# BIOLOGY

## FOR INTERNATIONAL STUDENTS

## IN THE SPECIALTY «PHARMACY»

**Practical book**

Minsk BSMU 2016

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ
БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ
КАФЕДРА БИОЛОГИИ

# БИОЛОГИЯ

## ДЛЯ ИНОСТРАННЫХ СТУДЕНТОВ ПО СПЕЦИАЛЬНОСТИ «ФАРМАЦИЯ»

# BIOLOGY

## FOR INTERNATIONAL STUDENTS IN THE SPECIALTY «PHARMACY»

Практикум

Минск БГМУ 2016

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Предназначен для студентов 1-го курса медицинского факультета иностранных учащихся, обучающихся на английском языке по специальности «Фармация».

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# Current marks

Name of the student _____

| №№ | Topic of practice | Mark | Teacher's signature |
|---|---|---|---|
| 1. | Magnifying devices. Methods of studying cells | | |
| 2. | Biology of the cell. The flow of substance and energy in the cell | | |
| 3. | The flow of genetic information in the cell | | |
| 4. | Organization of hereditary material | | |
| 5. | Inheritance regularities. Interaction of genes | | |
| 6. | Genetic linkage | | |
| 7. | Variation | | |
| 8. | Biology and genetics of sex | | |
| 9. | Fundamentals of human genetics | | |
| 10. | Genetic engineering | | |
| 11. | Genetic of populations | | |
| 12. | **Control practice in cytology, molecular biology and genetics** | | |
| 13. | Reproduction of organisms | | |
| 14. | Fundamentals of ontogenesis (embryonic development) | | |
| 15. | Fundamentals of ontogenesis (post-embryonic development) | | |
| 16. | Introduction to parasytology | | |
| 17. | Parasytes as pathogens of the diseases | | |
| 18. | Toxic animals | | |

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# БИОЛОГИЯ

**ДЛЯ ИНОСТРАННЫХ СТУДЕНТОВ ПО СПЕЦИАЛЬНОСТИ «ФАРМАЦИЯ»**

# BIOLOGY

**FOR INTERNATIONAL STUDENTS IN THE SPECIALTY «PHARMACY»**

Практикум

На английском языке

Ответственный за выпуск В. Э. Бутвиловский
Переводчики: В. В. Григорович, Е. А. Романовский
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**Practice 1.** Topic: **MAGNIFYING DEVICES. METHODS OF STUDYING CELLS** «____» _____ 201__ year

**Purpose of the practice:** to get acquainted with methods of studying cells, to study the microscope system and the rules of its operation.

## CONTROL QUESTIONS

1. Subject, tasks and methods of cytology.
2. Magnifying devices and their purpose. Structure of a light microscope.
3. Rules of working with the microscope.

## BASIC TERMS AND CONCEPTS

1. **Immersion —**
2. **Condensor —**
3. **Cremaliera —**
4. **Objective lens —**
5. **Ocular —**
6. **Resolution —**
7. **Revolving mechanism —**

## RULES OF WORKING WITH A SMALL MAGNIFICATION (7 × 8) MICROSCOPE

1. Put the microscope at the distance approximately a palm width from the table edge; set the column towards yourself and the mirror towards the light origin.
2. Set the objective lens to 2–3 cm from the surface of the stage by the *macrometric* knob.
3. Check the adjustment of the objective with small magnification (8×) until it "clicks", it should be fixed opposite the aperture on the stage.
4. Put the condenser into a neutral position and open the diaphragm completely.
5. *Looking into the ocular*, direct the mirror surface to the light source for good illumination.
6. Place the micropreparation on the stage, the cover glass should be directed towards the objective!
7. *Looking on the side* (!), lower the objective 0.5 cm from the surface of the cover glass with a macrometric screw (the focal distance of the objective with 8× is *about 1 cm*).
8. Looking into the ocular, rotate *the macrometric screw towards "yourself"* slowly (!) to get a clear image of the object.
9. Study the object. Move the preparation manually.

**Note:** If the object is too small and is not seen at small magnification, then you may set the microscope to an edge of the cover glass. Having obtained a clear image of the glass edge, move it further to a working field searching the object.

## WORKING WITH HIGH MAGNIFICATION OBJECTIVE LENS (×40)

1. Get a clear object image at small magnification (see above).
2. Center the needed area of a micropreparation — move it to the center of the field of vision.
3. Rotate the objective lens with large magnification (×40) using a revolver until it 'clicks'
4. Put the condenser into an upper position. Looking from the side, *carefully* lower the large magnification objective with the macrometric screw until it touches the surface of the cover glass (the focal distance of 40x objective is approximately 1–2 mm).
5. Looking into the ocular, turn *slightly* a *macrometric screw towards yourself* (!) until the object outlines appear.
6. Use a *micrometric screw* for getting a better image turning it towards yourself or from yourself.
7. Study the needed area of the micropreparation.

## TERMINATING THE WORK WITH THE MICROSCOPE:

1. Having finished studying the object, raise the draw-tube 2–3 cm with a macrometric screw and take off the preparation off the stage.
2. Set a small magnification objective until it "clicks" by turning the revolver and fix it against the aperture on the stage
3. Lower the objective to the stage level with a macrometric screw.

## PRACTICAL WORK

**Task No 1. Make indications for the picture.**

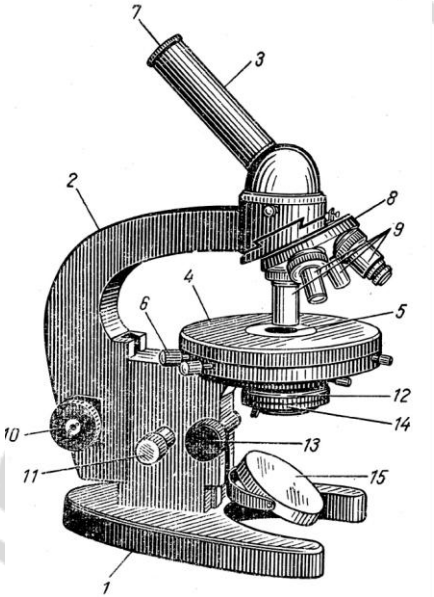


Fig. 1. Microscope:
1 –
2 –
3 –
4 –
5 –
6 –
7 –
8 –
9 –
10 –
11 –
12 –
13 –
14 –
15 –

**Task No 2. Study the micropreparations, color the pictures and make indications:**

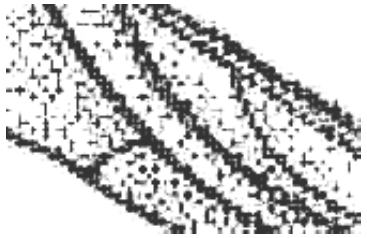

Fig. 2. Fragment of the fly's wing (7×8)

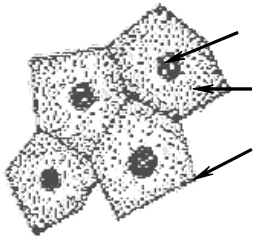

Fig. 3. Frog epithelium:
1 — membrane; 2 — cytoplasm;
3 — nucleus

**Teacher's signature**

**Practice 2.** Topic: **BIOLOGY OF THE CELL. THE FLOW OF SUBSTANCE AND ENERGY IN THE CELL** «____» _____ 201__ year

**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.

**CONTROL QUESTIONS**

1. The present state of the cell theory.
2. Distinguishing features of pro- and eukaryotic cells.
3. The structure (models) of elementary membrane, its properties and functions.
4. Ways of passing substances into the cell.
5. Anabolic system of the cell.
6. Catabolic system of the cell.
7. Energy exchange in the cell. Enzyme systems of mitochondria.

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**BASIC TERMS AND CONCEPTS**

1. **Concentration gradient —**
2. **Glycocalyx —**
3. **Glycolysis —**
4. **Glyoxysomes —**
5. **Enzymes of Krebs cycle —**
6. **Enzymes of oxidative phosphorylation —**
7. **Enzymes of tissue respiration —**
8. **Mesosomes —**
9. **Nucleoid —**
10. **Peroxisomes —**
11. **Plasmalemma —**

## TESTS FOR SELF-CONTROL

1. **Properties of elementary membrane are:** a) plasticity; b) impermeability and fluidity; c) semi-permeability; d) elasticity; e) self-locking.
2. **Transport of substances into the cell that require ATP energy is:** a) transport of ions into the cell according to the concentration gradient; b) phagocytosis; c) pinocytosis and diffusion; d) osmosis and endocytosis; e) transport of substances into the cells against the concentration gradient.
3. **Organelles of the cell anabolic system are:** a) mitochondria and endoplasmic reticulum; b) ribosomes and Golgi complex; c) endoplasmic reticulum; d) lysosomes and peroxisomes; e) glyoxysomes and ribosomes.
4. **Ribosomes are located:** a) on membranes of endoplasmic reticulum and in hyaloplasm; b) in hyaloplasm and karyoplasm; c) on internal nuclear membrane and in chloroplasts; d) on external nuclear membrane and in the mitochondria; e) in mitochondrial matrix and lysosomes.
5. **Functions of the endoplasmic reticulum are:** a) synthesis of proteins; b) DNA synthesis and compartmentalization; c) synthesis of fats and carbohydrates; d) compartmentalization and transport of substances; e) formation of peroxisomes and RNA synthesis.
6. **Functions of Golgi complex are:** a) sorting, packing and secretion of substances; b) formation of lysosomes and complex organic compounds; c) synthesis of ATP, proteins and glyoxysomes; d) synthesis of cell membranes; e) protein synthesis and substance secretion.
7. **Organelles of the cell catabolic system are:** a) mitochondria; b) ribosomes, glyoxysomes and endoplasmic reticulum; c) endoplasmic reticulum and mitochondria; d) Golgi complex and peroxisomes; e) peroxisomes and lysosomes.
8. **Functions of mitochondria are:** a) synthesis of specific proteins; b) splitting of proteins into amino acids; c) synthesis of monosaccharides and ATP; d) synthesis of AMP (adenylic acid); e) splitting of organic substances into $H_2O$ and $CO_2$.
9. **Anaerobic stage of energy exchange occurs in:** a) intestine; b) cytoplasm and mitochondria; c) cytoplasm and endoplasmic reticulum; d) cytoplasm; e) Golgi complex and cell nucleus.

## Fill in the gaps:

1. The ability of biological membranes to divide cytoplasm of the cell is called ...
2. The receptor apparatus located on the outer surface of a plasmalemma is called ...
3. ER (endoplasmic reticulum) and ... form the transport system of the cell.
4. The large subunit of ribosomes contains 40–50 molecules of proteins and … molecules of r-RNA ...
5. The destruction of cell organelles by its own lysosomes is called ...
6. Integral proteins in the outer mitochondrion membrane forming pores and providing permeability of membranes are called …
7. The efficiency of the anaerobic stage of energy exchange is ... %.

## PRACTICAL WORK

**Task 1. Fill the table.**

| Structure | ER | Ribosomes | Golgi complex | Lysosome | Mito-chondria |
|---|---|---|---|---|---|
| Membrane | | | | | |
| Cisterns | | | | | |
| 2 membranes | | | | | |
| Vesicles | | | | | |
| Cristae | | | | | |
| Hydrolyzing enzymes | | | | | |
| ATP-some | | | | | |
| Subunits | | | | | |

**Task 2. Study the diagram, make indications.**

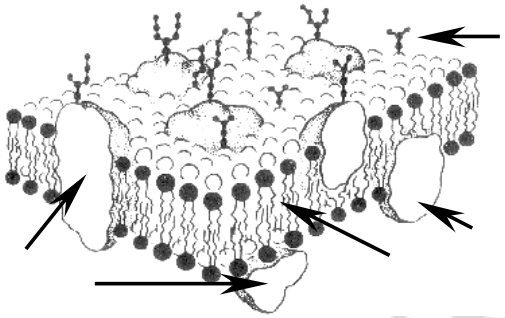

Fig. 1. Plasma membrane:
1 — lipids; 2 — integral; 3 — semi-integral protein;
4 — peripheral proteins; 5 — glycocalyx

**Task III. Study electron-diffraction photographs and make indications.**

Fig. 2. Plasma membrane electron-diffraction photograph:
1 — protein layer; 2 — bilipid layer

Fig. 3. Electron-diffraction photograph of a rough endoplasmic reticulum:
1 — membrane; 2 — canal;
3 — ribosomes

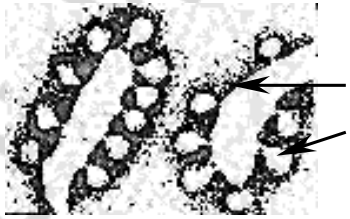

Fig. 4. ATP-some on the mitochondrion cristae:
1 — inner membrane; 2 — ATP-some

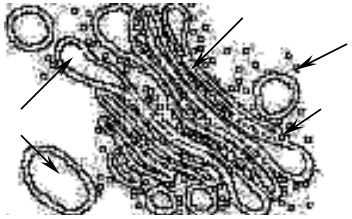

Fig. 5. Electron-diffraction photograph of a Golgi complex:
1 — membrane; 2 — canal; 3 — cistern; 4 — lysosome; 5 — vesicle

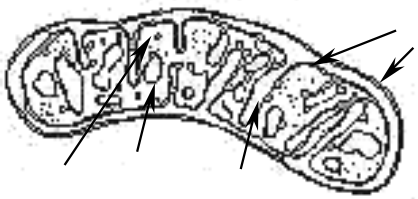

Fig. 6. Electron-diffraction photograph of a mitochondrion:
1 — outer membrane; 2 — inner membrane; 3 — matrix; 4 — cristas;
5 — ribosomes

**Teacher's signature**

**Practice 3.** Topic: **THE FLOW OF GENETIC INFORMATION IN THE CELL** «____» _____ 201__ year

**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.

**CONTROL QUESTIONS**

1. Structure and functions of the nucleus.
2. Types of chromosomes. The structure of a metaphase chromosome.
3. Cell and mitotic cycles.
4. Interphase, characteristic of periods. Causes of mitosis.
5. Characteristic and significance of mitosis.
6. Characteristic and significance of meiosis.
7. Amitosis.

