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BIOLOGY

Methodological recommendations for the students studying
in the speciality «Pharmacy»



Minsk BSMU 2018

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ
БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ
КАФЕДРА БИОЛОГИИ

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БИОЛОГИЯ

BIOLOGY

Методические рекомендации для студентов, обучающихся
по специальности «Фармация»



Минск БГМУ 2018

УДК 57(075.8)–054.6
ББК 28.70я73
Б63

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Содержат контрольные вопросы 19 тем занятий, основные термины, планы практической работы, иллюстративный материал, вопросы к итоговым занятиям и экзамену по биологии.

Предназначены для студентов медицинского факультета иностранных учащихся, обучающихся на английском языке по специальности «Фармация».

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INFORMATION ABOUT THE COURSE OF BIOLOGY FOR THE STUDENTS STUDYING IN THE SPECIALTY «PHARMACY» IN THE BELARUSIAN STATE MEDICAL UNIVERSITY

PLAN OF THE COURSE

Students of the specialty «Pharmacy» study the course «Biology» during **one semester** of the first year. In the end of the semester they are examined.

In the Department of Biology students predominantly study **Genetics**. The program of the course includes **19 classes**:

1. The role of Biology in medical education. Methods used to investigate cell.
2. Biology of the cell. Flow of substances and energy in the cell.
3. The flow of genetic information in the cell.
4. Arrangement of hereditary material (part 1).
5. Arrangement of hereditary material (part 2).
6. Genetic engineering.
7. Gene interactions. Genetic linkage. Genetics of sex.
8. Variation.
9. Fundamentals of human genetics (part 1).
10. Fundamentals of human genetics (part 2).
11. Colloquium in Cytology and Genetics (topics 1–10).
12. Reproduction of living matter.
13. Fundamentals of ontogenesis (prenatal period).
14. Fundamentals of ontogenesis (postnatal period).
15. Introduction to Parasitology.
16. Parasites as pathogens of diseases.
17. Poisonous fungi and plants.
18. Poisonous and venomous animals.

LITERATURE

All students must have **practical book** (can be bought in the book shops of the university) and **text-books** (can be bought in the book shops of the university or borrowed in the library).

The **lecture course book** can be borrowed in the library.

The information for the course including the **text-book online** is at the web-site *etest.bsmu.by*. Your login and password are printed on your student card. Usually the materials on the site have the newest information (lectures, last editions of the book).

The **information for students** such as schedules of classes and lectures are at the web-site *bsmu.by* → Departments → Biology → Information for students.

EXAMINE IN BIOLOGY

Date, time, examiner:

The **date** of your examine is appointed in the end of the semester and is not known from the beginning of the course.

The day of the examination is a day of the examination session. Check the list with your schedule (bsmu.by → Main → For students → Schedule for English groups ...). The earliest possible date of the examination – 3 days after the last class of the semester.

The **time** of the exam is appointed one day before.

The **examiner** is assigned on the day of the examination.

The examine itself is a **test**. There are no oral questions and your mark depends on what you write. The *examiners do not change the questions*.

Admission and requirements:

Students are admitted to the examination if they:

- have no missed classes and lectures;
- are **admitted to examines by the dean's office** (must have the **stamp** in the credit-book **or an individual paper** allowing to take the examine).

For taking the examine students must have:

- credit-book (with stamp allowing to take the examine or the individual paper if the stamp is absent);
- white gown;
- pen (the test must be solved with pen, not pencil) and calculator (optional);
- calculator.

The ultimate grade in «Biology» is based on:

- average of all grades of the semester (30 %);
- the grade of the colloquium (10 %);
- the grade of the examination test (60 %).

Retakes: Two retakes are always appointed after examines **at the days of student's vacation**. The first one is usually in a few days after the examine and the second one by the end of the recess. After the recess new semester starts and **extra retakes are not planned**.

The criteria of grades at the retakes can be stricter than on the exam.

DEMANDS OF THE BIOLOGY DEPARTMENT TO THE STUDENTS

1. Students must observe the *safety rules* and *obey the rules* of the Belarusian State Medical University.

2. Students must not to come late for lessons and lectures. *At the appointed time students must be in the class and ready to start*. Students who came late are *not admitted* and miss the class or lecture.

3. For every lesson students must have *white gowns* and *practical books*. Students who do not have gowns and practical books *are not admitted* and miss the class or lecture.

