobin, grow, form pseudopodia and transform into amoeboid stage. The shape is irregular and resembles amoebae with one or several vacuoles. The size is about <math>\frac{1}{2}</math>–<math>\frac{2}{3}</math> of RBC diameter. All the cytoplasm of the schizont contains dark brown pigment.</p>
	<p><b>Morula Pl. vivax.</b>  <b>Phylum Apicomplexa, class Sporozoa.</b>          The nucleus of the schizont divides into 6–24 nuclei, dark areas of cytoplasm form around them. This is formation of the morula.</p>
	<p><b>Gametocyte Pl vivax.</b>  <b>Phylum Apicomplexa, class Sporozoa.</b>          The female gametocyte is bigger than the male one and takes all the volume of the RBC.</p>

## **Class 7 (21). PHYLUM PLATHELMINTHES, CLASS TREMATODA**

**Purpose of the practice:** to learn morphological and biological features of flatworms and to the parasitic way of living, peculiarities of morphology and biology of flukes; routes of their transmission, diagnosis and prophylaxis of trematodoses.

### **CONTENTS OF THE TOPIC**

1. General characteristic and systematics of the phylum Plathelminthes.
2. Progressive adaptations of flukes to parasitic life. Peculiarities of life cycles of trematodes.

3. Liver fluke: morphological peculiarities, life cycle, routes of transmission, pathogenic action; symptoms, diagnosis and prophylaxis of fascioliasis.

4. Cat liver fluke: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of opisthorchiasis.

5. Lung fluke: morphological peculiarities, life cycle, pathogenic action, characteristic symptoms. Diagnosis and prophylaxis of paragonimiasis.

6. Blood flukes (*Schistosoma haematobium*, *S. mansoni*, *S. japonicum*): morphological peculiarities, life cycle, routes of transmission, pathogenic action, characteristic symptoms. Diagnosis and prophylaxis of schistosomiasis.

7. Laboratory diagnostic techniques of trematodosis.

8. Biological basis of prophylaxis of trematodosis.

### BASIC TERMS AND CONCEPTS

**Cercarial dermatitis** — syndrome caused by the cercariae of certain species of schistosomes whose normal hosts are birds and mammals other than humans.

**Dermo-muscular body wall** — a body wall of flatworms that consists of tegument and 3 layers of smooth muscles.

**Marita** — stage of sexually mature worm in the life cycle of flukes.

**Metacercaria** — invasive stage for a principal host in the life cycle of flukes.

**Miracidium** — the 1<sup>st</sup> larval stage in the life cycle of flukes.

**Redia** — larval stage of flukes in which parasitize the 1<sup>st</sup> intermediate host.

**Sporocyst** — larval stage of flukes that develops in the organism of the 1<sup>st</sup> intermediate host from a miracidium.

**Tegument** — external layer of a dermo-muscular body wall of flukes.

**Cercaria** — mobile larva of the fluke that leaves the mollusk's organism and gets to water.

**Ootype** — part of the female reproductive system of flukes where eggs are fertilized, surrounded with yolk and covered with a shell.

**Polyembryony** — asexual reproduction of living matter consisting in development of more than one embryo from a single zygote.

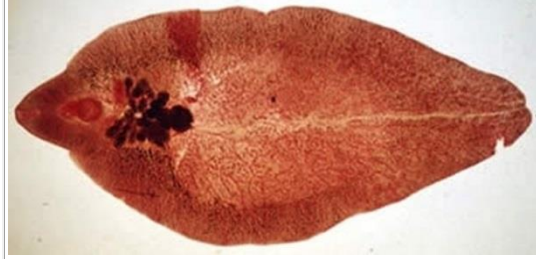


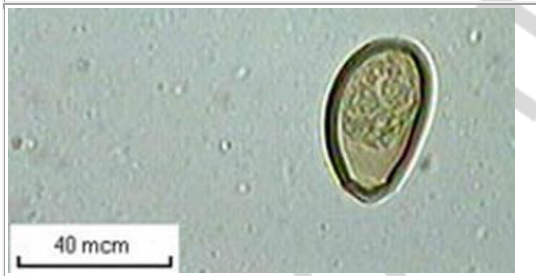

**Cirrus** — copulatory organ of flukes which is modified appendage of the male reproductive duct.

#### Practical work

**Task 1.** Study the diagram of life cycles of trematodes.

**Task 2.** Solve the problems from the practical book.

**Task 3.** Study the micropreparations: «Liver fluke», «Eggs of the liver fluke», «Cat liver fluke», «eggs of the cat liver fluke», «Eggs of schistosomes», write indications.