**BASIC TERMS AND CONCEPTS**

1. **Bivalents —**
2. **Karyolymph —**
3. **Cell cycle —**
4. **Synapsis of chromosomes —**
5. **Crossing-over —**
6. **Chiasms —**
7. **Chromatin —**
8. **Meiosis —**
9. **Mitotic cycle —**
10. **Nuclear-cytoplasmic ratio —**
11. **Telomeres of chromosomes —**

## TESTS FOR SELF-CONTROL

1. **Processes that take place in the cell during the pre-synthetic period of interphase are:** a) synthesis of RNA, proteins and enzymes; b) synthesis of DNA, RNA, proteins and ATP; c) ATP synthesis and cell growth; d) accumulation of DNA nucleotides, synthesis of proteins of a division spindle; e) synthesis of DNA, RNA and proteins of a division spindle.
2. **Processes that take place in the cell during the post-synthetic period of interphase are:** a) synthesis of DNA and enzymes; b) synthesis of DNA, r-RNA, cell growth; c) ATP synthesis; d) accumulation of DNA nucleotides; e) synthesis of proteins of a division spindle.
3. **The content of genetic material in the cell at the end of synthetic period of interphase is:** a**)** 1n 1chr 1c; b) 1n 2chr 2c; c) 2n 1chr 2c; d) 2n 2chr 4c; e) 1n 4chr 4c.
4. **Reasons of mitosis are:** a) increase of nuclear-cytoplasmic ratio; b) decrease of nuclear-cytoplasmic ratio; c) replication of DNA and «wound hormones»; d) «wound hormones» and mitogenetic rays; e) impairment of karyolemma's integrity.
5. **The content of genetic material in the cell during the telophase of mitosis is:** a) 1n 1chr 1c; b) 1n 2chr 2c; c) 2n 1chr 2c; d) 2n 2chr 4c; e) 1n 4chr 4c.
6. **Cells that divide by mitosis are:** a) somatic cells; b) cells of gonads; c) gametogoniums; d) tumor cell; e) cells of regenerating tissues.
7. **Cells that divide by amitosis are:** a) somatic and old cells; b) cells of gonads and embryo; c) gametogoniums; d) tumor cells; e) cells of regenerating tissues.
8. **Cells that divide by meiosis are:** a) somatic and old; b) cells of gonads and embryo; c) gametocytes; d) tumor cells; e) cells of regenerating tissues.
9. **Content of cell genetic material in meiosis I prophase is:** a) 1n 1chr 1c; b) 1n 2chr 2c; c) 2n 1chr 2c; d) 2n 2chr 4c; e) $1n_{biv}$ 2chr 2c.
10. **Processes that take place in the cell during the telophase of meiosis I are:** a) spiralization of chromatin and dissolution of nucleolus; b) despiralization of chromosomes and formation of nucleolus; c) formation of karyolemma; d) conjugation of chromosomes and crossing-over; e) cytokinesis.

## Fill in the gaps:

1. The nuclear lamina consists mostly of proteins that are called …
2. On A protein complex at the site of primary constriction of a chromosome which provide attachment of division spindle fibers is called ...
3. A secondary constriction site of a chromosome is also called ...
4. The content of genetic material in a cell during the $G_2$ period is …
5. The content of genetic material in a cell during the diplotene period is …
6. The content of genetic material in a cell during the diakinesis period is …
7. The content of genetic material in a cell during the pachitene period is …
8. Bivalents are bound together only by sites called ... during the diplotene of the meiosis I prophase.
9. ... are observed in the equatorial plate during the metaphase of meiosis I.
10. The content of genetic material in a cell during the metaphase of meiosis II is …

## PRACTICAL WORK

**Task I. Study the diagrams, electron-diffraction photographs, make indications.**

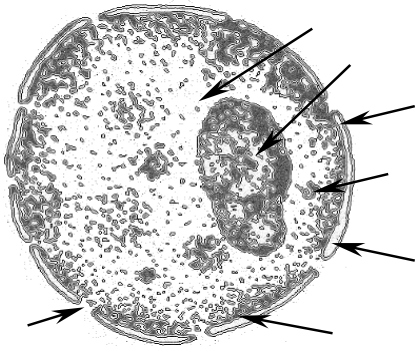

Fig. 1. Electron-diffraction photograph of the cell nucleus:
1 — external nuclear membrane; 2 — internal nuclear membrane; 3 — perinuclear space; 4 — pore; 5 — nucleoplasm; 6 — chromatin; 7 — nucleolus

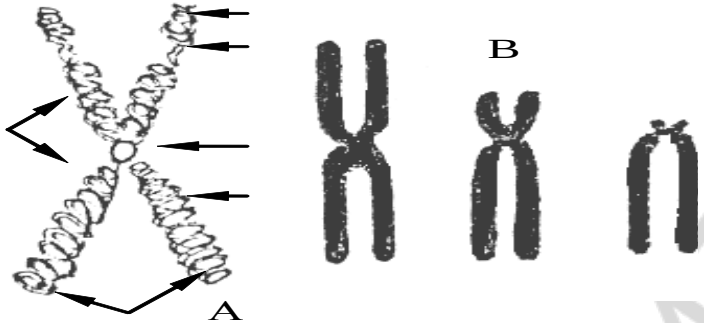


Fig. 2. Make indications in schemes of a metaphase chromosome (A) and various types of chromosomes (B):
1 — arm; 2 — centromere; 3 — secondary constriction; 4 — satellite; 5 — chromatid; 6 — telomeres; 7 — metacentric chromosome; 8 — submetacentric chromosome; 9 — acrocentric chromosome

**Task II. Solve the problem:**

Genes which might become active in the $G_2$ period remained inactive. Will it affect the process of mitosis?

**Task III. Fill the table.**

**Fill the formulas of genetic material content for each stage of mitotic cycle, mitosis and meiosis.**

| Phases and periods | Interphase | Mitosis | Meiosis I | Meiosis II |
|---|---|---|---|---|
| **I.** Presynthetic | | | | |
| **II.** Synthetic | | | | |
| **III.** Postsynthetic | | | | |
| A. Prophase | | | | |
| • leptotene | | | | |
| • zygotene | | | | |
| • pachytene | | | | |
| • diplotene | | | | |
| • diakinesis | | | | |
| B. Metaphase | | | | |
| C. Anaphase | | | | |
| D. Telophase | | | | |

**Task IV. View the micropreparation using the high magnification of the microscope, make a sketch and indications**

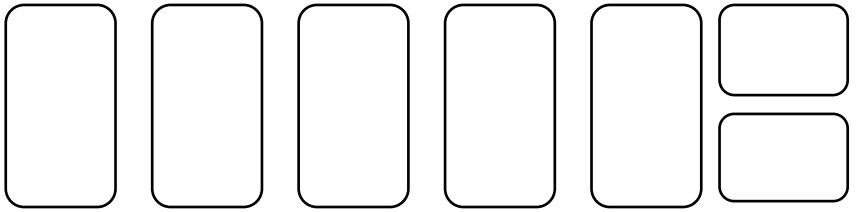


Fig. 3. Mitosis in the cells of onion roots (7×40):
1 — interphase; 2 — prophase; 3 — metaphase; 4 — anaphase; 5 — telophase; 6 — daughter cells; 7 — chromosomes

**Teacher's signature**

**Practice 4.** Topic: **ORGANIZATION OF HEREDITARY MATERIAL** «____» _____ 201__ year

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

## CONTROL QUESTIONS

1. Nucleic acids (DNA and RNA): the structure and functions. Chargaff's rules.
2. Properties of genes.
3. DNA replication.
4. The genetic code and its properties. Biosynthesis of protein.

## BASIC TERMS AND CONCEPTS

1. **Anticodon —**
2. **Codon —**
3. **Complementarity of nitrogenous basics —**
4. **Gene —**
5. **Elongation —**
6. **Initiation —**
7. **Lability of the gene —**
8. **Nucleotide —**
9. **Stability of the gene —**
10. **Termination —**

## TESTS FOR SELF-CONTROL

1. **Amount of purine bases is equal to amount of:** a) A + T; b) C + T; c) G + T; d) A + C; e) G +C.
2. **Bonds between complementary nucleotides in a two-strand DNA are:** a) hydrogen; b) covalent; c) phosphodiester; d) peptide; e) disulfide lfide.
3. **DNA functions are:** a) storage and reproduction of genetic information; b) transport of amino acids to ribosomes; c) transmission of genetic information to daughter DNA molecules; d) transport of amino acids; e) determination of r-RNA synthesis.
4. **Functions of t-RNA are:** a) storage of genetic information; b) transport of amino acids to ribosomes; c) transmission of the genetic information to daughter t-RNA molecules; d) direct participation in assembling of polypeptides; e) transfer of the genetic information from DNA to the ribosome.
5. **Gene properties are:** a**)** stability and lability; b) integrity and pleiotropy; c) integrity, specificity and unambiguity; d) discretion and absence of specificity; e) specificity, tripletness and universality.

6. **Specificity is the gene property to:** a) mutate; b) determine synthesis of the certain polypeptide; c) be responsible for exhibiting several characters; d) vary the degree of its phenotypic manifestation; e) have different frequency of phenotypic manifestations.
7. **Pleiotropy is the gene property to:** a) mutate; b) determine synthesis of the certain polypeptide; c) be responsible for exhibiting several characters; d) vary the degree of its phenotypic manifestation; e) have different frequency of phenotypic manifestations.
8. **Elementary structural unit of a gene is:** a) nitrogenous base; b) pair of complementary nucleotides; c) codon; d) one nucleotide; e) triplet of nucleotides.
9. **Elementary functional unit of a gene is:** a) one nucleotide; b) pair of complementary nucleotides; c) codon; d) transcripton; e) triplet of nucleotides.
10. **Heterosynthetic function of a gene is:** a**)** transcription and replication; b) translation and transcription; c) DNA replication and reparation; d) transformation and translation; e) only translation.
11. **The genes are classified into:** a) structural, modifiers and repressors; b) introns, exons and inhibitors; c) functional and structural; d) corepressors and operators; e) regulators and intensifiers.

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**Fill in the gaps:**

1. The autosynthetic function of the DNA molecule is its … .
2. The DNA-polymerase can move along the matrix strand from the … end to the … end.
3. The direction of the genetic information reading from the 5’ to the 3’-end is the property of the genetic code called … .
4. The identification process by tRNA of its amino acid is called … .
5. There is the initiating mRNA triplet … in the peptidylic center of a ribosome during the translation.
6. The process which begins with the first peptide bond formation and ends up with addition of the last amino acid to the polypeptide molecule is called … .
7. Some antibiotics are … of protein biosynthesis.

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**PRACTICAL WORK**

**Task 1. Solve the problems:**

**Problem No 1.** Indicate and write down the first letters of chemical components of nucleotides in the diagrams of DNA and RNA molecules: **A** for adenine, **G** for guanine, **C** for cytosine, **T** for thymine, **U** for uracyl, **P** for phosphate, **R** for ribose, **D** for deoxyribose.

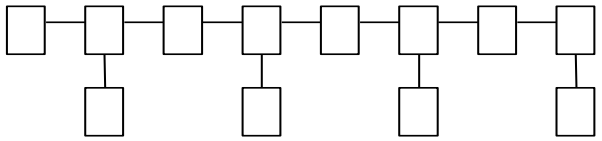

Diagram of RNA molecule

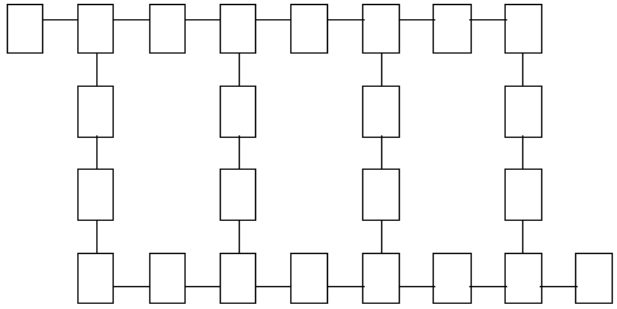

Diagram of DNA molecule

**Problem No 2.** The content of the cytosine nucleotides in the DNA molecule is 18 %. Find the percentage of other nucleotides in this DNA molecule.

**Problem No 3.** A protein consists of 200 amino acids. What is the length of the coding region of its gene if the distance between two adjacent nucleotides in the DNA helix (measured along the helix axis) is $3{,}4 \times 10^{-10}$ m?

**Correspondence of mRNA codons and amino acids**

| First nitrogenous base | Second nitrogenous base: U | C | A | G | Third nitrogenous base |
|---|---|---|---|---|---|
| | Phenylalanine | Serine | Tyrosine | Cysteine | **U** |
| **U** | Phenylalanine | Serine | Tyrosine | Cysteine | **C** |
| | Leucine | Serine | **non** | **non** | **A** |
| | Leucine | Serine | **non** | Tryptofane | **G** |
| | Leucine | Proline | Histidine | Arginine | **U** |
| **C** | Leucine | Proline | Histidine | Arginine | **C** |
| | Leucine | Proline | Glutamine | Arginine | **A** |
| | Leucine | Proline | Glutamine | Arginine | **G** |
| | Isoleucine | Threonine | Asparagine | Serine | **U** |
| **A** | Isoleucine | Threonine | Asparagine | Serine | **C** |
| | Isoleucine | Threonine | Lysine | Arginine | **A** |
| | Methionine | Threonine | Lysine | Arginine | **G** |
| | Valine | Alanine | Aspartic acid | Glycine | **U** |
| **G** | Valine | Alanine | Aspartic acid | Glycine | **C** |
| | Valine | Alanine | Glutamic acid | Glycine | **A** |
| | Valine | Alanine | Glutamic acid | Glycine | **G** |

**Problem No 4.** One of the DNA strands has the following nucleotide sequence: **GAGGCTCTAGGTACCAGT**

a) find the sequence of the nucleotides in the second strand.
b) find the mRNA codons synthesized on the complementary strand.
c) find the sequence of the amino acids in the encoded polypeptide

**Original DNA**
**G A G G C T C T A G G T A C C A G T**

a)

b)

c)

**Problem No 5.** The part of the protein molecule has the following structure: **Serine – Lysine – Histidine – Valine.** How many different variants of the DNA fragment could code for this part of protein molecule?

**Teacher's signature**

**Practice 5.** Topic: **INHERITANCE REGULARITIES. INTERACTION OF GENES** «____» _____ 201__ year

**Purpose of the practice:** to study the inheritance laws during the mono- and polyhybrid crossing, intra- and interallelic gene interaction; to learn how to solve standard problems that demonstrate the objective laws of mono- and polyhybrid crossing, gene interaction.

**CONTROL QUESTIONS**

1. Genetics as a science. Basic concepts of Genetics.
2. Peculiarities of the hybridological method.
3. Inheritance regularities in monohybrid crossing.
4. Hypothesis of purity of gametes and its cytological basis.
5. Analyzing crossing. Phenotypical radical.
6. Regularities of inheritance in polyhybrid crossing. The Law of Independent Assortment.
7. Conditions limiting the Mendel's laws. Pleiotropy. Semi-lethal and lethal genes.
8. Intra-allelic interaction of genes. Inheriting of blood groups.
9. Inter-allelic interaction of genes.

**BASIC TERMS AND CONCEPTS**

1. **Allelic genes** —
2. **Complementation** —
3. **Genome** —
4. **Genotype** —
5. **Homozygous organism** —
6. **Multiple allelism** —
7. **Phenotypical radical** —
8. **Phenotype** —
9. **Polygenic inheritance** —
10. **Superdominance** —

## TESTS FOR SELF-CONTROL

1. **The main features of G. Mendel's hybridological method are:** a) one or of two pairs of alternative alleles are analyzed; b) many alternative alleles are analyzed; c) analysis starts with cross of homozygous organisms; d) several generations are analyzed; e) one generation is analyzed.
2. **Concepts of the hypothesis of purity of gametes:** a) genes of one allelic pair of a hybrid organism are hybridized; b) genes of one allelic pair of a hybrid organism are not hybridized; c) genes of different allelic pairs can be hybridized; d) both allelic genes get in one gamete; e) from each pair of allelic genes one gene gets into gamete.
3. **The conditions necessary for actuality of Mendel's laws:** a) codominance; b) semidominance; c) presence of lethal genes; d) equiprobable formation of gametes and zygotes of different types; e) genes of different allelic pairs are in one chromosome.
4. **Analyzing cross is performed to reveal:** a) mutations; b) a phenotype of the individual; c) a genotype of the individual with a recessive character; d) a genotype of the individual with dominant character; e) lethal genes.
5. **Features of incomplete dominance are:** a) a dominant gene does not completely suppress the action of a recessive gene; b) the dominant gene completely suppress the action of a recessive one; c) homo-and heterozygotes are identical phenotypicly; d) homo-and heterozygotes are not identical phenotypicly; e) the dominant gene in a heterozygous state express stronger, than in homozygous.
6. **Features of co-dominance are:** a) the dominant gene does not completely suppress the action of recessive gene; b) it is a type of interaction of allelic genes, genes are equivalent; c) homo- and heterozygotes are identical phenotypicly; d) it is a type of interaction of non-allelic genes; e) the dominant gene in a heterozygous state express stronger, than in homozygous.
7. **Features of polymeria are:** a) mutual influence of different alleles that occupy adjacent loci of one chromosome; b) 2 dominant genes of different allelic pairs are responsible for a new character; c) 2 recessive genes of different allelic pairs are responsible for a new character; d) one gene is responsible for different characters; e) genes from different allelic pairs have an effect on a manifestation degree of one character.