4. Missed classes must be fulfilled within 2 weeks.

5. Students who have not fulfilled the missed practical classes within 2 weeks *are not admitted* to the further classes, colloquia and the end-of-course examination without dean's permission.

6. Students grades gained at the end-of-course examination *lower than 4.0* can retake the examination only at the end of August.

7. Students with average of all marks (except summary classes) for the year 8.25 or higher (under condition that they pass all final classes with the marks «8», «9» and «10») may be examined only for micropreparations and problems. If the task is done successfully, they get a grade «10».

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

	Points		Grade
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

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) — a 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 × 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 × 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 × 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 the membranes of animal cells.

Concentration gradient — the difference of substance concentrations on the sides of the plasma membrane.

Facilitated diffusion— transport of solutes across the membrane performed by carrier proteins.

Antiport — active transport of substances by the same carrier protein in opposite directions against their concentration gradient.

Microtubules — hollow cylinders that serve as «railways» for special transport proteins.

Cisterna — a flattened membrane-enclosed discs comprising dictyosomes of the Golgi body.

Dictyosome — a stack of flat disc-like sacks cisternae in the Golgi body.

Autophagy—a process in which lysosomes break down cell's own structures, which are no longer useful.

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

Glycolysis — breakdown of glucose into 2 pyruvates in the cell cytoplasm.

Citric acid cycle — a circular chain of chemical reactions in which acetyl-CoA is broken down into CO₂ and electrons with protons are collected for further reactions.

ATP-synthase — the enzyme complex of the inner mitochondrial membrane, which uses energy of protons flowing, down the gradient to create ATP.

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.

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 (fig. 1).

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: autotrophic (replication) and heterotrophic (protein biosynthesis).
4. The central dogma of molecular biology.

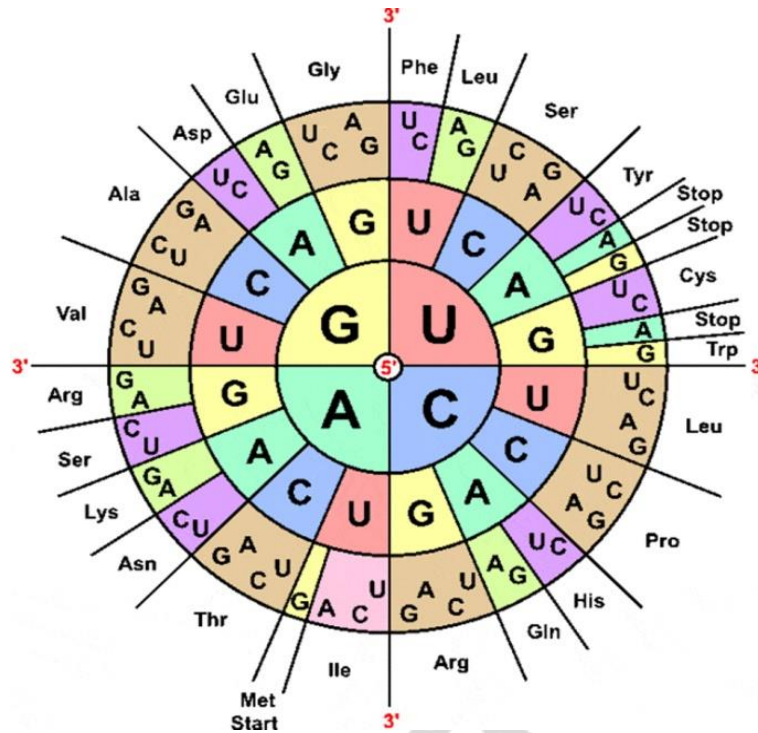


Fig. 1. Genetic code of mRNA. Codons should be read from the center (5') to the periphery (3'). For example, AUG codes for methionine

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 the polypeptide.

Practical work

Task 1. Solve the problems from the practical book.

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 protein repressor attaches.

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 (fig. 2).

Transcripton — the transcription unit of eukaryotes.

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

Exon — informative part of structural genes of eukaryotes.