	<p><b>Fasciola hepatica. Phylum Plathelminthes, class Trematoda.</b> The shape is leaf-like, 3–5 cm in length, 2 suckers (oral and ventral). Intestine are branched. Behind the abdominal sucker is a uterus, and beneath it — a branching ovary, on the body sides — viteline gland, in the middle part — testes.</p>
	<p><b>Egg of the Fasciola hepatica. Phylum Plathelminthes, class Trematoda.</b> Eggs are large (135 × 80 μm), oval, yellowish-brown; there is a lid on one of the poles.</p>
	<p><b>Opisthorchis felineus. Phylum Plathelminthes, class Trematoda.</b> The body is yellowish, length is 10 mm. There is a uterus in its middle. It is followed by a rounded ovary and a bean-like semen-receiver. There are 2 rosette-like testes in the posterior part of the body, and between them is a S-shaped canal of the excretory system. The gut canals do not branch; viteline glands are located on both sides of the body.</p>
	<p><b>Egg of the Opisthorchis felineus. Phylum Plathelminthes, class Trematoda.</b> Eggs are 26–30 × 10–15 μm in size, of yellowish-brown color, oval, there is a lid on one pole.</p>
	<p><b>Egg of the Schistosoma Haematobium. Phylum Plathelminthes, class Trematoda.</b> Size: 120–190 x 50–73 μm, ovoid shape, lid is absent. There is a sharp spike on the end of the egg. The shell is thin and transparent.</p>

**Educational and research work (library-research papers)**

1. Opisthorchiasis.
2. Fascioliasis.

## Class 8 (22). PHYLUM PLATHELMINTHES, CLASS CESTOIDEA

**Purpose of the practice:** to learn morphological and biological features of tapeworms and their adaptations to parasitism; to learn Biology of beef and pork tapeworms, dwarf tapeworm, echinococcus and alveococcus, diphyllbothrium which are pathogens of human diseases; to know pathogenic actions, routes of transmission, diagnostic methods and prophylaxis principles of the cestodoses caused by the tapeworms.

### CONTENTS OF THE TOPIC

1. Characteristic of the class tapeworms: external and internal anatomy and adaptations to parasitism.
2. Life cycles of *Taeniae* and *Diphyllobothria*. Types of measles.
3. *Taenia solium* and *Taeniarhynchus saginatus*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; symptoms, diagnosis and prophylaxis of taeniarhynchosis and cysticerciasis.
4. Dwarf tapeworm: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of hymenolepidosis.
5. *Echinococcus* and *Alveococcus*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms. Diagnosis and prophylaxis of echinococcosis and alveococcosis.
6. *Diphyllobothrium latum*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of diphyllbothriosis.
7. Laboratory diagnosis of cestodoses.
8. Prophylaxis of cestodoses.

### BASIC TERMS AND CONCEPTS

**Biohelminthes** — helminthes that requires an intermediate host for development of their larvae.

**Bothria** — fixation organs of *Diphyllobothrium latum*.

**Contact helminthes** — helminthes whose eggs are transmitted during contact of a healthy person with a sick one or through domestic objects.

**Plerocercoid** — mease of a *Diphyllobothrium latum*.

**Proglottid** — segment of tapeworm's body.

**Scolex** — head of a tapeworm.

**Strobila** — body of tapeworms consisting of segments.

**Cisticercus** — mease of *Taeniarhynchus saginatus* and *Taenia solium*.



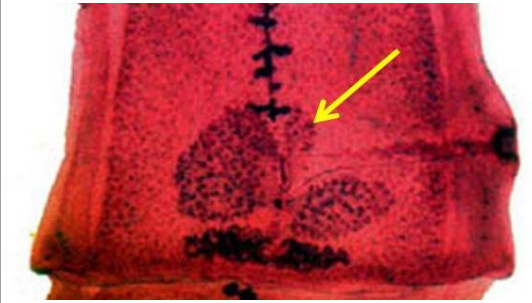
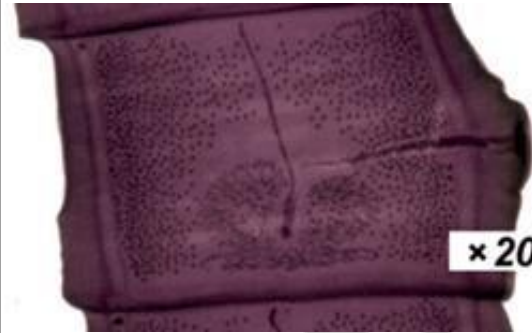
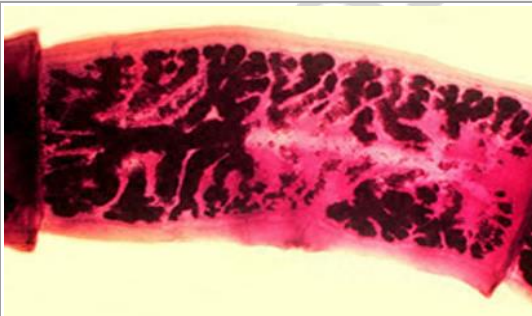
**Cysticercoid** — mease of *Hymenolepis nana*.



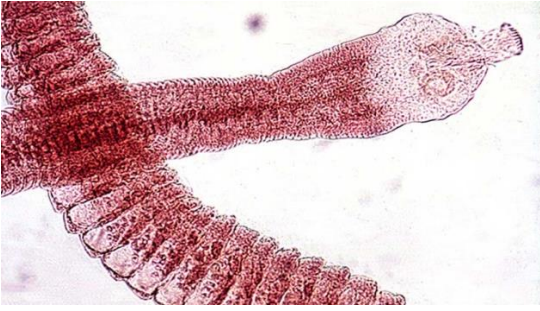


**Echinococcus** — tapeworm, pathogen of echinococcosis.



### Practical work

**Task 1.** Solve the problems from the practical book.

**Task 2.** Study the micropreparations: «*Taenia solium*», «*Taeniarhynchus saginatus*», «*Hymenolepis nana*», «*Diphyllobothrium latum*», «*Echinococcus granulosus*», draw the micropreparations.