## Fill in the gaps:

1. Characters with different qualitative states are called …
2. The second and third Mendel's laws require the gene penetrance … %.
3. Bombay phenomenon is an example of the genetic interaction which is called …
4. Phenotypic segregation in ratio 9 : 7 in crossing diheterozygotes result from interallelic gene interaction called ….
5. Independent combination of two pairs of allelic genes during an analyzing cross result in phenotypic segregation ... in the first generation of offsprings.
6. Alleles presented in the populations more than in two states are called …

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## PRACTICAL WORK

**Solve the problems:**

**Problem No 1.** How many and what type of gametes would be formed in the organisms with the genotypes:

P: AaBbDd AAbbCCddRR?

**Problem No 2.** Brown color of eyes is dominant human character while blue color is recessive. The parents of a blue-eyed child have got brown eyes. Find the genotypes of all members of the family.

| Character | Gene | Genotype |
|---|---|---|
| Brown eyes | B | BB; Bb |
| Blue eyes | b | bb |

**Problem No 3.** Angiomatosis of retina is caused by the dominant autosomal gene with 50 % penetrance. What is the possibility of sick children for heterozygous parents?

**Problem No 4.** The allele of brown eyes color dominate over the allele of blue color and the allele of right-handedness (a habit to use mostly the right hand to perform usual work) dominate over the allele of left-handedness. The genes of both characters are situated in the different chromosomes. Parents are brown-eyed right-handed diheterozygotes. What characters would their children get and what is their percentage ratio?

**Problem No 5.** A woman has blood group I (0), Rh-, MN, her husband has blood group IV (AB), Rh+ (homozygote), N. Which combinations of blood groups by all systems will their children get?

**Human's blood group inheritance**

| Signs | Gene | Genotype | Signs | Gene | Genotype |
|---|---|---|---|---|---|
| **AB0 system** | | | **MN system** | | |
| Group I (0) | $I^O$ | $I^OI^O$ | Group M | $L^M$ | $L^ML^M$ |
| Group II (A) | $I^A$ | $I^AI^A$, $I^AI^O$ | Group N | $L^N$ | $L^NL^N$ |
| Group III (B) | $I^B$ | $I^BI^B$, $I^BI^O$ | Group MN | $L^M$ and $L^N$ | $L^ML^N$ |
| Group IV (AB) | $I^A$ and $I^B$ | $I^A I^B$ | | | |
| **Rh system** | | | | | |
| Rh+ | D | DD, Dd | | | |
| Rh- | d | dd | | | |

**Problem No 6.** Congenital deafness can be determined by recessive genes **d** and **e.** The presence of both dominant alleles (**D** and **E**) is necessary for normal hearing. Find out the genotypes of parents if both of them are deaf and their seven children have normal hearing.

**Teacher's signature**

**Practice 6.** Topic: **GENETIC LINKAGE** «____» _____ 201__ year

**Purpose of the practice:** to get acquainted with T. Morgan experiments in the linked inheritance, to study the inheritance in cases of autosomal and gonosomal linkage, to know how to write gametes and solve the problems in gene linkage, to compose and analyze chromosome maps.

## CONTROL QUESTIONS

1. Experiments of T. Morgan. Complete and incomplete genetic linkage.
2. Autosomal and gonosomal linkage groups.
3. Crossing-over, crossover and non-crossover gametes.
4. Basic concepts of the chromosome theory of inheritance.
5. Maps of eukariotic chromosomes (genetic and cytological).

## BASIC TERMS AND CONCEPTS

1. **Cytological map of a chromosome** —
2. **Crossover gametes** —
3. **Genetic map of the chromosome** —
4. **Linkage of genes** —
5. **Non-crossover gametes** —
6. **Recombinants** —

## TESTS FOR SELF-CONTROL

1. **The phenomenon of genetic linkage is observed when genes of different allelic pairs are situated:** a) in the same chromosome; b) in the different chromosomes; c) only in the autosomes; d) only in the X-chromosome; e) only in the Y-chromosome.
2. **Complete genetic linkage is observed:** a) in a female Drosophila and a male silkworm; b) if non-allelic genes are located in different chromosomes; c) if crossing-over occurs; d) if crossing-over does not occur; e) in a male Drosophila and a female silkworm.
3. **Incomplete genetic linkage is observed:** a) if genes of different allele pairs are located in one chromosome; b) if non-allelic genes are located in different chromosomes; c) if crossing-over occurs; d) if crossing-over does not occur; e) in a male Drosophila and a female silkworm.
4. **The main concepts of the chromosome theory of inheritance are:** a) allelic genes are located in the linear order in identical locus's of homologous chromosomes; b) allelic genes occupy different locus's of homologous chromosomes; c) the number of linkage groups is equal to monoploid set of chromosomes; d) the number of linkage groups is equal to diploid set of chromosomes; e) between homologous chromosomes of Drosophila male the crossing-over is possible.
5. **Phenotypic segregation ratio for monohybrid cross of homozygotes at complete dominance:** a) is absent; b) 3:1; c) 1:2:1; d) 9:3:3:1; e) 1:1.
6. **Phenotypic segregation ratio for incomplete genetic linkage in Morgan's experiences:** a) 3:1; b) 1:2:1; c) 9:3:3:1; d) 1:1; e) 41.5:8.5:8.5:41.5.
7. **Phenotypic segregation ratio for complete linkage in Morgan's experiences:** a) 41.5:8.5:8.5:41.5; b) 3:1; c) 1:2:1; d) 9:3:3:1; e) 1:1.

**Fill in the gaps:**

1. Conditions limitting Mendel's 3rd law are: incomplete penetrance of genes, lethal and semi-lethal genes, unequal formation of different types of gametes and zygoteges, genes' pleyotropy, interaction of genes apart from complete dominance and ...
2. If a diheterozygous organism forms only 2 types of gametes, then genetic linkage is …
3. If a diheterozygous organism forms 4 types of gametes, then genetic linkage is ...
4. If crossing-over occur between the genes of a pair of homologous chromosomes, then genetic linkage is ...
5. Biological phenomenon breaking the genetic linkage is …
6. The distance between genes measured in morganids is equal to % of …
7. The maximal probability of crossing-over for linked genes is ... %.
8. Individuals formed from crossover gametes are called …
9. The number of human's autosomal linkage groups is …

**PRACTICAL WORK**

**Genetic experiment of T. Morgan:**

| Gene | Character |
|---|---|
| B | Grey colour of body |
| b | Black colour of body |
| V | Long wings |
| v | Short (vestigial) wings |

**Experiment 1.**

**P. BBVV x bbvv**

**G. (BV) (bv)**

**$F_1$. BbVv**

**Grey colour of body with Long wings - 100 %**

**Experiment 2.**

**P. bbvv x BbVv**

**G. (bv) (BV) (bv)**

**$F_1$. bbvv BbVv**

**50% 50%**

**Experiment 3**

**P. BbVv x bbvv**

**G. (BV) (bV) (bv) (Bv) (bv)**

**$F_1$. BbVv; Bbvv; bbVv; bbvv**

**41,5% 8,5% 8,5% 41,5%**

**Solve the problems**

**Problem No 1.** How many and which types of gametes are formed in the organisms of Drosophilae with the genotypes:

1. Male $\frac{A\ B}{a\ b}$ 2. Female $\frac{A\ B}{a\ b}$ 3. Male $\frac{AB}{a\ b}$ 4. Female $\frac{AB}{a\ b}$

b) a man with the genotype $\frac{AB}{A\ b}\ \frac{V}{v}$

c) a woman with the genotype $\frac{AB}{a\ b}\ \frac{D}{d}$

**Problem No 2.** The human's dominant gene of elliptocytosis (**El**) and the gene that code for the Rh-antigen on the erythrocytes (**D**) are situated in the same autosome at the distance 3 centimorgans. How many and what types of gametes can be produced in the body of:

a) a woman with the genotype: $\frac{Eld}{elD}$

b) a man with the genotype: $\frac{ElD}{eld}$

c) One of the spouses is heterozygous for both characters (Rh+ was inherited from the one parent and the elliptocytosis from the other one). The other spouse has the Rh- and normal erythrocytes. Find out the percentage of the possible genotypes and phenotypes of the children in this family.

| Character | Gene | Genotype | Gene location |
|---|---|---|---|
| Rh+ | D | D- | One autosome<br>Distance D-El = 3 centomorgans |
| Rh- | d | dd | |
| Elliptocytosis | El | El- | |
| Norm | el | elel | |

**Problem No 3.** Genes **L, M** and **N** are referred to one linkage group. During the experiment it was revealed that the distance between genes **L** and **M** is 5 centomorgans, and between genes **M** and **N** is 3 centomorgans. Is it possible to find the distance between genes **L** and **N**? During the additional experiment it was revealed that the distance between **L** and **N** is 2 centomorgans. Draw a diagram to represent the location of these genes in the chromosome.

**Problem No 4.** Cross of heterozygous female drosophilae with recessive male flies showed the following results:

1) AB : Ab : aB : ab = 25 % : 25 % : 25 % : 25 %;

2) BC : Bc : bC : bc = 45 % : 5 % : 5 % : 45 %;

3) CD : Cd : cD : cd = 5 % : 45 % : 45 % : 5 %.

What cases correspond to genetic linkage and free combination of genes? What is the position of the genes in the chromosomes in the 1st, 2nd and 3rd case? Find the distance between the genes in the 2nd and 3rd case.

**Teacher's signature**

**Practice 7.** Topic: **VARIATION** «____» _____ 201__ year

**Purpose of the practice**: to study the main forms of variation, its reasons, medical and biological importance, mechanisms of gene, chromosome and genomic mutations, genetic material repair and biological principles of oncogenesis.

**CONTROL QUESTIONS**

1. Variation and its types.
2. Phenotypic variation. The reaction norm.
3. Genotypic variation and its types.
4. Mutagenic factors.
5. Classification of mutations.
6. Genome, chromosome and gene mutations.
7. Stability and repair of genetic material; anti-mutagens.
8. Biological basis of cancerogenesis.

**BASIC TERMS AND CONCEPTS**

1. **Reading frame shift** —
2. **Cancerogenesis** —
3. **Deletions** —
4. **Duplications** —
5. **Inversion** —
6. **Reaction norm** —
7. **Ring chromosomes** —
8. **Transgenations** —
9. **Transitions** —
10. **Translocations** —

## TESTS FOR SELF-CONTROL

1. **The properties of modifications:** a) have adaptive character; b) are inherited; c) are not inherited; d) are the matter for natural selection; e) are the matter for artificial selection.
2. **Biological mutagens cause:** a) structural defects of genes and chromosomes; b) polyploidy; c) formation of thymine dimers; d) haploidy; e) embedding of its DNA in DNA of the host cells.
3. **Characteristic features of gametic mutations are:** a) occur in sex cells; b) occur in somatic cells; c) manifest in the individual; d) pass to offsprings by sexual reproduction; e) pass to offsprings by asexual reproduction.
4. **Types of functional genes mutations:** a) a transposition; b) impairment of the alternation of recognition and terminations; c) impairment of the alternation of initiation and elongation; d) impairment of the alternation of induction and repression; e) transitions.
5. **Polyploidy is:** a) not multiple of a haploid complement increase of the chromosome number; b) multiple of a haploid complement increase of the chromosome number; c) not multiple of a haploid complement decrease of the chromosome number; d) multiple of a haploid complement decrease of the chromosome number; e) haploid set of chromosomes.
6. **Haploidy is:** a) a positive mutation; b) nullsomy; c) monosomy; d) absence of one chromosome; e) a haploid set of chromosomes.
7. **Kinds of structural genes mutations:** a) transductions; b) a transpositions; c) translocations; d) reading frame shift; e) transitions.
8. **Stages' order of excision repair of a DNA: 1) synthesis of a new DNA strand fragment; 2) ligation of the synthesized strand with the main strand; 3) recognition the damaged DNA strand; 4) cutting out of the damaged DNA fragment; 5) replication of a DNA molecule:** a) 1–5–2–3; b) 5–1–3–2; c) 3–4–5–2; d) 3–4–2–1; e) 3–4–1–2.
9. **According to the oncogene concept, the basis of carcinogenesis is:** a) protooncogenes received from parents or introduced into the cell genome by viruses; b) chromosome mutations of somatic cells; c) presence of protooncogenes in somatic cells of an organism; d) genome mutations of somatic cells; e) incorporations of viral DNA in the genome of somatic cells.

## Fill in the gaps:

1. Enzymes capable of cutting out the damaged part of the DNA during the repair are …
2. Transgenation when one purine base is replaced with another purine base is called ...
3. … of the terminal parts of chromosomes leads to formation of ring chromosomes.
4. Mutation of … genes leads to the impairment of alternation of repression and induction of genes.
5. Non-disjunction of chromosomes during the mitosis or meiosis leads to … mutations.
6. Aneuploidy when only one chromosome of a pair is present in the karyotype is called …
7. Genome mutation when somatic cells have single chromosome set is called …
8. Disease caused by the infringement of DNA repair mechanisms and is characterized by insufficiency of red bone marrow functions resulting in deficit of blood cells and hyperpigmentation is called …

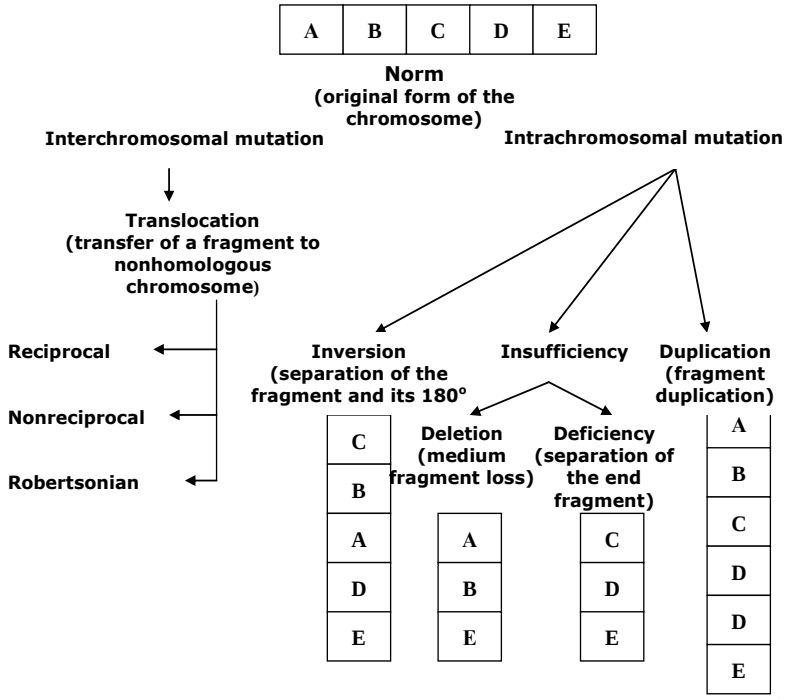



Fig. 1. Change of chromosome structure

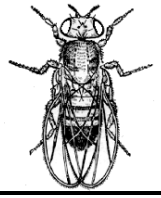
## PRACTICAL WORK

**Task I. Solve the problems.**

**Problem No 1.** Some cells of a sick person have normal karyotype, others — 47 or 45 chromosomes. What is the name this phenomenon and its possible explanation?