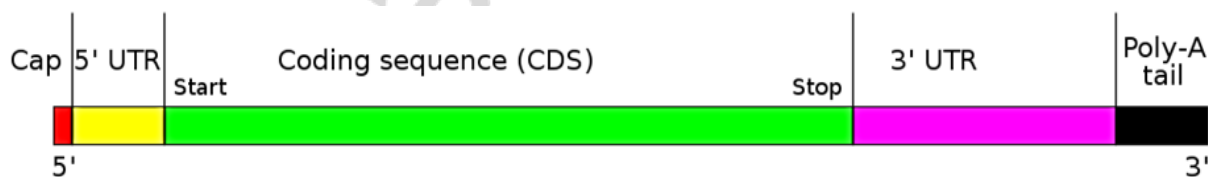


Fig. 2. Diagram of eukaryotic mRNA

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)

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 (table 1).
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 (fig. 3), southern blot, DNA fingerprinting.

Table 1

Some restriction endonucleases

Enzyme	Recognition site and cleavage points
Bal I	5' - TGG CCA - 3' 3' - ACC GGT - 5'
Bam H I	5' - G GATCC - 3' 3' - CCTAG G - 5'
Eco R I	5' - G AATTC - 3' 3' - CTTAA G - 5'
Hind III	5' - A AGCTT - 3' 3' - TTCGA A - 5'
Sal I	5' - G TCGAC - 3' 3' - CAGCT G - 5'
Xba I	5' - T CTAGA - 3' 3' - AGATC T - 5'

Polymerase chain reaction

– **Denaturation:** the mixture of reagents is heated up to 90°C. During 15 seconds 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 seconds.

– **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 10⁶.

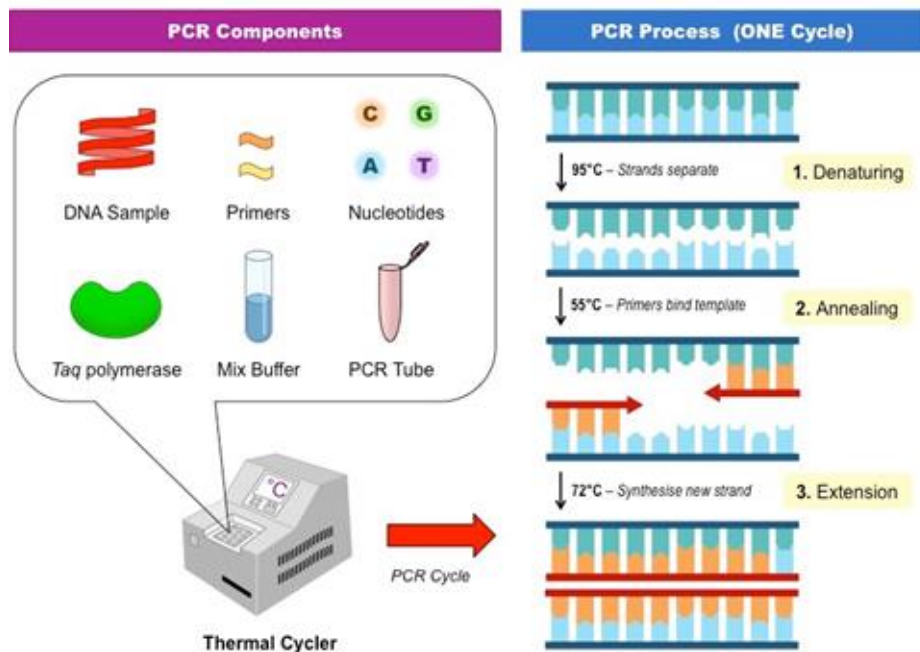


Fig. 3. Polymerase chain reaction

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 λ , ψ 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. 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 (table 2, fig. 4).

Table 2

Inheritance of blood groups

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

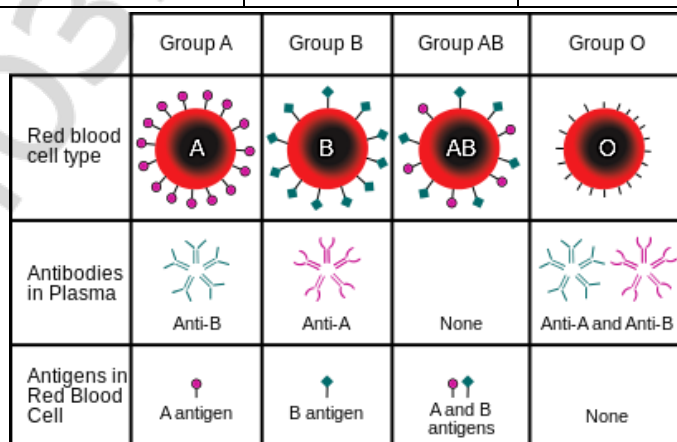


Fig. 4. Antigens and antibodies of the ABO system

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 (fig. 5).
Mary F. Lyon's hypothesis of X-chromosome inactivation.
7. Sex chromosome disorders.