	<p><b>Scolex of <i>Taenia solium</i>.</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>          There are 4 suckers and a rostellum with 2 rows of hooks on the scolex.</p>
	<p><b>Scolex of <i>Taeniarhynchus saginatus</i>.</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>          There are 4 suckers on the scolex.</p>
	<p><b>Hermaphroditic (immature) proglottid of <i>Taenia solium</i>.</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>          The proglottid contains a 3-lobed ovary. The third lobule of the ovary is situated between uterus and vagina.</p>
	<p><b>Hermaphroditic (immature) proglottid of <i>Taeniarhynchus saginatus</i>.</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>          The proglottids have a 2-lobed ovary, viteline glands are located under it; vesicle-like testes are in lateral parts of the proglottid.</p>
	<p><b>Gravid (mature) proglottid of <i>Taenia solium</i>.</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>          A mature proglottid contains a uterus with 7–12 branches.</p>

	<p><b>Gravid (mature) proglottid of Taeniarrhynchus saginatus.</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>          The uterus in mature proglottids has 17–35 branches and contains up to 175 000 eggs.</p>
	<p><b>Egg of Taenia solium or Taeniarrhynchus saginatus.</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>          Eggs are round or slightly oval, 30-40 × 20–30 μm, They have a double-contour lined with thick transparent shell and contain an oncosphere inside.</p>
	<p><b>Hymenolepis nana.</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>          Length is 1–5 cm, contains about 200 proglottids, there are 4 suckers and a rostellum with a double crown of hooks on the scolex. The uterus is closed, but a thin wall of proglottids is easily destroyed.</p>
	<p><b>Cross-section of the scolex of Diphylobothrium latum.</b> <b>Phylum Plathelminthes, class Cestoidea.</b>          Injures a mucous membrane of the intestines with 2 sucking grooves on the scolex — bothriae.</p>
	<p><b>Egg of Diphylobothrium latum.</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>          Eggs are russet, widely oval (70 × 45 μm) with smooth surface. There is a lid on one pole, on the other — a protuberance.</p>

	<p><b>Mature proglottid of Diphylobothrium latum.</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>  The width of proglottids is more than their length. Mature proglottids contain an open rosette-like uterus.</p>
	<p><b>Echinococcus granulosus</b>  <b>Phylum Plathelminthes, class Cestoidea.</b>  Mature helminthes are 3-5 mm length. The scolex of such parasite has suckers and rostellum with hooks. The neck is short. strobila consists of 3-4 proglottids. The last two proglottids are mature and hermaphroditic (from the end to the head).</p>

### **Class 9 (23). PHYLUM NEMATHELMINTHES, CLASS NEMATODA**

**Purpose of the practice:** to learn morphological and biological features of roundworms, morphological and biological features of parasitic nematodes, their pathogenic action, routes of transmission, diagnostic methods and prophylaxis principles.

#### **CONTENTS OF THE TOPIC**

1. General characteristic of the phylum roundworms and the class Nematoda.
2. *Ascaris lumbricoides*: morphological and biological peculiarities, routes of transmission, pathogenic action of ascaris and its larvae; symptoms of migration and intestinal stages of ascariasis, diagnosis and prophylaxis of ascariasis.
3. Whipworm: morphological and biological peculiarities, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of trichocephaliasis.
4. Seatworms: morphological and biological peculiarities, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of enterobiasis.
5. *Trichinella*: morphological and biological peculiarities, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of trichinelliasis.
6. Threadworm: morphological peculiarities and life cycle, routes of transmission, pathogenic action, and characteristic symptoms. Diagnosis and prophylaxis of strongyloidiasis.



7. Dog roundworm: morphological peculiarities and life cycle, routes of transmission, pathogenic action, and characteristic symptoms. Diagnosis and prophylaxis of toxocarosis.

8. Diagnostic methods of nematodoses.

9. Prophylaxis of geohelminthiasis.

### **BASIC TERMS AND CONCEPTS**

**Migration stage of ascariasis** — period of ascariasis associated with migration larvae of ascaris.

**Bulb** — dilation of the esophagus in some nematodes.

**Vesicule** — swelling of a cuticle around the oral opening of a seatworm.

**Geohelminthes** — helminthes that require development in soil for their larvae or eggs.

**Dehelmithization** — complex of measures taken to eliminate helminthes in the human organism.

**Hypodermis** — epithelial tissue of roundworms.

**Capsule of a trichinella** — covering of trichinella's larvae formed by connective tissue of the host.

**Migration** — movement of a larval stage of ringworms in the host's organism in order to continue their life cycle.

**Nematodoses** — a group of diseases caused by ringworms.

**Muscle biopsy** — diagnostic technique allowing to find larvae of trichinella in muscle specimens under the microscope.

**Adhesive tape test** — diagnostic technique consisting in applying a piece of adhesive tape to perianal area with its further microscopy for diagnosis of enterobiosis.