**Problem No 2.** A man has blue eyes, a woman has brown ones and their daughter has one brown eye and the other blue eye. How can it be explained?

**Task II.** Study the preparations of drosophila flies mutations and add the missing elements.

| | | |
|---|---|---|
| Eyes<br>***Bar***<br>Flat, I chromosome, dominant character, chromosome mutation<br>  | Wings<br>***Curly***<br>Bend, II chromosome, dominant character, gene mutation<br>  | Body color<br>***Yellow***<br>Yellow, I chromosome, recessive character, gene mutation<br>  |
| ***White***<br>White, I хромосома, recessive character, gene mutation<br>  | ***Vestigial***<br>Vestigial, II chromosome, recessive character, gene mutation<br>  | ***Black***<br>Black, II chromosome, recessive character, gene mutation<br>  |
| ***Normal***<br>Red eyes, normal wings, grey body color<br>  | | |

**Teacher's signature**

**Practice 8.** Topic: **BIOLOGY AND GENETICS OF SEX** «____» _____ 201__ year

**Purpose of the practice:** to study the objective laws of sex inheritance, principles of its differentiation and determination, mechanisms of chromosomal sex diseases, to know how to solve problems in the context of the characters linked to the X-chromosome and holandric ones

**CONTROL QUESTIONS**

1. Sex as a biological character. Sex characters.
2. X-linked and holandric characters.
3. Chromosome theory of sex determination.
4. Peculiarities of sex determination in humans and its impairments.
5. Disorders associated with sex chromosomes.
6. Primary, secondary and tertiary ratios of sexes.

**BASIC TERMS AND CONCEPTS**

**1. Sex-controlled characters —**

**2. Sex-limited characters —**

**3. X-linked characters —**

**4. Hermafroditism —**

**5. Holandric characters —**

**6. Klinefelter syndrome —**

**7. Morris syndrome —**

**8. Physical sex determinants —**

**9. Shereshevsky–Turner syndrome —**

**10. Trisomy X-syndrome —**

## TESTS FOR SELF-CONTROL

1. **Formation of gonad primordium proceeds untill the week of embryogenesis:** a) 1st; b) 2nd; c) 3rd; d) 4th; e) 5th.
2. **The differentiation of donads' primordia into the gonads occurs during the weeks of embryogenesis:** a) from 1st to 4th; b) from 4th to 6th; c) from 4th to 8th; d) from 4th to 12th; e) from 10th to 15th.
3. **Till 4th week of an embryogenesis, formation of gonad primordiua goes under the control of genes of:** a) autosomes; b) one X-chromosome; c) two X-chromosomes; d) Y-chromosomes; e) X-and Y-chromosomes.
4. **The differentiation of donads' primordia into the gonads occurs under the control of genes of:** a) autosomes; b) one X-chromosome; c) the second X-chromosome; d) Y-chromosomes; e) cytogene.
5. **In case of absence of the second gonosome in karyotype, gonads:** a) are differentiated; b) are not differentiated; c) connective tissues are formed on their place; d) partially atrophy; e) completely atrophy.
6. **Physical abnormality of sex the determination in humans:** a) a genetic gender; b) homosexuality; c) transvestism; d) gametic gender; e)hermaphroditism.
7. **Transvestism is a phenomenon, when the person:** a) chooses the sexual partner of the other gender; b) chooses the sexual partner of the same gender; c) the sexual satisfaction is reached by wearing clothes of the opposite gender; d) wishes to change his/her gender; e) infertile.
8. **The karyotype at Shereshevsky-Turner syndrome is :**a) 46, XY, 5p-; b) 45, X0; c) 47, XXY; d) 47, XX, 21 +; e) 46, XX, 9p +.
9. **The karyotype at Klinefelter syndrome is :**a) 47, XXY; b) 45, X0; c) 47, XXX; d) 46, XY; e) 46, XY, 9p +.
10. **A Barr's body is:** a) an activated Y-chromosome; b) inactivated Y-chromosome; c) activated X-chromosome; d) inactivated X-chromosome; e) inactivated X- and Y-chromosomes.

## Fill in the gaps:

1. Two Barr bodies in the nucleus of a female somatic cell are typical for the … syndrome.
2. Female phenotype, low position of ears, short neck with a skin fold are typical for the … syndrome.
3. Men with female phenotype, gynecomastia and impairment of spermatogenesis suffer from … syndrome.
4. Phenomenon when sexual excitement and satisfaction are reached while wearing clothes of the opposite sex is called …
5. Human chromosomal diseases of sex result from the impairmnt of the process called.
6. Charactrs determined by genes located in the non-homologous part of theY-chromosome are called …
7. Persistent discordance of person's sexual self-conscious and his real genetic and gonad sex is called …

**PRACTICAL WORK**

**Task I. Solve the problems.**

**Problem No 1.** An albino woman (autosome recessive character) married a daltonian man (recessive X-linked character). The rest of their genotype is normal. Which combinations of genotypes and characters are possible for their children?

**Problem No 2.** Recessive gene of hemophilia is located in the X-chromosome. The girl's father has hemophilia and the mother is healthy and there were no cases of hemophilia in her family. The girl marries a healthy man. What is the probability of giving birth to hemophiliacs?

**Problem No 3.** Genes of hemophilia (**h**) and daltonism (**d**) are located in the X chromosome at the distance of 10 centimorgans. A woman whose father is sick with both diseases and the mother don't have such genes, married a healthy man. Find the probability of giving birth to a child suffering from both diseases.

**Teacher's signature**

**Practice 9.** Topic: **FUNDAMENTALS OF HUMAN GENETICS** «____» _____ 201__ year

**Purpose of the practice:** to study the purposes and the main methods of the human genetics at the present day, to learn how to solve problems in the context of composition and analysis of the family trees, finding the role of heredity in the character formation.

**CONTROL QUESTIONS**

1. Human as an object of genetic investigations.
2. Clinical-genealogical methods.
3. Twins method.
4. Cytogenetic method.
5. Biochemical methods.
6. Methods of a recombinant DNA. The Human genome project.
7. Express-methods.
8. Prenatal diagnosis of hereditary diseases.

**BASIC TERMS AND CONCEPTS**

1. **Amniocentesis** —
2. **Chorionbiopcy** —
3. **Dizygotic twins** —
4. **Genealogy** —
5. **Monozygotic twins** —
6. **Proband** —
7. **Sequencing** —
8. **Guthrie test** —
9. **Ultrasonography** —
10. **α-fetoprotein** —

## TESTS FOR SELF-CONTROL

1. **Difficulties of studying human genetics are:** a) simple karyotype; b) early puberty; c) small amount of offsprings; d) a plenty of offsprings; e) an experimentation opportunity.
2. **The stages of genealogic analysis:** a) the taking the anamnesis; b) definition of frequencies of genes and genotypes in a population; c) making genetic maps of chromosomes; d) studying the role of the environment in exhibiting character; e) analysis of a family tree.
3. **Order of stages of the cytogenetic method: 1) processing of the cells by hypotonic solution NaCl; 2) staining of chromosomes; 3) stopping mitosis (with colchicine) at the stage of metaphase; 4) cultivation of cells on artificial nutrient mediums; 5) stimulation of mitosis by PHA:** a) 1–5–3–4–2; b) 4–5–3–1–2; c) 4–1–5–3–2; d) 5–3–4–1–2; e) 4–5–1–3–2.
4. **Holzinger's formula is used for calculation:** a) frequencies of genes and genotypes in a population; b) quotient of inheritance; c) roles of environment in exhibiting an attribute; d) probabilities of inheritance; e) degree of genetic risk.
5. **What is studied by biochemical methods of human genetics?** a) general blood test; b) activity of enzymes of blood plasma; c) activity of enzymes of gastric juice; d) composition of primary urine; e) spatial structure of enzymes.
6. **Methods of recombinant DNA are based on:** a) using mathematical expression of the law of Hardy-Weinberg; b) obtaining and sequencing DNA fragments; c) analysis of family trees; d) analysis of enzyme activity; e) microscopic examination of the karyotype.
7. **Methods recombinant DNA allow:** a) to obtain separate genes and their parts; b) to reveal genome mutations; c) to create unlimited amount of copies of genes; d) to reveal chromosome mutations; e) to reveal type of inheritance.
8. **Microbiologic tests allow to:** a) build genetic maps of human chromosomes; b) determine the number of X-chromosomes; c) determine the number of Y-chromosomes; d) reveal some chromosome mutations; e) reveal some metabolism defects.
9. **Direct noninvasive methods of prenatal diagnostics are:** a) definition of the concentration of alpha-fetoprotein; b) ultrasonography; c) chorion biopcy; d) aminoicenthesis; e) fetoscopy.
10. **Optimal terms for carrying out direct noninvasive methods of prenatal diagnostics are:** a) 6–8 weeks; b) 8–10 weeks; c) 12–20 weeks; d) 23–30 weeks; e) 30–35 weeks.

**Fill in the gaps:**

1. Man from whom medical-genetic examination of family and compiling genealogy start is called …
2. If parents are heterozygous (complete dominance, type of inheritance is autosomal-dominant and gene penetrance 25 %), then the probability of giving birth to a sick baby is ... %
3. If a mother is heterozygous and a father is healthy (X-linked dominant inheritance, gene penetrance is 40 %), then the probability of giving birth to a sick baby is ... %.
4. Determining the order of nucleotides and finding a pathologic gene is possible by the method of nucleic acids' …
5. Type of inheritance when the father transmits his character to all daughters, but neither to sons is called ...
6. Method of human genetic that allows to reveal the role of heredity and environment in the formation of a character is called …
7. Genetic method that allows to reveal genome and chromosome mutations is called …
8. Chorion biopsy is performed within … weeks of pregnancy.
9. Each pregnant woman compulsory undergoes … — a direct non-invasive method of prenatal diagnostics.
10. Mother's age of over 37 years, spontaneous abortions and stillbirth in the anamnesis, children with congenital malformations are indications for carrying out ... methods of prenatal diagnostics.
11. Y-chromatin is determined by staining the buccal epithelium by …

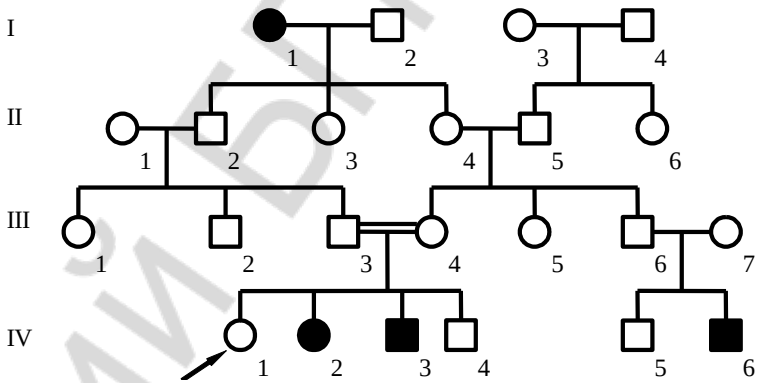
## PRACTICAL WORK

**Solve the problems**

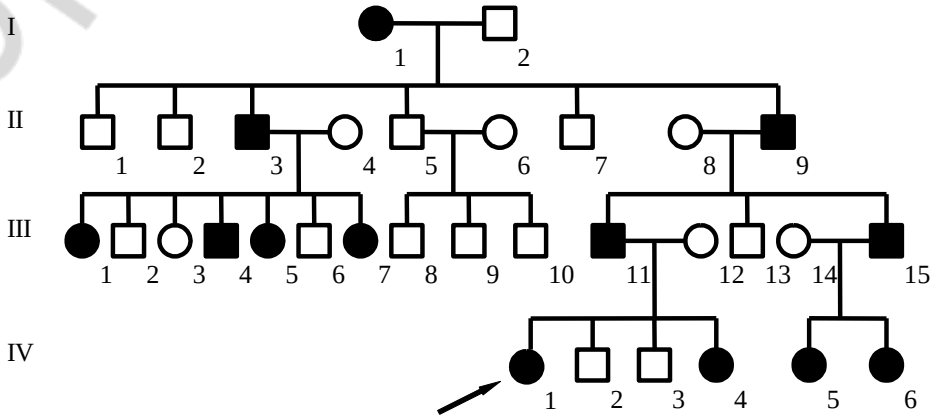
**Problem No 1.** The concordance of the monozygotic twins by the body weight is 80 %, and the concordance of the dizygotic ones for the same character is 30 %. What is the ratio of hereditary and environmental factors in the character formation?

**Problem No 2.** Draw and analyze the family tree: the proband is a boy suffering from Duchenne muscle dystrophy. His parents and two sisters are healthy. In the father's line: two uncles, aunt, grandfather and grand-mother are healthy. Cousins (two uncle's daughters and the aunt's son) are healthy. In the mother's line: one of the two uncles (the elder one) was sick with the distrophia. The second uncle (the healthy one) had two healthy sons and a healthy daughter. The aunt had a sick son. The grandfather and grandmother are healthy.

**Problem No 3.** Analyze the family tree, determine the inheritance type and find the genotypes of the family tree members.




**Problem No 4.** Analyze the family tree, determine the inheritance type and find the genotypes of the family tree members.




**Teacher's signature**

**Practice 10.** Topic: **GENETIC ENGINEERING** «____» _____ 201__ year

**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.

**CONTROL QUESTIONS**

1. Stages of genetic engineering.
2. Obtaining of genetic material.
3. Polymerase chain reaction (PCR).
4. Insertion of DNA fragments into the molecule-vector.
5. Incorporation of recombinant DNA in the cell-recipient.
6. Using methods of genetic engineering in medicine.