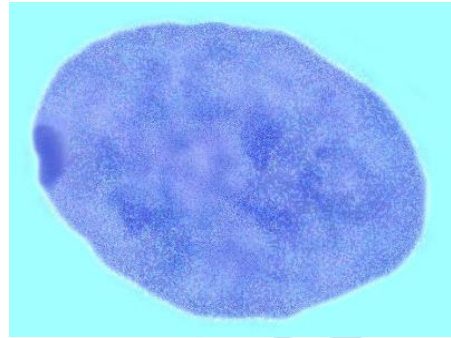


Fig. 5. Barr body in the nucleus in the nucleus of woman's cell

BASIC TERMS AND CONCEPTS

Antigen — any substance which can be recognized and bound by particular types of protective proteins antibodies.

Complementary gene action — a non-allelic gene interaction in which two genes are required for the development of a trait.

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

Inhibitory gene action — non-allelic gene interaction in which one gene inhibits the expression of the other one.

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

Recombinants — organisms who got crossover gametes from parents.

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.

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

Physical determinants of sex — sex determinants of an organism based on its morphology and physiology.

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.

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 (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.

Practical work

Task 1. Solve the problems from the practical book.

Class 8. 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, genome mutations, their characteristics, medical significance (fig. 6).

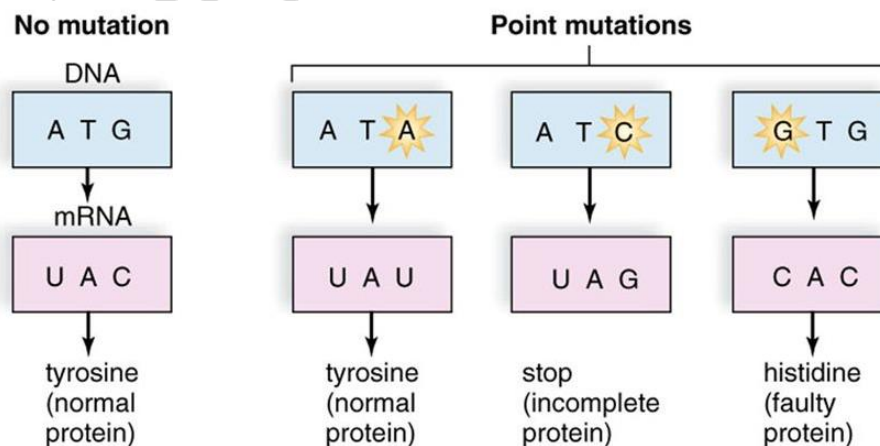


Fig. 6. Types of point mutations

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 an arm.

Duplications — intrachromosomal mutations caused by doubling of a part of the chromosome.

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

Inversion — intrachromosomal mutations when impairment of the gene arrangement 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 — genome 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 9. 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 (fig. 7).