**Immunoassay** — diagnostic methods that detect antibodies to a certain pathogen in blood plasma of a patient.

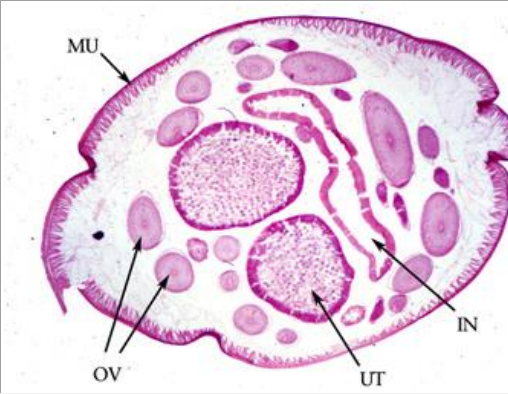

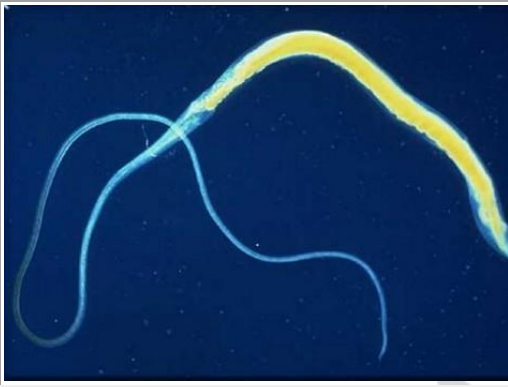

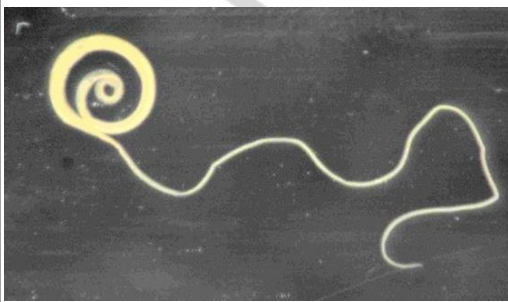
**Surgical implications of ascariasis** — complications of ascariasis caused by abnormal location of ascaris.

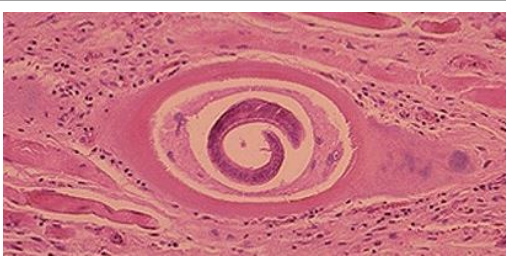
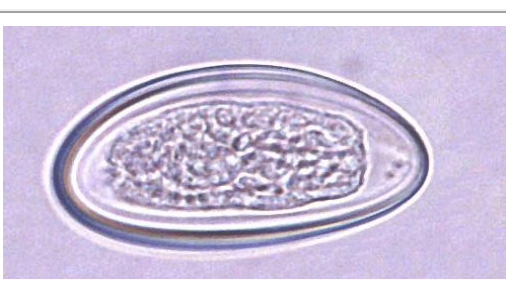

**Eutely** — phenomenon in which an organism has fixed number of somatic cells.

#### **Practical work**

**Task 1.** Solve the problems from the practical book.

**Task 2.** Study the micropreparations: «Egg of ascaris», «Egg of whipworm», «Egg of pinworm», «Pinworm», «Section of female ascaris», «Cross-section of ascaris», «Trichocephalus trichiurus», «Trichinella spiralis», write indications.

	<p><b>Cross-section of <i>Ascaris lumbricoides</i>.</b>  <b>Phylum Nematelminthes, class Nematoda.</b>  There are cuticle, hypodermis, muscular fibers, body cavity, excretory system canals, longitudinal nerve cords, intestines, ovaries, oviducts, uterus.</p>
	<p><b>Egg of <i>Ascaris lumbricoides</i>.</b>  <b>Phylum Nematelminthes, class Nematoda.</b>  Eggs are 50–70 × 40–50 μm, round, slightly oval. Shell is thick and multi-layer, uneven, tawny. There is an oval embryonic cell inside.</p>
	<p><b>Female <i>Trichocephalus trichiurus</i>.</b>  <b>Phylum Nematelminthes, class Nematoda.</b>  The length of a female is up to 5 cm. The anterior end of the body is thread-like, the posterior one is thickened. The esophagus is in the anterior region, all other organs are in the posterior one.</p>
	<p><b>Egg of <i>Trichocephalus trichiurus</i>.</b>  <b>Phylum Nematelminthes, class Nematoda.</b>  Eggs are 26–30 × 10–15 μm in size. Eggs have a lemon-shaped with plugs on the poles. Membrane is yellow-brown, thick and smooth.</p>
	<p><b>Male <i>Trichocephalus trichiurus</i>.</b>  <b>Phylum Nematelminthes, class Nematoda.</b>  The length of a male is 4–4.5 cm. The anterior end of the body is thread-like, the posterior one is thickened. The esophagus is in the anterior region, all other organs are in the posterior one.</p>

	<p><b>Larva of <i>Trichinella spiralis</i> in muscles.</b>  <b>Phylum Nematelminthes, class Nematoda.</b>          Larvae are screwed like a spiral and incapsulated with a connective tissue in skeletal muscles; <math>0,4 \times 0,25</math> mm in size.</p>
	<p><b>Egg of <i>Enterobius vermicularis</i>.</b>  <b>Phylum Nematelminthes, class Nematoda.</b>          Eggs are colorless, flattened from one side, asymmetric and oval; The membrane is thin, smooth, transparent.  <math>50-60 \times 26-30</math> <math>\mu\text{m}</math> in size.</p>
	<p><b>Female <i>Enterobius vermicularis</i>.</b>  <b>Phylum Nematelminthes, class Nematoda.</b>          Female is white, about 10 mm in size. There are cuticular swellings — vesicles, and a bulb — ball-like dilation of the posterior part of the esophagus. They take part in fixation of the parasite to intestinal wall.</p> <p><b>Male <i>Enterobius vermicularis</i>.</b>  <b>Phylum Nematelminthes, class Nematoda.</b>          The male <i>Enterobius vermicularis</i> is white, about 2–5 mm in size. There are cuticular swellings — vesicles, and a bulb — ball-like dilation of the posterior part of the esophagus. They take part in fixation of the parasite to intestinal wall.</p>