**BASIC TERMS AND CONCEPTS**

1. **Sticky ends —**
2. **Autoradiogram —**
3. **Cosmids —**
4. **DNA-probe —**
5. **Genome dactyloscopy —**
6. **Hybridization of primers —**
7. **Liposomes —**
8. **Phasmids —**
9. **Plasmids —**
10. **Restriction sites —**
11. **Restrtictases —**
12. **Vector —**

## TESTS FOR SELF-CONTROL

1. **Purposes of genetic engineering are:** a) designing of genetic structures according to a plan; b) decoding of the nucleotide orders of DNA; c) creation of organisms with the new genetic program; d) revealing of linkage groups; sequenation of genes; e) construction of a chromosome genetic map.
2. **Main stages of genetic engineering are:** a) obtaining genetic material; b) construction of a chromosome genetic map; c) decoding of the nucleotide order of a DNA site and building of recombinant DNA; d) selection of the transformed cells; e) incorporation of a recombinant DNA molecules in a chromosome.
3. **Ways of obtaining genes for transplantation:** a) synthesis of simple genes by chemical reactions; b) synthesis of genes on the base of a protein molecule; c) synthesis of complex genes by reverse transcription; d) making of a genetic map of a chromosome; e) cutting out of genes by restrictases.
4. **Recombinant DNA molecules can be received by embedding the gene in:** a) protein; b) bacteria plasmid; c) virus genome; d) lipid; e) a bacteriophage genome.
5. **The enzymes used in gene engineering are:** a) DNA-polymerase; b) lipase and restrictase; c) revertase and restrictase; d) restrictase and amylase; e) ligase.
6. **Genetic engineering allowed to receive:** a) the strains of Escherichia coli, capable to synthesize inulin; b) the strain of Escherichia coli, capable to synthesize somatotropinum; c) plants, capable to acquire atmosphere nitrogen; d) microorganisms, capable to synthesize carbohydrates of oil from alimentary proteins; e) antiviral serums.
7. **The future of gene engineering is based on the following achievements of molecular biology:** a) ability to transmit genetic information by sexual way in eukaryotes; b) receiving of modifications with help of chemical mutagens; c) sequenation of genes; d) substitution of defective genes; e) including artificially synthesized genes in the human genome.
8. **The chemical basis of plasmids is:** a) RNA; b) DNA; c) proteins; d) lipids; e) polysaccharides.

## Fill in the gaps:

1. Enzymes called … are used in the genetic engineering for obtaining genes.
2. Enzymes capable of cutting the DNA molecule in certain sites and form «sticky ends» are called …
3. The method of genes synthesis by reverse transcription is called ... .
4. Bacterial plasmids, phage and viral genome, phasmids and … can be used as vector molecules in genetic engineering.
5. Hybrid vectors capable of developing both as a phage and as a plasmid are called …
6. The plasmids containing cos-sites (sticky ends) of phage λ DNA are called …
7. Size of the DNA fragments which can be cloned in cosmids is about … thousand nucleotide pairs.
8. The basic vector for the animal genes cloning is the genome of the virus …
9. Restrictase Eco R I forms … when cuts the DNA.
10. Restrictase Hind II forms … when cuts both DNA strands in same places.

## Restrictases

| № | Restrictase | Definition sites and DNA cut points |
|---|---|---|
| 1. | Bal I | 5′ - T G G↓ C C A – 3′<br>3′ - A C C↑ G G T – 5′ |
| 2. | Bam H I | 5′ - G↓G A T C C – 3′<br>3′ - C C T A G↑ G – 5′ |
| 3. | Eco R I | 5′ - G↓A A T T C – 3′<br>3′ - C T T A A↑ G – 5′ |
| 4. | Hind III | 5′ - A↓A G C T T – 3′<br>3′ - T T C G A↑ A – 5′ |
| 5. | Sal I | 5′ - G↓ T C G A C – 3′<br>3′ - C A G C T↑ G – 5′ |
| 6 | X a I | 5′ - T ↓C T A G A – 3′<br>3′ - A G A T C↑ T – 5′ |

## PRACTICAL WORK

**Task 1. Make indications in the pictures:**

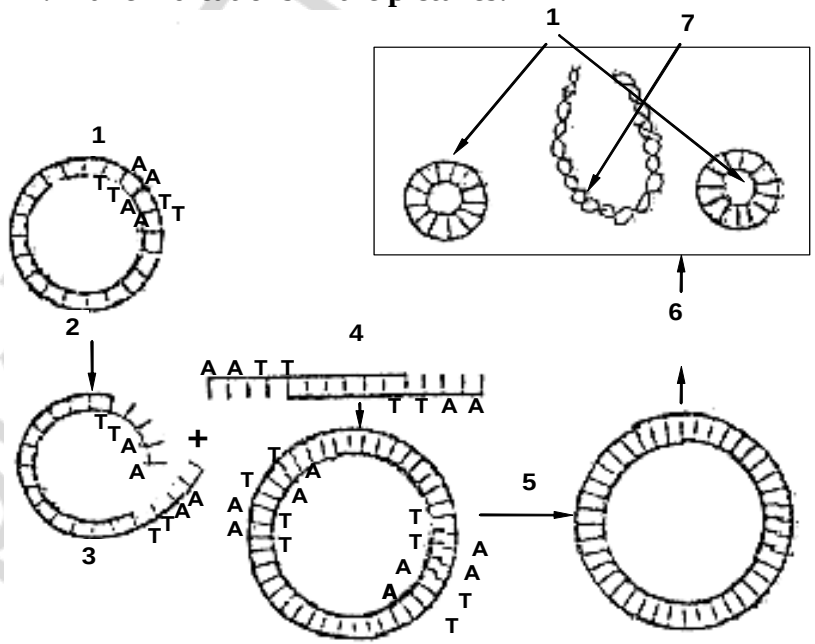



Fig. 1. Scheme of gene incorporation in the plasmid and injection of recombinant DNA into a bacteria:

1 –

2 –

3 –

4 –

5 –

6 –

7 –

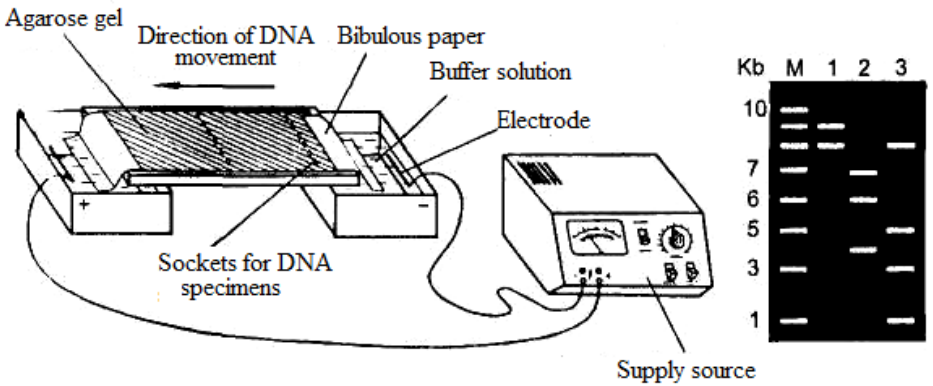
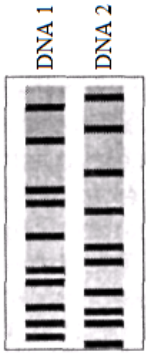



Fig. 2. Camera for DNA electrophoresis in the agarose gel and electrophoregram of the DNA colored by ethidium bromide and exposed to the ultraviolet rays (M – markers, 1, 2, 3 – samples treated with restrictases)

**Task 2. Solve the problems:**

**Problem No 1.** DNA samples treated with restrictases are analyzed with the fingerprint method using a radioactive labeled pathfinder, complementary to the links of the minisatellite DNA. The scheme of radiogram is shown in the Fig. Basing on the spectrum character indicate how many persons the DNA was taken for analysis from: one or two?



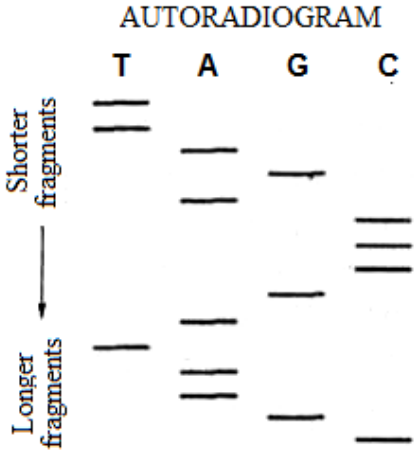

**Problem No 2.** There is a sequence of 27 nucleotide pairs of two-chained DNA:

$^{5/}$CTG AAT TAG GAT CCA GGC AAT AGT GTG$^{3/}$

$^{3/}$GAC TTA ATC CTA GGT CCG TTA TCACAC$^{5/}$

What enzyme can cut this DNA? How many parts will form?

**Problem No 3.** A nucleotide sequence of the restriction DNA fragment consisting from 15 nucleotides was analysed using the Maxam-Gilbert method. Find the nucleotide sequence of DNA fragment using the spectrum of the radiogram.




**Teacher's signature**

**Practice 11.** Topic: **GENETICS OF POPULATIONS** «____» _____ 201__ year

**Purpose of the practice:** to study the population statistics methods of human genetics, to learn to solve problems using the Hardy–Weinberg Law.

## CONTROL QUESTIONS

1. Characteristic of human populations. Types of marriages.
2. Genetic processes in large populations. The law of Hardy–Weinberg.
3. Genetic processes in small populations.
4. Genetic load and its biological importance.

## BASIC TERMS AND CONCEPTS

1. **Demes** —

2. **Genetic drift** —

3. **Panmixia** —

4. **Population** —

## TESTS FOR SELF-CONTROL

1. **Characteristic features of an ideal population are:** a) great number of individuals; b) small number of individuals; c) complete panmixia; d) absence of mutations; e) presence of mutations.
2. **In mathematical expression of the Hardy–Weinberg Law, p denotes the frequency of:** a) dominant gene; b) recessive gene; c) dominant homozygotes; d) recessive homozygotes; e) heterozygotes.
3. **In mathematical expression of the Hardy–Weinberg Law, q denotes frequency of:** a) dominant gene; b) recessive gene; c) dominant homozygotes; d) recessive homozygotes; e) heterozygotes.
4. **In mathematical expression of the Hardy–Weinberg Law, 2pq denotes frequency of:** a) dominant gene; b) recessive gene; c) dominant homozygotes; d) recessive homozygotes; e) heterozygotes.
5. **The genetic load is:** a) saturation of the population by positive mutations; b) saturation of the population by mutations, reducing adaptability of individuals; c) saturation of the population by neutral mutations; d) saturation of the population by negative mutations; e) absence of mutations in populations.

## Fill in the gaps:

1. Human populations with the number not exceeding 1500 people within-which marriages surpass 90 % are called … .
2. Genetic load has no phenotypic manifestation when … of a pathological gene is observed.

**PRACTICAL WORK**

**Solve the problems.**

**Problem No 1.** In the USA, the 30 % of persons of the examined population feel the bitter taste of phenylthiocarbamide (PTC) and the 70 % do not. The ability to feel its taste is determined by the recessive gene **a**. Find out the frequency of the alleles **A** and **a** in the population

**Problem No 2.** An aboriginal population of 127 (including children) persons lives in the jungle of the South America. The frequency of the M blood group is 64% here. Is it possible to find out the frequencies of N and MN blood groups in this population?

**Problem No 3.** Find out the frequency of albinos in the large African population where the concentration of the recessive pathology gene is 10 %.

**Problem No 4.** The rate of the disease gout is 2 % and it is conditioned by the dominant autosomal gene. According to some information (V. Efroimson, 1968), gene penetrance in men is 20 % and 0 % in women. Find out the genetic structure of the population.

**Teacher's signature**

**Practice 12.** Topic: **CONTROL PRACTICE IN CYTOLOGY, MOLECULAR BIOLOGY GENETICS** «____» _____ 201__ year

**Purpose of the practice:** to control the students' knowledge of cytology and genetics, their ability to solve typical problems.

**CONTROL QUESTIONS**

1. Properties and characters of living things. Organization levels of living things
2. The present state of the cell theory. Distinguishing features of pro- and eukaryotic cells.
3. The structure (models) of elementary membrane, its properties and functions. Ways of passing substances into the cell.
4. Anabolic system of the cell. Catabolic system of the cell.
5. Energy exchange in the cell. Enzyme systems of mitochondria.
6. Structure and functions of the nucleus. Types of chromosomes. Structure of a metaphase chromosome.
7. Cell and mitotic cycles. Interphase, characteristic of its periods. Causes of mitosis. Characteristics and significance of mitosis.
8. Characteristic and significance of meiosis. Amitosis.
9. Nucleic acids (DNA and RNA): structure and functions. Chargaff's rules. DNA replication.
10. Properties of genes. The Central Dogma of Molecular Biology
11. Genetic code and its properties. Biosynthesis of protein.
12. Classification of genes. Level of DNA packing.
13. Regulation of transcription in prokaryotes and eukaryotes.
14. Genetic engineering. Stages of genetic engineering.
15. Obtaining genetic material. Polymerase chain reaction (PCR).
16. Restrictases. Vectors. Incorporation of DNA fragments into the molecule-vector. Introduction of recombinant DNA in the cell-recipient.
17. Using methods of genetic engineering in medicine.
18. Inheritance regularities in monohybrid crossing.
19. Hypothesis of purity of gametes and its cytological basis.
20. Analyzing cross. Conditions limiting Mendel's laws. Pleyotropy. Semi-lethal and lethal genes
21. Regularities of inheritance in polyhybrid crossing. The Law of Independent Assortment.
22. Intra-allelic and inter-allelic interaction of genes. Inheritance of blood groups.
23. Experiments of T. Morgan. Complete and partial linkage. Autosomal and gonosomal linkage groups. Crossing-over.
24. Maps of eukariotic chromosomes (genetic and cytological). Basic concepts of the Chromosomal Theory of Inheritance.
25. Phenotypic variation. The reaction norm. Genotypic variation and its forms. Mutagenic factors. Biological basis of cancerogenesis.
26. Classification of mutations. Genome, chromosome and gene mutations. Stability and repair of genetic material, anti-mutagens.
27. Sex as a biological character. Sex characters. Sex-controlled and sex-limited characters. X-linked and holandric characters. Peculiarities of sex determination in humans and its impairments.
28. M. Lion's hypothesis. Chromosomal disorders of sex.
29. The human as an object of genetic investigations.
30. Clinical-genealogical methods. Twin method. Cytogenetic method.
31. Biochemical methods. Methods of recombinant DNA
32. Characteristic of human populations. Types of marriages. Genetic processes in large populations. The Law of Hardy-Weinberg.
33. Genetic processes in small populations. Genetic load.
34. Methods of prenatal diagnosis of hereditary diseases. Express-methods.

**Practice 13.** Topic: **REPRODUCTION OF ORGANISMS** «____» _____ 201__ year

**Purpose of the practice:** to study the reproduction as one of the universal property of the live, its ways and evolution; to study the structure of gametes, gametogenesis and the features of human reproduction.

**CONTROL QUESTIONS**

1. Forms of reproduction, its characteristics.
2. Evolution of the sexual process.
3. Structure of gametes.
4. Gametogenesis (oogenesis and spermatogenesis).
5. Insemination, its forms. Fertilization and its stages.
6. Biological peculiarities of human reproduction.