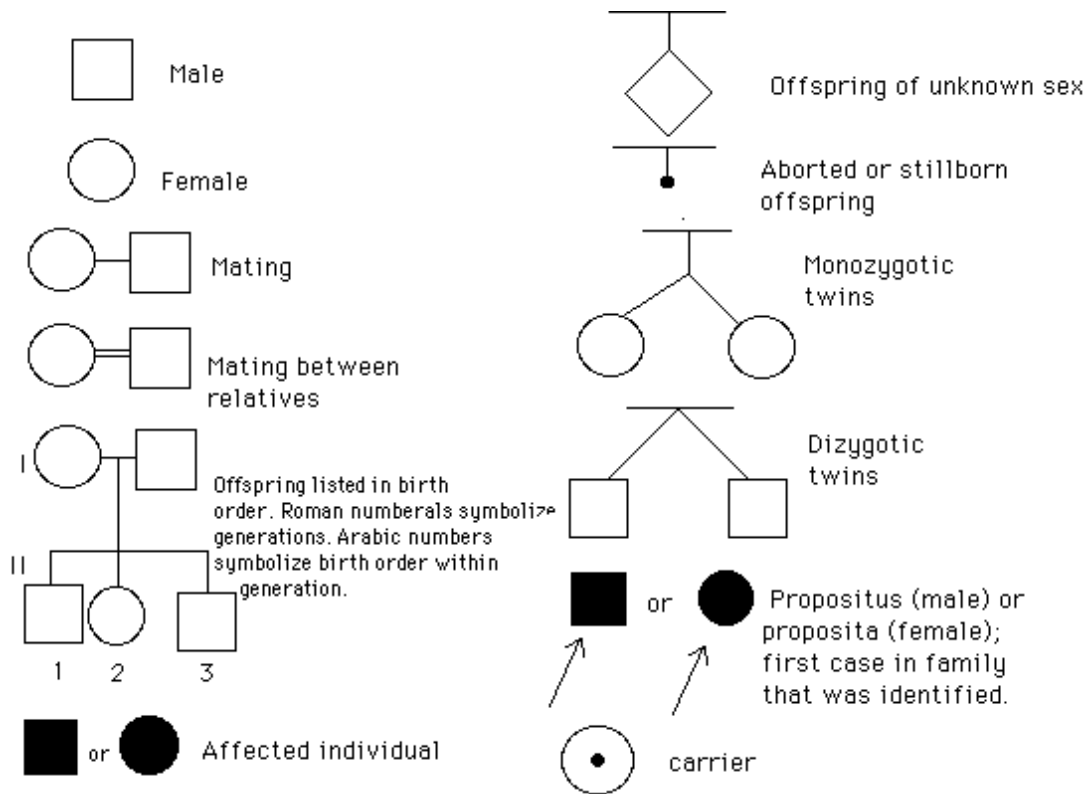


Fig. 7. Legend keys used for drawing pedigree charts

5. The method of twin study. Criteria determining zygoty of twins. Holinger'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 10. 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.

α -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, especially 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 in a 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 groups of this sort.

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

Ultrasonography — diagnostic method using ultrasound for visualization 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 11. COLLOQUIUM IN CYTOLOGY AND GENETICS

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

Questions for control

1. Role of Biology in medical education.
2. 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.
14. Classification of human chromosomes.
15. Mitotic and cell cycles.
16. Interphase.
17. Cause of mitosis.
18. Regulators of the cell cycle (cyclins and cyclin-dependent kinases).
19. Comparison of mitosis and meiosis (content of genetic material during different stages of division).
20. Classification of genes (structural and functional, unique, repeated sequences, transposons).
21. Regulation of transcription in prokaryotes (F. Jacob, J. Monod) and eukaryotes (G.P. Georgiev).
22. Cytoplasmic inheritance.

23. Genetic engineering as a science.
24. Obtaining genetic material: techniques.
25. Restriction endonucleases.
26. Insertion of DNA fragments into a vector molecule.
27. Vectors.
28. Incorporation of the recombinant DNA into a recipient cell.
29. Polymerase chain reaction.
30. Southern blot.
31. DNA fingerprinting.
32. Inheritance of blood groups: systems AB0, MN and Rh.
33. Non-allelic (inter-allelic) gene interactions.
34. Autosomal and gonosomal linkage groups.
35. Chromosome theory of inheritance.
36. Determination of sex in human and its disorders.
37. X-chromosome's sex chromatin. Mary F. Lyon's hypothesis of X-chromosome inactivation.
38. Sex chromosome disorders.
39. Phenotypic variation. Reaction norm.
40. Genotypic variation and its types (combinative and mutational).
41. Comparison of mutations and modifications.
42. Mutagenic factors, their classification and action.
43. Classification of mutations.
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45. Stability and repair of genetic material, antimutagens.
46. Biological basis of oncogenesis.
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48. The human as an object of genetic investigations.
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- 64. Factors impairing the equilibrium of genes and genotypes in populations (mutations, natural selection, population waves, isolation, migrations, genetic drift) and their characteristic.
- 65. Genetic load and its nature.
- 66. Methods of prenatal diagnosis of hereditary disorders and malformations.
- 67. Instant diagnosis tests (dermatoglyphics, microbiological, sex chromatin test, biochemical and chemical).
- 68. Human being as a biological and social object.

Class 12. 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 (fig. 8).