## **Class 10 (24). PHYLUM ARTHROPODA, CLASS ARACHNIDA. POISONOUS AND VENOMOUS ORGANISMS**

**Purpose of the practice:** to learn biology of arachnids, morphological and biological features of ticks and mites, their medical significance; to learn poisonous and venomous animals of different taxonomic groups and basic principles of the first aid in case of toxications with their toxins.

### **CONTENTS OF THE TOPIC**

1. General characteristic and taxonomy of the phylum Arthropoda.
2. General characteristic and taxonomy of the class Arachnida.
3. Ticks of the family Ixodidae as vectors of human diseases; mites of families Sarcoptidae, Tyroglyphidae and Demodicidae as pathogens of human diseases; morphology and biology of ticks

4. Poisonous fungi, their characteristics, toxins and effects on the organism. First aid and prevention of poisonings with mycotoxins.

5. Poisonous plants, their characteristics, classification, toxins and effects on the organism. First aid and prevention of poisonings with phytotoxins

6. Classification of poisonous and venomous animals.

7. Physiological characteristic of toxins of invertebrates (jellyfish, arachnids, hymenopterans), their effect on the body; the first aid and prophylaxis of bites and poisoning.

8. Physiological characteristic of toxins of vertebrate animals (fishes, amphibians, reptiles), their effect on the body; the first aid and prophylaxis of bites and poisoning.

## BASIC TERMS AND CONCEPTS

**Anthroponoses** — diseases in which causing agents are transmitted from a human to human.

**Actively-venomous animals** — have venomous glands and a specialized apparatus for injection of their venom.

**Vector-borne diseases** — diseases pathogens of which are transmitted by blood-sucking arthropods

**Secondary-toxic animals** — animals that accumulate exogenous poisons and are toxic when eaten.

**Passively-poisonous animals** — animals that have toxic metabolites accumulated in various organs and tissues.

**Primarily-toxic animals** — animals having special glands for production of toxic secretion or some toxic metabolites.

**Chelicerae** — the first pair of spider appendages used to inject venom into victims body.

**Pedipalps** — the second pair of spider appendages which function as mouthparts.

**Poisonous animals** — animals that can cause adverse effects on human organism when eaten or contacted by means of their toxins.

**Venomous animals** — animals that can cause adverse effects on human organism by means of bite and injection of venom.

### Practical work

**Task 1.** Study the diagrams «Stingray», «Portuguese man-of-war», «Honey bee», «Tarantula», «Scorpion», «Cobra», «Papaver somniferum», «Cannabis sativa», color the pictures and write indications.

**Task 2.** Solve the problems from the practical book.

**Task 3.** Study the micropreparations: «Ixodes ricinus», «Sarcoptes scabiei», «Tick of the genus Dermacentor», «Flour mite», color the pictures and write indications.



**Female Ixodes ricinus**

**Phylum Arthropoda, class Arachnoidea, order Acari, family Ixodidae.**

Mouthparts of a piercing-sucking type form a capitulum visible from the dorsal side. There are eyes. There is a scutum that covers only the anterior region of the back. This provides a greater dilatability of the abdomen in blood meal.



**Male Ixodes ricinus**

**Phylum Arthropoda, class Arachnoidea, order Acari, family Ixodidae.**

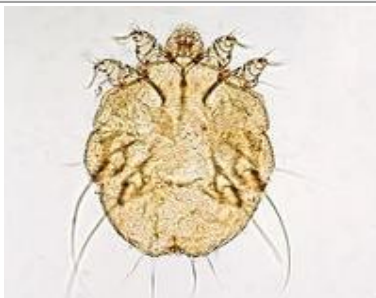
Mouthparts of a piercing-sucking type form a capitulum visible from the dorsal side. There are eyes. There is a scutum that covers the whole dorsal side of the tick.



**Tyroglyphus farinae.**

**Phylum Arthropoda, class Arachnoidea, order Acari, family Tyroglyphidae.**

The mite is small (0.4–0.7 mm), have no eyes, the body is slightly yellow and egg-shaped.



**Sarcoptes scabiei.**

**Phylum Arthropoda, class Arachnoidea, order Acari, family Sarcoptidae.**

Size 0.3–0.4 mm. Short appendages have conic shape, the body is wide and oval, it is covered with scales, eyes are absent.

**Class 11 (25). PHYLUM ARTHROPODA, CLASS INSECTA**

**Purpose of the practice:** to morphological and biological features of insects; to know their medical significance and measures to protect from them.

**CONTENTS OF THE TOPIC**

1. General characteristic and taxonomy of the class Insecta.
2. Order Aphaniptera: peculiarities of morphology and biology; medical significance; prophylaxis.