**BASIC TERMS AND CONCEPTS**

1. **Acrosome —**
2. **Conjugation —**
3. **Copulation —**
4. **Oogamy —**
5. **Oogenesis —**
6. **Insemination —**
7. **Fertilization —**
8. **Partenogenesis —**
9. **Sexual process —**
10. **Synkaryon —**
11. **Spermatogenesis —**

## TESTS FOR SELF-CONTROL

1. **Characteristics of asexual reproduction is:** a) two individuals participate in reproduction; b) only one individual participates in reproduction; c) the genotype of daughter individual differs from parental ones; d) genotype of daughter individuals are identical to parental ones; e) the number of daughter individuals increases slowly.
2. **Forms of asexual reproduction of multicellular organisms are:** a) reproduction via vegetative organs; b) conjugation; c) copulation; d) polyembryony; e) fragmentation.
3. **Characteristics of sexual reproduction is:** a) two individuals participate in reproduction; b) only one individual participates in reproduction; c) genotypes of daughter individual differs from parental ones; d) genotypes of daughter individuals are identical to parental ones; e) the number of daughter individuals increases quickly.
4. **Characteristics of sexual reproduction is:** a) two individuals participate in reproduction; b) only one individual participates in reproduction; c) genotypes of daughter individual differs from parental ones; d) genotypes of daughter individuals are identical to parental ones; e) the number of daughter individuals increases quickly.
5. **Characteristics of isolecithal ova:** a) contains a lot of yolk; b) a little of yolk; c) the yolk is uniformly distributed; d) the yolk is concentrated on the vegetative pole; e) the yolk is located at the animal pole.
6. **Movement forward of spermatozoons in the female reproductive tracts is provided by:** a) mobility of spermatozoons; b) ovum's immobility; c) contraction of uterine muscles; d) excretion of gyno-gamones; e) contraction of abdominal muscles.
7. **Fertilization stages are:** a**)** destruction of the ova by spermatozoons' hyaluronidase; b) acrosome reaction; c) splitting of the ovum; d) entrance of head, neck and tail of the spermatozoon into the ovum's cytoplasm; e) maturation of pronuclei.
8. **Features of human reproduction are:** a) women are capable for reproduction since the puberty till advanced age; b) men are capable for reproduction since the puberty up to 50 years; c) one oocyte of the second order is formed ones a moon month in women; d) spermatozoons are formed periodically in men; e) the older is the man, the longer is the time between the gamete's meiosis I and II.

## Fill in the gaps:

1. Exchange of genetic information between individuals of one species is called ...
2. Confluence of female and male pronuclei during fertilization is called ...
3. Sexual reproduction without fertilization is called ...
4. Ovum containing a lot of yolk concentrated at one of the poles is called ...
5. Complete even cleavage is typical for ... ova.
6. During the period of proliferation of gametogenesis, cells divide by ...
7. During the period of maturation of gametogenesis, cells divide by ...
8. Asexual reproduction occurring in embryo formed by sexual reproduction is called …
9. Gamones contributing to spermatozoon's fixation on the ovum's membrane are called ….
10. Spermatozoons possess the ability of fertilization within …

## PRACTICAL WORK

**Task 1. Study the preparation, colour the pictures and make indications:**

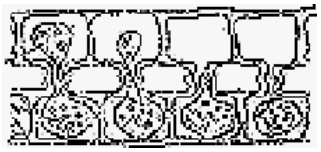


Fig. 1. Conjugation of spyrogyra (7×40)

Fig. 2. Human spermatozoon (7×40):
1 — head; 2 — midpiece (neck);
3 — tail; 4 — acrosome

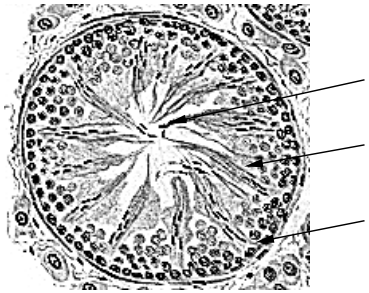


Fig. 3. Cross section of rat's seminiferous tubule (7×8):
1 – spermatogonia; 2 – primary and secondary spermatocytes; 3 – spermatozoons

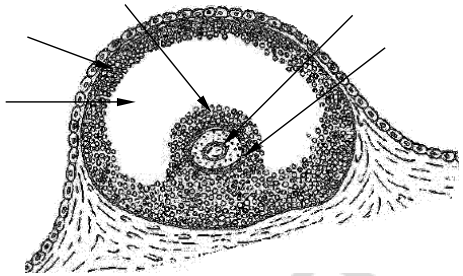


Fig. 4. The Graafian vesicle of cat ovarium (7×8):
1 — ovum; 2 — cumulus ooporus; 3 — follicular cells; 4 — cavity of the follicle;
5 — wall of the follicle

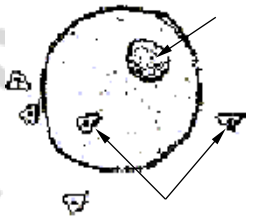


Fig. 5. Fertilization of ascaris ovum (7×40):
1 — nucleus of the ovum; 2 — sperm cell

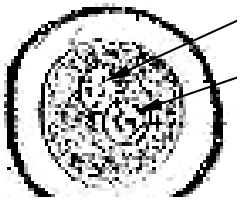


Fig. 6. Sincarion in the ascaris ovum (7×40):
1, 2 — male and female pronuclei

**Task II. Solve the problems.**

**Problem No 1.** Upon the parthenogenesis the organism is developing from unfertilized ovum. Why can't the spermatozoon give the beginning to a new organism without fertilization?

**Problem No 2.** A planaria is a hermaphrodyte and can multiply by self-fertilization. Besides, it is able multiply asexually. Is the genotype of the descendants of one individual same if one descendant is formed by self-fertilization and the other one by asexual reproduction?

**Teacher's signature**

**Practice 14.** Topic: **FUNDAMENTALS OF ONTOGENESIS (EMBRYONIC DEVELOPMENT)** «____» _____ 201__ year

**Purpose of the practice:** to get acquainted with periods of ontogenesis; to study and the stages of embryogenesis, critical periods and their reasons, the mechanisms of genetic information realization during the prenatal period.

**CONTROL QUESTIONS**

1. Ontogenesis, its types, division into periods.
2. Division of the human embryonic development into periods.
3. Characteristic of embryogenesis stages. Provisional organs.
4. Mechanisms of embryogenesis. Morphogenesis.
5. Critical periods of the prenatal ontogenesis. Teratogenesis.

**BASIC TERMS AND CONCEPTS**

1. **Aplasia —**
2. **Atresia —**
3. **Balstula —**
4. **Gradient of physiologic activity —**
6. **Critical periods —**
7. **Morphogenetic fields —**
8. **Ontogenesis —**
9. **Progenesis —**
10. **Teratogenesis —**
11. **Embryonic induction —**

## TESTS FOR SELF-CONTROL

1. **The type of zygote cleavage depends on:** a) sizes of the ovum; b) shape of the ovum; c) volume of yolk; d) distribution of yolk in the cytoplasm; e) potentialities of ovum's cytoplasm.
2. **Derivatives of the dermatome are:** a) epithelium of the gut; b) nervous system; c) respiratory system; d) urinogenital system; e) dermis.
3. **First causes of cells differentiation during embryogenesis are:** a) chemical homogeneity of the ovum's cytoplasm; b) chemical heterogeneity of the ovum's cytoplasm; c) chemical homogeneity of spermatozoon's cytoplasm; d) chemical heterogeneity of spermatozoon's cytoplasm; e) different potencials of animal and vegetative poles of the ovum.
4. **Realization sequence of genes' action during the ontogenesis is:** a) DNA → enzyme → mRNA → biochemical reaction → character; b) DNA → mRNA → enzyme → biochemical reaction → character; c) other genes have an impact on manifestation of the character; d) other genes do not influence the manifestation of the character; e) environmental factors do not influence the manifestation of the character.
5. **The main mechanisms of cell differentiation are:** a) blocking of different transcriptones at the certain development stage; b) turning on all genes at the certain development stage; c) blocking of all genes at the certain development stage; d) unblocking of different transcriptones at the certain development stage; e) blocking of one gene at the certain development stage.
6. **Characteristics of totypotential cells are:** a) their development is preprogrammed; b) their development is not preprogrammed; c) each of them can give rise to any type of cells; d) each of them can give rise to only one certain type of cells; e) the majority of transcriptons are blocked.
7. **Characteristics of determined cells are:** a) their development is finally preprogrammed; b) their development is not preprogrammed c) each of them can give rise to any type of cells; d) each of them can give rise to only one certain type of cells; e) the majority of genes can join the work.
8. **The causes of critical periods of embryogenesis are:** a) changes in conditions of embryo existence and feeding; b) transition from one development period to another one; c) appearance of new inductors; d) active dedifferentiation of cells; e) poor nutrition of the pregnant woman.

## Fill in the gaps:

1. Mitotic divisions of a zygote and blastomeres during the initial stage of embyogenesis is called ...
2. Period of human embryonic development from the $4^{th}$ week to the end of the $8^{th}$ week is called …
3. Method of gastrulation when some cells of blastoderm move into the blastocoel to multiply there and form the second layer of cells is called …
4. Organisms, in which blastopore transforms into the anal opening and the mouth forms on the opposite side of the body, are called …
5. Amnion, chorion, allantois, yolk sac and placenta are ... organs of chordates.
6. A primal cause of cells differentiation in the of embryogenesis is ... of the ovum cytoplasm.
7. Impact of a group of embryonic cells on the nearly located ones by specific substances is called …
8. Gradual decrease of metabolism intensity in fetus from its head to the caudal part is called ... of physiological activity.

## PRACTICAL WORK

**Task 1. Study the preparation, colour the pictures and write the indications:**

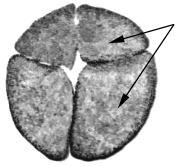


Fig. 1. Cleavage of the frog's ovum (7×8): 1 — blastomeres

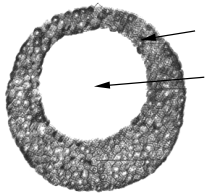


Fig. 2. Frog's blastula (7×8): 1 — blastomeres; 2 — blastocoel

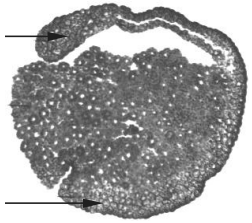


Fig. 3. Frog's gastrula (7×8): 1 — dorsal lip of the blastoporus; 2 — ventral lip of the blastoporus

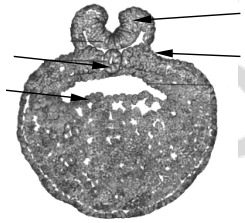


Fig. 4. Frog's neurula (7×8): 1 — ectoderm; 2 — crista neuralis; 3 — notochord; 4 — entoderm

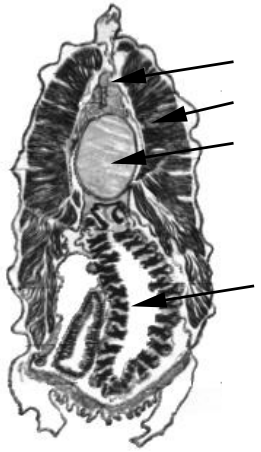


Fig. 5. Cross-section of lancelet (7×8):
1 — nerve tube; 2 — notochord; 3 — gut; 4 — myotome

**Task II. Solve the problems.**

**Problem 1.** Why is the frequency of meiosis disturbances occurring in the ovogenesis increases rapidly with the person's age and much slower in the spermatogenesis?

**Problem 2.** Embryos that have extra chromosomes keep alive during the zygote cleavage but after that the most of them die. How can you explain their survivability during the cleavage?

**Teacher's signature**

**Practice 15.** Topic: **FUNDAMENTALS OF ONTOGENESIS (POSTEMBRYONIC DEVELOPMENT)** «____» _____ 201__ year

**Purpose of the practice:** to study and to know the periodization of human postnatal ontogenesis, critical periods and their causes, types of tissue's growth, the main theories of aging; to have a view of gerontology, geriatrics, acceleration, and reanimation.

**CONTROL QUESTIONS**

1. Postnatal ontogenesis. Types of development. Metamorphosis.
2. Division of the postnatal human ontogenesis into periods.
3. Critical periods of postnatal ontogenesis.
4. Growth. Growth types of tissues and organs. Acceleration.
5. Constitution and the human habitus.
6. Ageing of organisms. Basic theories of ageing.
7. Clinical and biological death. Reanimation. Problems of euthanasia.

**BASIC TERMS AND CONCEPTS**

1. **Acceleration** —

2. **Habitus of the human** —

3. **Geriatrics** —

5. **Gerontology** —

6. **Constitution of the human** —

7. **Euthanasia** —

## TESTS FOR SELF-CONTROL

1. **Critical periods of a postnatal ontogenesis:** a) delivery; b) infancy; c) puberty; d) fading of reproductive function; e) senile age.
2. **Characteristics of cerebral growth type of organs:** a) intensive growth since birth and till 10–12 years; b) uniform growth during the whole period; c) intensive growth during the first year of life and puberty; d) intensive growth of tissue till 11–12 years, then gradual decrease of its volume up to the level of an adult; e) a rapid growth during puberty.
3. **Criteria of biological age:** a) a degree of development of a hair coat; b) the size of genitals; c) skeleton maturity ;d) body height; e) dental maturity.
4. **The constitution of the person is:** a) hereditary features of morphology, physiology and behaviour; b) state of the person at the given moment; c) persistent genetically caused disturbances of morphology, physiology and behaviour; d) a reactivity; e) resistibility to the agents of diseases.
5. **Hypersthenic are predisposed to:** a) to neurosises; b) hypertension; c) stomach ulcer; d) atherosclerosis; e) obesity.
6. **The essence of the intoxicating hypothesis of aging:** a) changes of cytoplasm colloidal properties; b) decrease in production of sexual hormones; c) accumulation of waste products in the large intestine and their adsorption to the blood; d) disturbance of adaptation and regulation processes; e) accumulation of mutations.
7. **The essence of the genetic hypothesis of aging:** a) changes of colloidal properties of a cell cytoplasm; b) decrease in production of sexual hormones; c) impairment of reparation and DNA replication processes; d) impairment of adaptation and regulation processes; e) genetically programmed number of cell's mitosis.
8. **Proofs of genetically programmed number of cell's mitoses is:** a) fibroblasts of man's embryos in culture give about 50 generations; b) at each DNA replication some nucleotides of telomeres are lost; at each DNA replication some nucleotides of telomeres are added; c) after every mitosis the length of telomeres decreases; d) after every mitosis the length of telomeres increases.

## Fill in the gaps:

1. Thymus and spleen are characterized by … type of growth.
2. The hormone of hypophysis ... play the main role in regulation of human growth.
3. The phenomenon of speeding-up growth, sexual maturity, physical and mental development of children and adolescents is called …
4. Stable, genetically determined peculiarities of morphology, physiology and behaviour of a person make his …
5. People of … constitutional type are predisposed to neuroses, ulcerous disease, tuberculosis.
6. Peculiarities of development, course, treatment and prevention of diseases of old people are studyed by the science called …
7. Science which studies healthy lifestyle is called …
8. The state of an organism characterized by cardiac and respiratory arrest, loss of consciousness but without impairments of metabolism, is called … death.
9. Medical assistance to pass from life for a terminally ill patient according to his will or request of his relatives is called ...