Genetic information	Cells names	Spermatogenesis	Ovogenesis	Cells names	Periods
2n2chr4c	Spermatogonia			Ovogonia	Proliferation (mitosis)
2n2chr4c	Primary spermatocytes			Primary ovocytes	Growth
1n2chr2c 1n1chr1c	Secondary spermatocytes			Secondary ovocytes	Maturation (meiosis)
1n1chr1c	Spermatides				Transformation
1n1chr1c	Spermatozoa			Ovum	

Fig. 8. Gametogenesis

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 an ovum and 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».

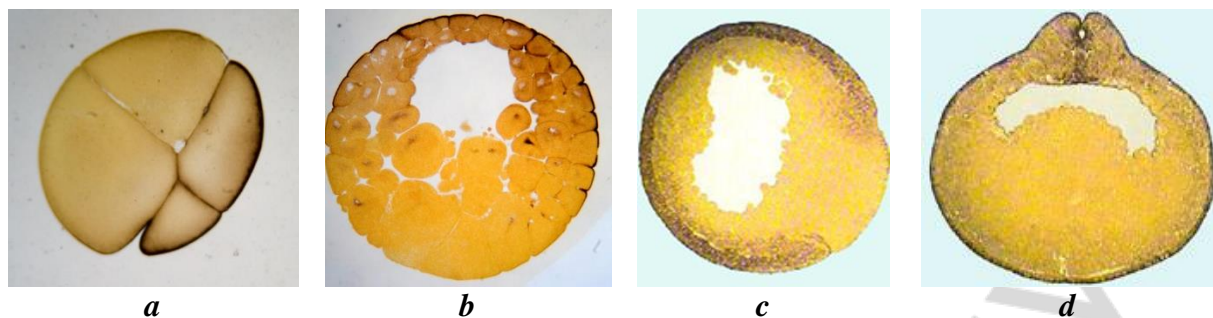
Task 2. Solve the problems from the practical book.

Class 13. FUNDAMENTALS OF ONTOGENESIS (PRENATAL PERIOD)

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.

Contents of the topic:

1. Ontogenesis, its types and periods.
3. Stages of embryogenesis (cleavage, gastrulation (fig. 9), hysto- and organogenesis). Provisional organs of chordates.
4. Peculiarities of embryonic development of human.
5. Realization of genetic information during prenatal ontogenesis. Mechanisms of embryogenesis and morphogenesis.
6. Critical periods of the prenatal ontogenesis. Teratogens.



*Fig. 9. Embryonic development of frog:
a — cleavage of frog's zygote, b — blastula of a frog, c — gastrula of a frog,
d — neurula of a frog*

BASIC TERMS AND CONCEPTS

Blastula — form of embryo consisting of sphere of cells with a cavity inside.

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

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.

Practical work

Task 1. Solve the problems from the practical book.

Task 2. Study the micropreparations «Cleavage of frog's zygote», «Blastula of a frog», «Gastrula of a frog», «Neurula of a frog».

Class 14. FUNDAMENTALS OF ONTOGENESIS (POSTNATAL PERIOD)

Purpose of the practice: 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. Periods of human postnatal ontogenesis. Critical periods of postnatal ontogenesis.
2. Growth. Growth types of human tissues and organs. Acceleration.
3. Human constitution and habitus.

4. Ageing. Basic theories of ageing.
5. 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.

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

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

Gerontology — a science about aging and old age.

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

Metamorphosis — transformation of larval organs into organs of an adult organism.

Indirect development — development of an organism through the stage of larva with further metamorphosis.

Direct development — development of an organism in which it grows and complicate its structure.

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

Class 15. 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 parasitize 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 lie cycle.