3. Order Anoplura: peculiarities of morphology and biology; lice as pathogens and vectors of diseases; prophylaxis.

4. Order Blattoidea: peculiarities of morphology and biology; medical significance; prophylaxis.

5. Order Heteroptera: peculiarities of morphology and biology; medical significance; prophylaxis.

6. Mosquitoes of genera *Culex*, *Anopheles* and *Aedes*: morphological and biological peculiarities and medical significance.

7. Flies (house fly, stable fly, tsetse fly, spotted flesh fly), and sand flies morphological and biological peculiarities and medical significance.

### BASIC TERMS AND CONCEPTS

**Gonotrophic cycle** — maturation of eggs in female insects of the Diptera order during digestion of blood.

**Zooprophylaxis** — use of biological barriers (cattle farms) between hatching places of insects and human habitations.

**Inoculation** — infection of the host that occurs during blood sucking through a proboscis.

**Insecticides** — substances used to kill insects.

**Contamination** — infection that occurs by rubbing vector's feces into the skin during scratching.

**Myiasis** — disease caused by larvae of flies and bot-flies.

**Repellent** — substance which discourages insects.

**Pediculosis** — disease caused by lice of genus *Pediculus*.

**Phthiriasis** — disease caused by a pubic louse.

**Mechanic vector** — vector in which pathogens do not multiply and do not develop, but only transmitted to the host.

#### Practical work

**Task 1.** Study the micropreparations: «Head lice», «Flea», «Pubic lice», «Mouthparts of a cockroach», «Eggs, larvae, pupae of mosquitoes of genera *Culex* and *Anopheles*», «Head of female mosquitoes of genera *Culex* and *Anopheles*», «Heads of male mosquitoes of genera *Culex* and *Anopheles*».


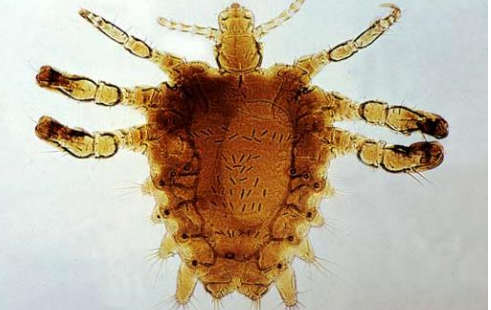


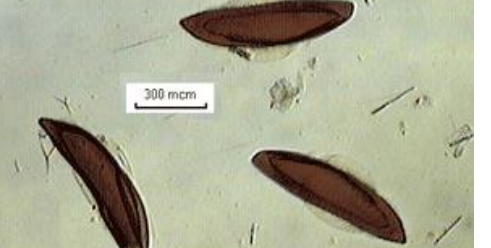


#### ***Pulex irritans*.**

**Phylum Arthropoda, class Insecta, order Aphaniptera**

Body is flattened from the sides. There are multiple hairs, bristles, small teeth on the body surface. There are short antennae and a pair of simple eyes on the head.

The last pair of legs is longer than all the rest and serves for leaping. The mouthparts is of a piercing-sucking type.

	<p><b>Pediculus humanus capitis</b>  <b>Phylum Arthropoda, class Insecta, order Anoplura.</b>  The length of a male is 2–3 mm, of a female — 3–4 mm. The posterior end of the male's body is rounded, of the female's — is forked. The mouthparts is of a piercing-sucking type.</p>
	<p><b>Phthirus pubis.</b>  <b>Phylum Arthropoda, class Insecta, order Anoplura.</b>  Size up to 1,5 mm. The body is short and wide.</p>
	<p><b>Blattella germanica.</b>  <b>Phylum Arthropoda, class Insecta, order Blattoidea</b>  The mouthparts is of a gnawing type: an upper lip, upper jaw, lower jaw, palps, lower lip.</p>
	<p><b>Egg of mosquito.</b>  <b>Phylum Arthropoda, class Insecta, order Diptera, family Culicidae, genus Culex</b>  Eggs have a wedge shape and no air floats.</p>
	<p><b>Egg of mosquito.</b>  <b>Phylum Arthropoda, class Insecta, order Diptera, family Culicidae, genus Anopheles</b>  Eggs have air floats; swim separately</p>



**Larva of mosquito.**  
**Phylum Arthropoda, class Insecta, order Diptera, family Culicidae, genus Culex**  
Larvae of Culex mosquitoes have a respiratory trumpet in the shape of narrow tube on penultimate segment. Such larvae form an angle with the water surface.



**Larva of mosquito.**  
**Phylum Arthropoda, class Insecta, order Diptera, family Culicidae, genus Anopheles**  
Larvae of Anopheles mosquitoes have no respiratory siphon and are located parallel with water surface.



**Pupa of mosquito.**  
**Phylum Arthropoda, class Insecta, order Diptera, family Culicidae, genus Culex**  
Chrysalid of Culex mosquito has straight tube-shaped respiratory trumpet.






**Pupa of mosquito.**  
**Phylum Arthropoda, class Insecta, order Diptera, family Culicidae, genus Anopheles**  
Chrysalid of Anopheles mosquito has funnel-shaped respiratory trumpet



**Head of male mosquito.**  
**Phylum Arthropoda, class Insecta, order Diptera, family Culicidae, genus Culex**  
Palps of Culex are usually longer than the proboscis and have no thickenings.