## PRACTICAL WORK

**Task 1. Draw and compare the variation curves of height variability of conscripts according the data of years 1927 and 1997.**

**Height of 50 conscripts (cm) long according the data of the year 1927:**
158, 176, 174, 170, 171, 179, 162, 174, 169, 171, 160, 163, 163, 170, 168, 180, 173, 175, 169, 171, 159, 177, 178, 169, 168, 177, 161, 161, 170, 172, 164, 165, 165, 168, 169, 164, 166, 166, 172, 172, 164, 165, 166, 168, 167, 175, 175, 172, 167, 169.

**Height of 50 conscripts (cm) long according the data of the year 1997:**
166, 184, 182, 178, 179, 187, 170, 182, 177, 179, 168, 171, 171, 178, 176, 188, 181, 183, 177, 179, 167, 185, 186, 177, 176, 185, 169, 169, 178, 180, 172, 173, 173, 176, 177, 172, 174, 174, 180, 180, 172, 173, 174, 176, 175, 183, 183, 180, 175, 177

**Fill in the table № 1.**

| Limits of the classes | Frequency variants f | Sum of variants ΣX | The average X |
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**Fill in the table № 2.**

| Limits of the classes | Frequency variants f | Sum of variants ΣX | The average X |
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**According the tables' data make the graphs**


**Teacher's signature**

**Practice 16.** Topic: **INTRODUCTION TO PARASYTOLOGY** «____» _____ 201__ year

**Purpose of the practice:** to study and the forms of biotic relations, parasitism as an biologic phenomenon, classification of parasites and their hosts, adaptation of parasites, their pathogenic action and responses of their hosts.

**CONTROL QUESTIONS**

1. Origin of parasitism. Criteria of parasitism.
2. Classification of parasites and their hosts.
3. Rotes of transmission of parasites.
4. Morphophysiological and biological adaptations of parasites.
5. Pathogenic action and specificity of parasites.
6. Host's response to parasitic invasion.
7. Basis of biological prophylaxis of parasitic diseases.

**BASIC TERMS AND CONCEPTS**

1. **Anthroponoses** —
2. **Invasive diseases** —
3. **Infectious diseases** —
4. **Hyperparasitism** —
5. **True parasites** —
6. **Pathogenicity** —
7. **Parasite** —
8. **Parasitism** —
9. **Specificity of the parasite** —
10. **Invasive stage** —

**TESTS FOR SELF-CONTROL**

1. **Characteristic of parasitism:** a) both organisms receive benefit; b) the individual of one species uses the individual of another species only as habitation; c) the individual of one species uses the individual of another species as habitation and the source of nutrition, not causing any harm; d) the individual of one species uses the individual of other species as habitation and the source of nutrition and harms it; e) none of the organisms receive any benefit.
2. **Examples progressive morpho-physiological adaptations of parasites:** a) the presence of attachment organs and specialized body integument; b) simplification of the nervous system and sense organs; c) molecular mimicry and secretion of anti-enzymes; d) reduction of the alimentary system; e) high fertility and complex life cycles.
3. **Examples of biological adaptations of parasites:** a) presence of attachment organs and anti-enzymes; b) simplification of the nervous system and sense organs; c) various forms of asexual reproduction and high fertility; d) complex life cycles, alternation of hosts and migration of larvae over the organism of the host; e) immunosuppressive action.
4. **Pathogenic action of the parasite:** a) mechanical injury of tissues, toxicoallergic; b) supplying the host with vitamins; c) supplying the host with nutrients; d) absorption of nutrients and vitamins from the host; e) weakening the organism and increasing probability of secondary infection.
5. **Pathogenicity of a parasite does not depend on:** a) host's genotype and environmental factors; b) parasite's genotype and virulence; c) host's age and diet; d) body height and a sex of the host; e) presence of other parasites in the host.
6. **Protective reactions of the host's organism occur at levels:** a) subcellular and cellular; b) cellular and organism; c) specific and tissue; d) cellular and tissue; e) population-specific.
7. **Adaptation of parasites at the population level:** a) presence of cysts and active searching for hosts; b) simplification of nervous system and reduction of alimentary system in tapeworms; c) molecular mimicry and anti-enzymes; d) involving of intermediate and reservoir hosts into the life cycle; e) synchronization of parasite's life cycle and hosts behavior.

**Fill in the gaps:**

1. Free-living organisms which can become parasites when they get to the organism of other species are called …
2. Hosts providing optimal biochemical conditions for the parasite and have biocoenotic contact with it are called ...
3. Hosts providing biochemical conditions for the parasite but don't have biocoenotic contact with it are called ...
4. Hosts characterized by the presence of biocoenotic contacts with parasites but abcence of biochemical conditions for their development are called …
5. Route of transmission of parasites with water and foodstuffs is called …
6. Route of transmission of parasites through mucous membranes of respiratory pipes is called ...
7. Route of transmission of parasites with household goods is called …
8. Route of transmission of parasites with infected donor blood is called...

**PRACTICAL WORK**

**Fill the table: «Adaptations of parasites»**

**Morphophysiological progressive adaptations:**

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**Morphophysiological regressive adaptations:**

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**Biological adaptations:**

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**Teacher's signature**

**Practice 17.** Topic: **PARASYTES — PATHOGENS OF THE DISEASES** «____» _____ 201__ year

**Purpose of the practice:** to study and morphology and biology of some parasites, to know the pathogenic action, rotes of transmission, methods of diagnostics and prevention of diseases they cause.

## CONTROL QUESTIONS

1. Parasitizing flagellates: Trichomonas: morphological peculiarities, life cycle, rotes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis.
2. Cat liver fluke: morphological peculiarities, life cycle, rotes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of opisthorchiasis.
3. Taenia solium: morphological peculiarities, life cycle, rotes of transmission, pathogenic action; symptoms, diagnosis and prophylaxis of teniasis and cysticerciasis.
4. Ascaris lumbricoides: morphological and biological peculiarities, rotes of transmission, pathogenic action of ascaris and its larvae; symptoms of migration and intestinal stages of ascariasis, diagnosis and prophylaxis of ascariasis.
5. Itch mite: peculiarities of morphology and biology, pathogenic action; symptoms, diagnosis and prophylaxis of scabies.
6. Order Anoplura: peculiarities of morphology and biology; lice as patogens and vectors of diseases; prophylaxis.

## BASIC TERMS AND CONCEPTS

1. **Prglottid —**
2. **Cisticercus —**
3. **Dehelmithization —**
4. **Geohelminthes —**
5. **Marita —**
6. **Metacercaria —**
7. **Migration —**
8. **Migration ascariasis —**

| | |
|---|---|
| **9. Miracidium —**<br><br>**10. Pediculosis —**<br><br>**11. Phthiriosis —**<br><br>**12. Scolex —**<br><br>**13. Strobila —**<br><br>**14. Biohelminths —** | **TESTS FOR SELF-CONTROL**<br>**1. Techniques used for laboratory diagnostics of opistorchosis:** a) Fulleborn and Kalantaryan techniques; b) Gorachev technique; c) Schulman technique; d) direct smear and thick-blood film; e) adhesive tape technique.<br>**2. Invasion with teniasis occurs during:** a) personal hygiene breaches; b) contacts with sick persons; c) eating undercooked beef; d) eating undercooked pork; e) eating undercooked fish, shrimps and crabs.<br>**3. Invasion with cysticercosis occurs during:** a) swallowing eggs of park tapeworm; b) eating undercooked pork and beef; c) eating undercooked shrimps and crabs; d) contact with domestic pigs; e) autoinvasion in teniasis.<br>**4. Diagnostic signs of migration ascariasis are:** a) intestinal obstruction; b) fever and an asthmatic bronchitis; c) non-constant eosinophilic infiltrations in lungs; d) occlusion of choledoch duct; e) appendicitis.<br>**5. Surgical implications of ascariasis are:** a) obstructive jaundice and obstruction of the intestine; b) affection of an eyeball by an adult worm; c) perforation of the intestinal wall; d) pneumonia and bronchitis; e) pancreatitis and appendicitis.<br>**6. Medical significance of Sarcoptes scabiei:** a) it is a specific vector of tick-borne relapsing fever; b) it is a specific vector of tularemia and brucellosis; c) it causes inflammation of the intestine; d) it causes asthmatic symptoms; e) it causes scabies.<br>**7. Scabies is spread:** a) by vector-bone route; b) during a direct skin contact with a sick person; c) by eating of uncooked fish; d) by bedclothes of sick persons; e) by drinking water from the open sources.<br>**8. Medical significance of order Anoplura is:** a) mechanic vectors of helminthes' eggs and protozoans' cysts; b) specific vectors of the louse-borne relapsing fever; c) specific vectors of epidemic typhus; d) lice of genus Pediculus cause pediculosis; e) pubic lice cause phthiriasis. |

9. **Prophylaxis of scabies is:** a) revealing and treating sick persons; b) elimination of vectors; c) maintaining the purity of the body; d) washing vegetables and fruits before eating; e) sanitary inspection of hostels, bathhouses and heath education.
10. **Migration way of ascaris larvae in the body is:** a) intestine → right heart → lungs → blood vessels → liver → bronchi → trachea → pharynx → intestine; b) intestine → liver → bronchi → right heart → lungs → blood vessels → trachea → pharynx → intestine; c) liver → bronchi → right heart → lungs→ blood vessels → trachea → pharynx → intestine; d) intestine → blood vessels → liver → right heart → lungs → bronchi → trachea → pharynx → intestine; e) intestine → blood vessels → right heart → lungs → liver → bronchi → trachea → pharynx → intestine.
11. **Life cycle features of order Anoplura are:** a) lay eggs in dry dust and on food products; b) nits stick to hair; c) development is direct; d) development with incomplete metamorphosis; e) duration of the life cycle is 48 days.
12. **Morphology of pubic louse:** a) sizes up to 1.5 mm; b) sizes up to 1.5 cm; c) the body is short, almost round; d) piercing-sucking mouthparts; e) the body is short, almost square.
13. **Medical significance of pubic louse:** a) mechanic vectors of helminthes' eggs and protozoans' cysts; b) specific vectors of the louse-borne relapsing fever; c) specific vectors of epidemic typhus; d) cause pediculosis; e) causes phthiriasis.

**Fill in the gaps:**

1. Vegetative form of protozoans is called ...
2. Supporting axis of some Zoomastigotes is called ...
3. Trichomonas vaginalis has ... flagella.
4. Fluke which has 2 rosette-like testes and S-like canal of the excretory system between them is called ...
5. Life cycle of a Cat liver fluke: egg → miracidium → sporocyst → redia → ... → metacercaria.
6. Taenia solium is characterized by the finna of ... type.
7. Hermaphroditic progottids of Taenia solium have an ovarium consisting of ... lobes.
8. Mature proglottid of Taenia solium have... branches of the uterus.
9. Life span of mature Ascaris in the human body is about ... .
10. Pediculus humanus capitis and Pediculus humanus humanus cause ...
11. Phthirus pubis causes …
12. Eggs of lice are called ...
13. Insects of the order Anoplura cause ...
14. Pathogen of louse-borne relapsing fever is …

## PRACTICAL WORK

**Study the preparations, color the pictures and make the indications.**

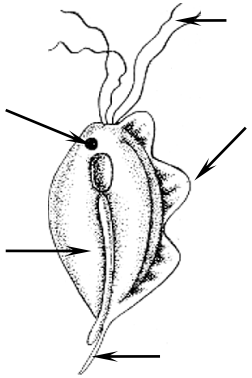

Fig. 1. Morphology of trichomonas (7×40) ( )
1 — nucleus; 2 — undulating membrane; 3 — flagellum; 4 — axostyle; 5 — thorn

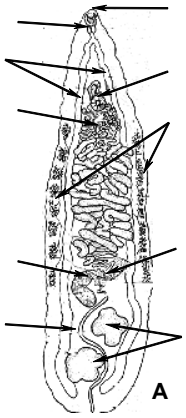


Fig. 2. Cat liver fluke ( )
A — marita (×20): 1 — oral sucker, 2 — abdominal sucker, 3 — esophgus, 4 — branches of intestine, 5 — vitellaria, 6 — uterus, 7 — ovaria, 8 — seminal receptacle, 9 — testes, 10 — canal of excretory system

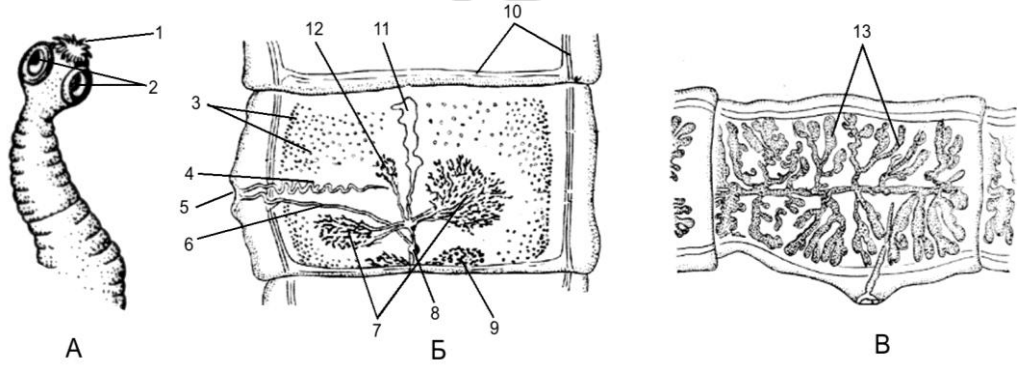


Fig. 3. Taenia solium:
A-C — schemes; A — scolex; B — hermaphroditic proglottid; C — mature proglottid
1 – 2 –
3 – 4 –
5 – 6 –
7 – 8 –
9 – 10 –
11, 13 – 12 –

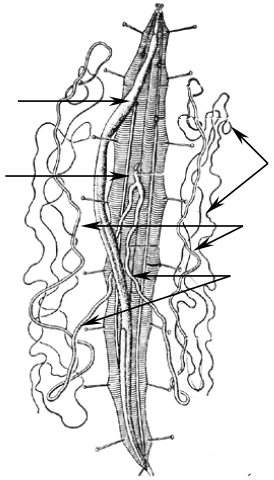

Fig. 4. Dissected female of ascaris
( )
(macropreparation)
1 — ovaries; 2 — oviducts; 3 — uteri; 4 — vagina; 5 — intestine

Fig. 5. Egg of Cat liver fluke, Taenia solium and Ascaris lumbricoides (7×40)

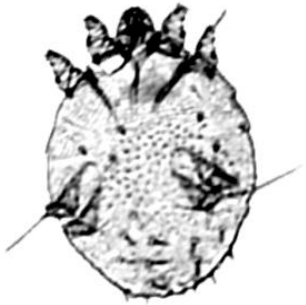

Fig. 6. Itch mite (7×40) ( )

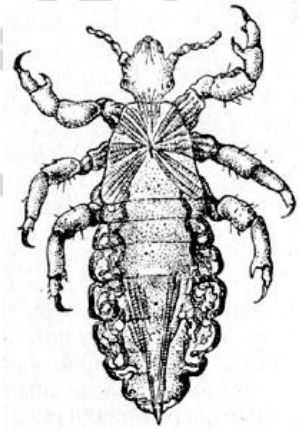

Fig. 7. Head louse
A — scheme (×20) ( )