Practical work

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


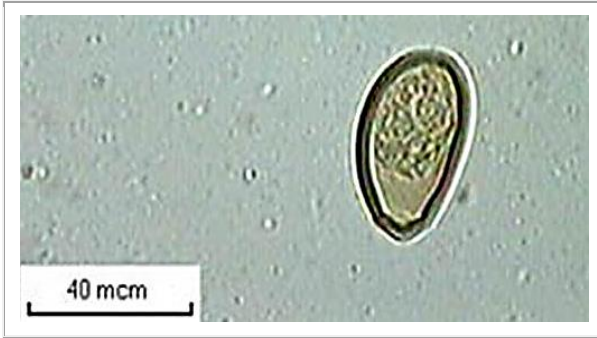
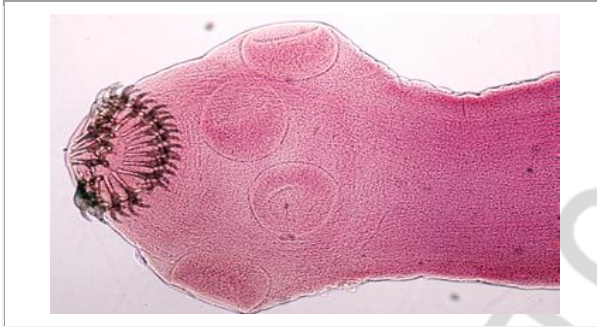
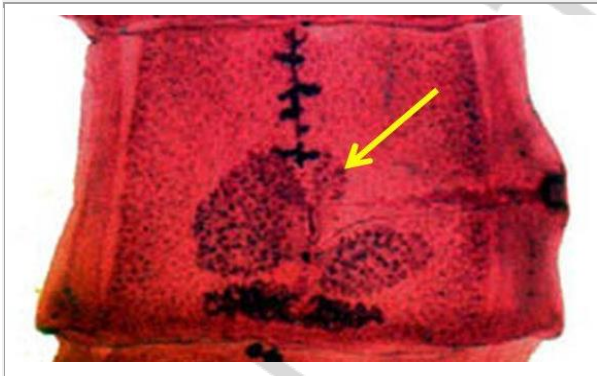
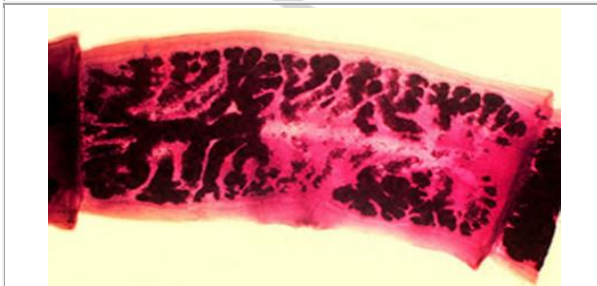
Class 16. PARASITES AS PATHOGENS OF DISEASES





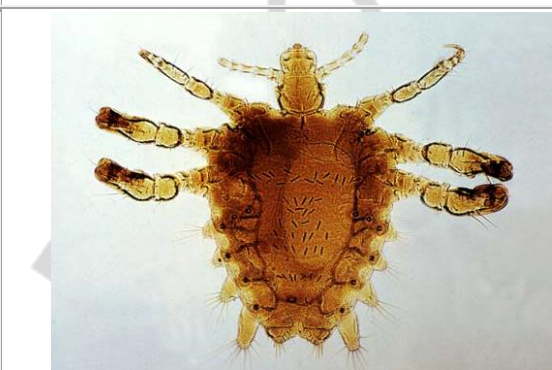
Purpose of the practice: to study peculiarities of morphology (table 3) and biology of parasitic species of classes Zoomastigota, Trematoda, Cestoidea, Nematoda, Arachnida, Insecta, their pathogenic action; to learn methods of diagnosis and prevention of diseases they cause.

Table 3

Parasitic protists

	<p>Trichomonas vaginalis. Phylum Sarcomastigophora, class Zoomastigota. Oval shape Spike on the 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 vacuoles. Causes <i>trichomoniasis</i>.</p>
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	<p>Opisthorchis felineus. Phylum Plathelminthes, class Trematoda. 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>Egg of the Opisthorchis felineus. Phylum Plathelminthes, class Trematoda. Eggs are 26–30 × 10–15 μm in size, of yellowish-brown color, oval, there is a lid on one pole.</p>
	<p>Scolex of Taenia solium. Phylum Plathelminthes, class Cestoidea. There are 4 suckers and a rostellum with 2 rows of hooks on the scolex.</p>
	<p>Hermaphroditic (immature) proglottid of Taenia solium. Phylum Plathelminthes, class Cestoidea. The proglottid contains a 3-lobed ovary. The third lobule of the ovary is situated between uterus and vagina.</p>
	<p>Gravid (mature) proglottid of Taenia solium. Phylum Plathelminthes, class Cestoidea. A mature proglottid contains a uterus with 7–12 branches.</p>

	<p>Egg of <i>Taenia solium</i> or <i>Taeniarhynchus saginatus</i>. Phylum Plathelminthes, class Cestoidea. 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>Egg of <i>Ascaris lumbricoides</i>. Phylum Nematelminthes, class Nematoda. 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><i>Sarcoptes scabiei</i>. 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.</p>
	<p><i>Pediculus humanus capitis</i> Phylum Arthropoda, class Insecta, order Anoplura. 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><i>Phthirus pubis</i>. Phylum Arthropoda, class Insecta, order Anoplura. Size up to 1,5 mm. The body is short and wide.</p>

Contents of the topic:

1. Trichomonas — parasitic protest.
2. Cat liver fluke — parasitic fluke.
3. Pork tapeworm — parasitic tapeworm.
4. Ascaris — parasitic roundworm.
5. Itch mite — pathogen of scabies.
6. Lice — insects pathogens and vectors of diseases.