	<p><b>Head of male mosquito.</b>  <b>Phylum Arthropoda, class Insecta, order Diptera, family Culicidae, genus Anopheles</b>  Palps of Anopheles males are equal in length to the proboscis and have club-shaped thickenings,</p>
	<p><b>Head of female mosquito.</b>  <b>Phylum Arthropoda, class Insecta, order Diptera, family Culicidae, genus Culex</b>  Palps of Culex females comprise <math>\frac{1}{3}</math>–<math>\frac{1}{4}</math> of the proboscis length</p>
	<p><b>Head of female mosquito.</b>  <b>Phylum Arthropoda, class Insecta, order Diptera, family Culicidae, genus Anopheles</b>  Palps of Anopheles females are equal in length to the proboscis.</p>

## Class 12 (26). COLLOQUIUM IN PARASITIC MICROPREPARATIONS

**Purpose of the practice:** to increase ability to differentiate parasitic micropreparations.

**Variant 1.** Computer testing.

**Variant 2.** Each student differentiate 5 micropreparations, answers their Latin names and taxonomy, explains peculiarities of the micropreparations.

### List of micropreparations

1. Lamblia.
2. Trypanosoma.
3. Leischmania.
4. Trichomonas.
5. Balantidium.
6. Toxoplasma.
7. Plasmodia (ring-shaped schizont, amoeboid schizont, morula, gamont).
8. Common liver fluke.
9. Eggs of common liver fluke.
10. Cat liver fluke.
11. Eggs of cat liver fluke.
12. Eggs of schistosomes.
13. Scolex of beef tapeworm.

14. Scolex of pork tapeworm.
15. Immature (hermaphroditic) proglottids of beef tapeworm.
16. Immature (hermaphroditic) proglottids of pork tapeworm.
17. Mature (gravid) proglottids of beef tapeworm.
18. Mature (gravid) proglottids of pork tapeworm.
19. Eggs of beef and pork tapeworms
20. Dwarf tapeworm.
21. Echinococcus and Alveococcus
22. Mature proglottid of broad tapeworm.
23. Cross-section of the scolex of broad tapeworm.
24. Eggs of broad tapeworm.
25. Cross-section of *Ascaris suum*.
26. Eggs of *Ascaris lumbricoides*.
27. Whipworm (male).
28. Whipworm (female).
29. Eggs of whipworm.
30. Trichinella.
31. Larva of trichinella.
32. Pinworm (male).
33. Pinworm (female).
34. Eggs of pinworm.
35. Tick of the family Ixodidae.
36. Tick of the genus *Dermacentor*.
37. Flour mite.
38. Itch mite.
39. Head louse.
40. Body louse.
41. Flea.
42. Mouthparts of oriental cockroach.
43. Eggs of *Culex* mosquito.
44. Eggs of *Anopheles* mosquito.
45. Larvae of *Culex* mosquito.
46. Larvae of *Anopheles* mosquito.
47. Chrysalis of *Culex* mosquito.
48. Chrysalis of *Anopheles* mosquito.
49. Head of female of *Culex* mosquito.
50. Head of male *Culex* mosquito.
51. Head of female *Anopheles* mosquito.
52. Head of male *Anopheles* mosquito.

## **Class 12 (26). CONTROL PRACTICE IN PARASITOLOGY**

**Purpose of the practice:** to estimate student's knowledge in studied topics.

### **QUESTIONS FOR CONTROL**

1. Origin and age of parasitism. Criteria of parasitism. Classification of parasites and their hosts. The parasite–host system.
2. Transmission routes of parasites. Adaptations to parasitism.
3. Pathogenic action and specificity of parasites. Response of the host to parasitic invasion.
4. Biological basis of prophylaxis of parasitic diseases.
5. General characteristic of the kingdom Protista.
6. *Entamoeba histolytica*, *E. coli*, *E. gingivalis*. Life cycle of the *E. histolytica*, pathogenic action, characteristic symptoms, diagnosis and prophylaxis.
7. *Leishmania*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis
8. *Trypanosoma*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis
9. *Lambliia*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis
10. *Trichomonas*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis.
11. Characteristics of the classes Ciliata and Sporozoa.
12. *Balantidium coli*: route of transmission, pathogenic action, symptoms and diagnosis.
13. Life cycle of a malaria parasite. Types of malaria parasites, their appearance in a thin blood smear.
14. Route of transmission of malaria, pathogenic action of malaria parasites; symptoms and diagnosis of malaria.
15. *Pneumocystis carinii*: life cycle, route of transmission, pathogenic action, symptoms and diagnosis General characteristic and systematics of the phylum Plathelminthes.
16. *Toxoplasma gondii*: life cycle, route of transmission, pathogenic action, symptoms and diagnosis.
17. Progressive adaptations of flukes to parasitic life. Peculiarities of life cycles of trematodes.
18. Liver fluke: morphological peculiarities, life cycle, routes of transmission, pathogenic action; symptoms, diagnosis and prophylaxis of fascioliasis.

**19.** Cat liver fluke: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of opisthorchiasis.

**20.** Lung fluke: morphological peculiarities, life cycle, pathogenic action, characteristic symptoms. Diagnosis and prophylaxis of paragonimiasis.

**21.** Blood flukes (*S. haematobium*, *S. mansoni*, *S. japonicum*): morphological peculiarities, life cycle, routes of transmission, pathogenic action, characteristic symptoms. Diagnosis and prophylaxis of schistosomiasis.