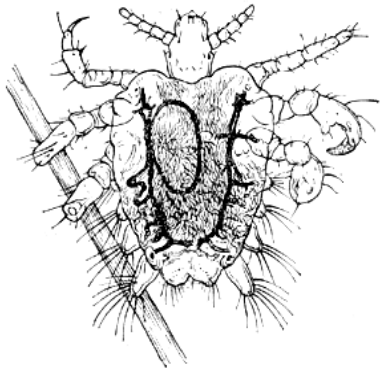

Fig. 8. Pubic louse.
A — scheme (7×8) ( )

**Teacher's signature**

**Practice 18.** Topic: **TOXIC ANIMALS** «____» _____ 201__ year

**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.

## CONTROL QUESTIONS

1. Classification of toxic animals (primarily and secondarily toxic, actively and passively toxic).
2. Physiological characteristic of toxins of invertebrates (jellyfish, arachnoids, 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

1. **Actively-venomous animals** —
2. **Actively-poisonous animals** —
3. **Secondary-toxic animals** —
4. **Passively-poisonous animals** —
5. **Primarily-toxic animals** —

## TESTS FOR SELF-CONTROL

1. **Actively-venomous and poisonous animals**: a) jellyfish and snails; b) cobra and tarantula; c) python and tarantula; d) tarantula and pufferfish; e) pufferfish and snails.
2. **Pas Passively-poisonous animals:** a) jellyfishes and a tarantula; b) cobra and a boa; c) python and a pufferfish; d) tarantula and snails; e) pufferfish and snails.
3. **Actively-venomous animals:** a) snakes and sting ray; b) pufferfish and wasps; c) bees and amphibiand; d) snails and bees; e) snakes and amphibians.
4. **Actively-poisonous animals:** a) both snakes and amphibious; b) pufferfish and sting ray; c) bees and sting ray; d) snails and amphibious; e) sting ray and snails.
5. **Toads and frogs are:** a) primary-toxic; b) secondary-toxic; c) actively-poisonous; d) passively-poisonous; e) secondary-venomous.
6. **Bees and wasps are:** a) primary-toxic; b) secondary-toxic; b) actively-venomous; d) passively-venomous; e) passively-poisonous.
7. **Factors determining clinical presentation of toxication with zootoxins are:** a) composition and the volume of the venom; b) site of biting; c) sex of the affected person; d) habitus of the affected person; e) time of a day.
8. **Symptoms of toxication with scorpion venom:** a) a sharp pain, hyperemia and edema of the affected area; b) hyperemia and edema of the injured area, fear; c) neither hyperemia nor edema of the injured place, but nausea and vomiting; d) sharp pain, fear; e) fear, nausea and vomiting.

**9. Symptoms of toxication with tarantula venom:** a) sharp pain and drowsiness; b) hyperemia and a edema of the affected area, necrosis of skin; c) neither hyperemia nor edema of the affected area; d) hyperemia and edema of the affected area, drowsiness; e) drowsiness, necrosis of skin.

**10. Symptoms of toxication with bee or wasps venom:** a) sharp pain, fear; b) hyperemia and edema of the affected area, allergic reactions; c) neither hyperemia nor edema of the injured area; d) allergic reactions, of fear; e) sharp pain.

**11. Symptoms of toxication with cobra venom:** a) sharp pain, inflammation of lymphatic vessels; b) inflammation of lymphatic vessels, a necrosis of tissues; c) sharp pain, necrosis of tissues; d) excitation and then depression of CNS, necrosis of tissues; e) excitation and then depression of CNS, impairment of respiration are observed.

**12. Symptoms of toxication with Viper snakes venom:** a) sharp pain and impairment of blood clotting; b) extremities numbness and hemorrhagic edema; c) hemorrhagic edema; d) numbness of extremities and impairment of respiration; e) impairment of blood clotting and respiration.

**13. First aid in a toxication with hymenopterian venom:** a) to suck off the venom, to treat the area of stinging with disinfectants; b) to remove a sting, to treat the place of stinging with disinfectants; c) to treat the place of stinging with disinfectants, to apply heat to a place of stinging; d) to apply a warm compressive bandage to the place of stinging; e) to leave a sting, to treat the place of stinging with disinfectants.

**14. First aid in a toxication with snake venom is:** a) to suck away venom and to treat the place of a biting with disinfectants; b) to scorch the place of biting and to put a victim in a shade; c) to scorch and to treat the place of a biting with disinfectants; d) to transport a victim in lying position; e) to apply a hard bandage to a place of a biting and to transport a victim in any position.

**Fill in the gaps:**

**1.** Animals having glands producing toxins and specialized apparatus for its injection are called …

**2.** According to physiological effect on the body zootoxins are divided into neurotoxins, cytotoxins, hemorrhagins and …

**3.** Physalia's stinging organs are …

**4.** Toxin of a scorpion belongs to …

**5.** Toxin of a karakurt belongs to …

**6.** Toxins of a Brazilian spider belong to cytotoxins and …

**7.** Toxins of hymenopterans belong to cytotoxins and …

**8.** Toxin of Colombian cocoa frog is … times stronger than tetanus toxine.

**9.** Viper snakes are primarily-toxic … animals.

**Fill in the table**

| Species | Characteristic of animal venoms. Apparatus for injecting venom | Physiological characteristic of venom | Clinics of poisoning | The first aid and prophylaxis of poisoning. |
|---|---|---|---|---|
| Phylum Coelenterate:<br>– Jellyfish | | | | |
| Phylum Arthropoda:<br>– Scorpions<br><br>– Arachnoidea<br><br>– Hymenopterans | | | | |
| Phylum Chordata<br>– Snakes<br>a) Elapidae (cobra)<br><br>b) Viperidae (blunt-nosed viper, carpet viper, common viper) | | | | |

**PRACTICAL WORK**

**Study the preparation, colour the pictures, and sign the indications:**

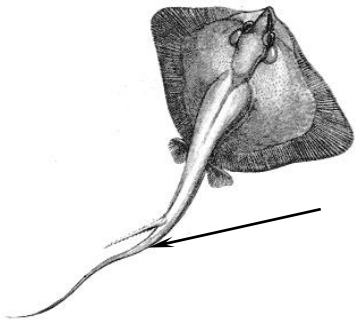

Fig. 1. Sting ray:
1 — stinger

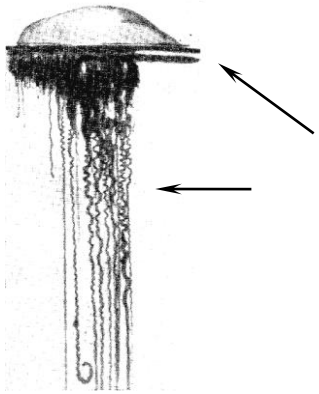

Fig. 3. Portuguese man-of-war:
1 — bell; 2 — tentacles

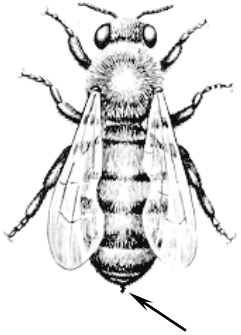

Fig. 2. Honey bee:
1 — sting

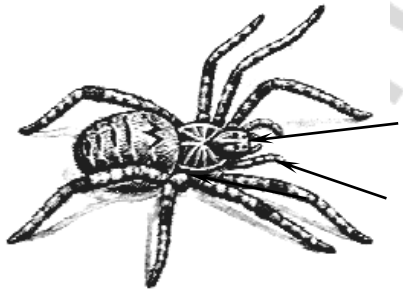

*Fig. 4*. Tarantulas
1 — chelicerae; 2 — pedipalps

**Teacher's signature**

**DEMANDS OF THE BIOLOGY DEPARTMENT TO THE STUDENTS:**

1. **Observe the safety rules in the classrooms of the department** (the safety instructions have been carried out), obey internal regulations of the Belarusian State Medical University.
2. Do not come late for practical classes. Students who are late for practical classes **are not admitted**.
3. Students must have **gowns, practical books, pencils** for practical trainings. Students who do not have gowns and practical books **are not admitted** to the practical classes.
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, summary classes, credit and the examination without dean's permission.
6. Students with result marks for the year **lower than 4.0** who got a **poor mark** at the examination 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 and 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 obtain a "**ten**".

I have read the demands of the department: _____ 201___ _____ (signature)

## LITERATURE


1. *Bekish, O.-Y. L.* Medical biology : textbook for student of higher educational establishments / O.-Y. L. Bekish. Vitebsk : VSMU Press, 2003. 346 p.
2. *Biology* for international students : lecture course / V. E. Butvilovsky [et al.]. Minsk : BSMU, 2016. 141 p.
3. *Biology* for international students : учеб.-метод. пособие / В. Э. Бутвиловский [и др.]. Минск : БГМУ, 2016. 166 с.
4. *Медицинская* биология и общая генетика : сборник задач / В. Э. Бутвиловский [и др.]. 2-е изд. Минск : БГМУ, 2010. 264 с.
5. *Медицинская* биология и общая генетика : терминологический словарь для иностранных студентов / В. Э. Бутвиловский [и др.]. Минск : БГМУ, 2007. 55 с.
6. *Медицинская* биология и общая генетика : тесты / В. Э. Бутвиловский [и др.]. Минск : БГМУ, 2006. 228 с.
7. *Медицинская* биология для медицинского факультета иностранных учащихся : учеб. пособие / В. Э. Бутвиловский [и др.]. Минск : БГМУ, 2014. 232 с.
8. *Медицинская* биология и общая генетика / Р. Г. Заяц [и др.]. 2-е изд. Минск : Выш. школа, 2012. 496 с.

## EXAMINATION QUESTIONS

**1.** Properties and characters of living things. Organization levels of living things.
**2.** The present state of the Cell Theory. Differentiating signs of pro- and eukaryotic cells.
**3.** Structure (models) of plasma membrane, its properties and functions. Passing substances into the cell.
**4.** The cell anabolic system.
**5.** The cell catabolic system.
**6.** Energy exchange in the cell. Enzymatic systems of mitochondria.
**7.** The structure and functions of the nucleus.
**8.** Types of chromosomes. The structure of a metaphase chromosome.
**9.** Cell and mitotic cycles. Interphase, characteristic of periods. Reasons of mitosis.
**10.** Characteristic and significance of mitosis.
**11.** Characteristic and significance of meiosis. Amitosis.
**12.** Nucleic acids (DNA and RNA): structure and functions. Chargaff's rules. DNA replication.
**13.** Properties of genes. The Central Dogma of Molecular Biology
**14.** Genetic code and its properties. Protein biosynthesis.
**15.** Classification of genes.
**16.** Levels of genetic material packing.
**17.** Regulation of transcription in prokaryotes and eukaryotes.
**18.** Genetic engineering. Stages of genetic.
**19.** Obtaining genetic material.
**20.** Polymerase chain reaction (PCR).
**21.** Restrictases. Vectors. Incorporation of DNA fragments into the molecule-vector.
**21.** Introduction of recombinant DNA in the cell-recipient.
**22.** Using methods of genetic engineering in medicine.
**23.** Inheritance regularities in monohybrid crossing.
**24.** Hypothesis of purity of gametes and its cytological basis.
**25.** Analyzing cross. Conditions limiting the manifestation of Mendel's laws. Pleotropic action of the gene. Semi-lethal and lethal genes
**26.** Regularities of inheritance in polyhybrid crossing. The Law of Independent Assortment.
**27.** Intra-allelic interaction of genes.
**28.** Inheriting blood groups.
**29.** Inter-allelic interaction of genes.
**30.** Experiments of T. Morgan. Complete and partial linkage.
**31.** Autosomal and gonosomal linkage groups. Crossing-over.
**32.** Maps of eukariotic chromosomes (genetic and cytological). Basic concepts of the Chromosome Theory of Inheritance.
**33.** Phenotypic variation. The reaction norm. Genotypic variation and its forms.
**34.** Mutagenic factors. Biological bases of cancerogenesis.
**35.** Classification of mutations. Genome, chromosome and gene mutations
**36.** Stability and repair of genetic material, antimutagens.
**37.** Sex as a biological character. Sex characters.
**38.** Sex-controlled and sex-limited characters. X-linked and holandric characters.
**39.** Peculiarities of sex determination in humans and its impairments.
**40.** Sex disorders associated with chromosomes.
**41.** M. Lion's hypothesis.
**42.** The human as an object of genetic investigations.
**43.** Clinical-genealogical method. Twin method.
**44.** Cytogenetic method. Biochemical methods.
**45.** Methods of a recombinant DNA.

**46.** Characteristic of human populations. Types of marriages. Genetic processes in large populations. The law of Hardy–Weinberg.
**47.** Genetic processes in small populations. Genetic load and its biological nature.
**48.** Methods of prenatal diagnosis of hereditary disorders. Express-methods.
**49.** Forms of reproduction, their characteristic. Evolution of the sex process.
**50.** Gametogenesis. The structure of gametes.
**51.** Insemination. Fertilization.
**52.** Biological peculiarities of human reproduction.
**53.** Periods of ontogenesis. Embryogenesis.
**54.** Critical periods of development. Teratogenesis.
**55.** Growth: laws and regulation of growth.
**56.** Constitution and habitus. Aging and old age. Theories of aging.
**57.** Clinical and biological death. Reanimation and euthanasia.
**58.** Origin of parasitism. Criteria of parasitism.
**59.** Classification of parasites and their hosts. Transmission rotes of parasites.
**60.** Morphophysiological and biological adaptations of parasites.
**61.** Pathogenic action and specificity of parasites.
**62.** Host's response to parasitic invasion. Basis of biological prophylaxis of parasitic diseases.
**63.** Parasitizing flagellates: Trichomonas vaginalis: morphological peculiarities, life cycle, rotes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis.
**64.** Cat liver fluke: morphological peculiarities, life cycle, rotes of transmission, pathogenic action; characteristic symptoms, diagnosis and prophylaxis of opisthorchiasis.
**65.** Taenia solium: morphological peculiarities, life cycle, rotes of transmission, pathogenic action; symptoms, diagnosis and prophylaxis of taeniosis and cysticerciasis.
**66.** Ascaris lumbricoides: morphological and biological peculiarities, rotes of transmission, pathogenic action of ascaris and its larvae; symptoms of migration and intestinal stages of ascariasis, diagnosis and prophylaxis of ascariasis.
**67.** Itch mite: peculiarities of morphology and biology; pathogenic action; symptoms, diagnosis and prophylaxis of scabies.
**68.** Order Anoplura: peculiarities of morphology and biology; lice as patogens and vectors of diseases; prophylaxis.
**69.** Poisonous micro- and macromycetes. Macromycetes classification.
**70.** Physiological characteristics of mycotoxins of micro- and macromycetes.
**71.** Toxic plants and their classification. Toxic agents produced by plants and mechanism of action.
**72.** Physiological characteristics of phytotoxins of thallophytes and embryophytes.
**73.** Physiological characteristic of fitotoxins, their impact on the human; the first aid and prophylactic measures against bites and poisoning.
**74.** Classification of toxic animals (primarily and secondarily toxic, actively and passively toxic).
**75.** Physiological characteristic of toxins of invertebrates (jellyfish, arachnoidea, hymenoptera), their effect on the body; the first aid and prophylaxis of bites and poisoning.
**76.** Physiological characteristic of toxins of vertebrate animals (fishes, amphibians, reptiles), their effect on the body; the first aid and prophylaxis of bites and poisoning.