BASIC TERMS AND CONCEPTS

Proglottid — a body segment of tapeworms.

Biohelminthes — worms that require several different host to complete their life cycle.

Cisticercus — a mease of Taenia solium.

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

Geohelminthes — worms that have life stages requiring development in soil.

Marita — a sexually mature life stage of flukes.

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

Migration of larvae — changing the site of parasitizing by a larval stage of roundworms in the human organism.

Migration ascariasis — a stage of ascariasis associated with migration of ascasis larvae within the body.

Miracidium — the 1st larval stage in the fluke development cycle.

Pediculosis — a disease caused by lice of g. Pediculus.

Phthiriasis — a disease caused by a pubic louse.

Scolex — a head of tape worms.

Strobila — a body of tape worms consisting of segments.

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: «Trichomonas vaginalis», «Toxoplasma gondii», «Morphology of malaria parasites in blood smears», color them and write indications.

Class 17. POISONOUS PLANTS

Purpose of the practice: to learn main groups of poisonous fungi and plants, physiological characteristics of myco- and phytotoxins and their medical use.

Contents of the topic:

1. Poisonous macro- and micromycetes, their characteristics, toxins and effects on the organism. First aid and prevention of poisonings with mycotoxins.
2. Poisonous algae, their characteristics, classification, toxins and effects on the organism. First aid and prevention of poisonings with algal toxins.
3. Poisonous plants, their characteristics, classification, toxins and effects on the organism.
4. Phytotoxins. Their nature and effects. First aid and prevention of poisonings with phytotoxins.

BASIC TERMS AND CONCEPTS

Mycotoxins — toxins produced by fungi.

Toxins — poisonous substance produced by living organisms and capable of causing impairment of health when introduced into the body.

Unpalatable mushrooms — mushrooms which are not toxic, but have unpleasant taste even after cooking.

Phytotoxins — toxins produced by plants.

Poison — substance or mixture of substances that impair health if absorbed body surface, ingested or inhaled.

Practical work

Task 1. Fill in the table «Poisonous mushrooms».

Task 2. Fill in the table «Poisonous plants».

Class 18. POISONOUS AND VENOMOUS ANIMALS

Purpose of the practice: to study the classification and species of venomous animals, structure of apparatus for injecting venom and physiological characteristic of toxins, their action on the human; the first aid and prophylactic measures against bites and poisoning.

Contents of the topic:

1. Classification of toxic animals (primarily and secondarily toxic, actively and passively toxic).
2. Physiological characteristic of toxins of invertebrates (jellyfish, arachnids, hymenopterans), their effect on the body; the first aid and prophylaxis of bites and poisoning.
3. 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

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

Mechanical vector — vector that transmits pathogens on body surface or on mouthparts.

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

Actively-toxic poisonous animals — have venomous glands but no specialized apparatus for injection of their venom.

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

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

Practical work

Task 1. Fill in the table «Venomous animals» in the practical book.

Task 2. Study the photographs of poisonous and venomous animals.

QUESTIONS FOR THE END-OF-COURSE EXAMINATION

Examination is conducted by means of *written testing*.

Plan of the test and estimation of answers (*table 4*)

Table 4

Type of issue	Points per issue	The number of issues	Maximal number of points for the issues
Written question	23	1	23
Multichoice tests	2	5	10
Problems	9	3	27
Gap-filling tests	2	20	40
Totally		31	100

CONTENTS OF THE END-OF-COURSE EXAMINATION

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3. Significance of Biology for pharmaceutical education.
4. Subject matter, tasks and methods of cytology.
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7. Difference between pro- and eukaryotic cells.
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26. Genetic engineering as a science.
27. Obtaining genetic material: techniques.
28. Restriction endonucleases. Insertion of DNA fragments into a vector molecule.
29. Vectors.
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