**22.** Laboratory diagnostic techniques of trematodes.

**23.** Biological basis of prophylaxis of trematodes.

**24.** Characteristics of the class tapeworms: external and internal anatomy and adaptations to parasitism.

**25.** Life cycles of Taeniae and Diphylobothria. Types of measles.

**26.** *Taenia solium* and *Taeniarhynchus saginatus*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; symptoms, diagnosis and prophylaxis of taeniarhynchosis and cysticerciasis.

**27.** Dwarf tapeworm: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of hymenolepidosis.

**28.** *Echinococcus* and *Alveococcus*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms. Diagnosis and prophylaxis of echinococcosis and alveococcosis.

**29.** *Diphylobothrium latum*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of diphylobothriosis.

**30.** Laboratory diagnosis of cestodes.

**31.** Prophylaxis of cestodes. General characteristics of the phylum roundworms and the class Nematoda.

**32.** *Ascaris lumbricoides*: morphological and biological peculiarities, routes of transmission, pathogenic action of ascaris and its larvae; symptoms of migration and intestinal stages of ascariasis, diagnosis and prophylaxis of ascariasis.

**33.** Whipworm: morphological and biological peculiarities, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of trichocephaliasis.

**34.** Seatworms: morphological and biological peculiarities, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of enterobiasis.

**35.** *Trichinella*: morphological and biological peculiarities, routes of transmission, pathogenic action; symptoms, diagnosis and prophylaxis of trichinelliasis.

**36.** Threadworm: morphological peculiarities and life cycle, routes of transmission, pathogenic action, and characteristic symptoms. Diagnosis and prophylaxis of strongyloidiasis.

**37.** Dog roundworm: morphological peculiarities and life cycle, routes of transmission, pathogenic action, and characteristic symptoms. Diagnosis and prophylaxis of toxocarosis.

**38.** Diagnostic methods of nematodoses.

**39.** Prophylaxis of geohelminthiasis. General characteristic and taxonomy of the phylum Arthropoda.

**40.** General characteristic and taxonomy of the class Arachnida.

**41.** Ticks of the family Ixodidae as vectors of human diseases; mites of families Sarcoptidae, Tyroglyphidae and Demodicidae as pathogens of human diseases; morphology and biology of ticks

**42.** General characteristic and taxonomy of the class Insecta.

**43.** Order Aphaniptera: morphology, biology, medical significance, prophylaxis.

**44.** Order Anoplura: morphology, biology, medical significance, prophylaxis.

**45.** Order Blattoidea: morphology, biology, medical significance, prophylaxis.

**46.** Order Heteroptera: morphology, biology, medical significance, prophylaxis.

**47.** Mosquitoes of genera Culex, Anopheles and Aedes: morphological and biological peculiarities and medical significance.

**48.** Flies: house fly, stable fly, tsetse fly, spotted flesh fly; morphological and biological peculiarities and medical significance

**49.** Sand flies; morphological and biological peculiarities and medical significance.

## QUESTIONS FOR THE END-OF-COURSE EXAMINATION

**Examination is conducted by means of *written testing*.**

**Plan of the test and estimation of answers**

<b>№</b>	<b>Type of issue</b>	<b>Points per issue</b>	<b>The number of issues</b>	<b>Maximal number of points for the issues</b>
<b>1.</b>	Written question	<b>23</b>	<b>1</b>	<b>23</b>
<b>2.</b>	Multichoice tests	<b>2</b>	<b>5</b>	<b>10</b>
<b>3.</b>	Problems	<b>7</b>	<b>3</b>	<b>21</b>
<b>4.</b>	Micropreparations	<b>3</b>	<b>2</b>	<b>6</b>
<b>5.</b>	Gap-filling tests	<b>2</b>	<b>20</b>	<b>40</b>
	Totally		<b>31</b>	<b>100</b>

## **Contents of the end-of-course examination**

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- 5.** General characteristic of the kingdom Protista.
- 6.** *Entamoeba histolytica*, *E. coli*, *E. gingivalis*. Life cycle of the *E. histolytica*, pathogenic action, characteristic symptoms, diagnosis and prophylaxis.
- 7.** *Leishmania*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis
- 8.** *Trypanosoma*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis
- 9.** *Giardia lamblia*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis
- 10.** *Trichomonas*: morphological peculiarities, life cycle, routes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis.
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- 41.** Ticks of the family Ixodidae as vectors of human diseases; mites of families Sarcoptidae, Tyroglyphidae and Demodicidae as pathogens of human diseases; morphology and biology of ticks
- 42.** Poisonous fungi, their characteristics, toxins and effects on the organism. First aid and prevention of poisonings with mycotoxins.
- 43.** Poisonous plants, their characteristics, classification, toxins and effects on the organism. First aid and prevention of poisonings with phytotoxins
- 44.** Classification of poisonous and venomous animals.
- 45.** Physiological characteristic of toxins of invertebrates (jellyfish, arachnids, hymenopterans), their effect on the body; the first aid and prophylaxis of bites and poisoning.
- 46.** Physiological characteristic of toxins of vertebrate animals, their effect on the body; the first aid and prophylaxis.
- 47.** General characteristic and taxonomy of the class Insecta.
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# **МЕДИЦИНСКАЯ БИОЛОГИЯ**

## **MEDICAL BIOLOGY**

Методические рекомендации для студентов, обучающихся  
по специальности «Лечебное дело»

На английском языке

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