MINISTRY OF HEALTH OF UKRAINE

ODESSA NATIONAL MEDICAL UNIVERSITY

Department of medical biology and chemistry

APPROVED
Vice-rector for research and educational work,

_____ Eduard BURYACHKOVSKY

01 of September, 2024.

METHODOLOGICAL RECOMMENDATIONS

FOR PRACTICAL CLASSES

OF HIGHER EDUCATION STUDENTS IN THE ACADEMIC DISCIPLINE

BIOLOGY WITH BASES OF GENETICS

The level of high education: second (magister)

Branch of knowledge: 22 "Health Care"
Speciality: 226 "Pharmacy, industrial pharmacy"
Educational- professional program: Pharmacy, industrial pharmacy

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Developments are discussed and approved at a methodic meeting of the Department of Medical Biology and Chemistry.

Minutes № 1, 26.08.2024.

Head of the department  Gennady STEPANOV

Module section 1. Molecular- cellular level of life organization

Practical class 1. Levels of living matter organization. Optical systems in biological studies.

The Purpose of the Lesson. To study the structure of the light microscope. To get the skills of microscoping and preparation of temporary slides. To realize the importance of studying the elementary units of life organization on the each level for understanding underlying basis of health and disease mechanisms.

TOPIC CONTENT

1. Structure of compound optical microscope
2. Usage of optical microscope in low and high magnification
3. Common mistakes in usage of optical microscope
4. Preparation of temporary slides.
5. Levels of organization of living matter. Their importance for understanding of pathological processes.
6. Elementary units and elementary functions of different levels of living matter organization.

TEST QUESTIONS for individual work

	Questions	Answers
1	What are the structural parts of the optical microscope: a ,b, c	
2	Name the main components of mechanical part: a, b, c, d, e, f, g	
3	Name the main components of illuminating part: a, b, c	
4	Name the main components of optical part: a, b	
5	What is the magnification of a)eye-piece lens – a,b,c b)objective lens of low magnification– a c)objective lens of high magnification– a d)objective lens of oil immersion magnification– a	
6	Calculate the total magnification of microscope, if magnification of eye-piece lens is 15x and magnification of objective lens is 8x	
7	List the main levels of biological organization : a, b, c, d, e, f.	

To study the objects smaller than 0.5 mm microscopes are used.

COMPOUND LIGHT MICROSCOPE (Fig.1.1)

There are **3 main parts** in structure of light microscope - **mechanical, optical and illumination ones.**

1. **Mechanical part** consists of the **base, arm, stage, tube, revolver (nose-piece), coarse adjustment and fine adjustment screws.**
2. **Illumination part** includes **mirror, condenser, diaphragm.** Diaphragm regulates the quantity of entering light.
3. **Optical part** is system of **eyepiece and objective lenses**.

Eyepiece gives **(x7, x10, x15)** magnification. **Objective lenses** can give low **(x8, x10), high (x40) and immersive (x90) magnification** and are attached to the nosepiece.

The **total magnification of the microscope** can be calculating by the following formula: **magnification of eyepiece multiply on magnification of objective lens.**

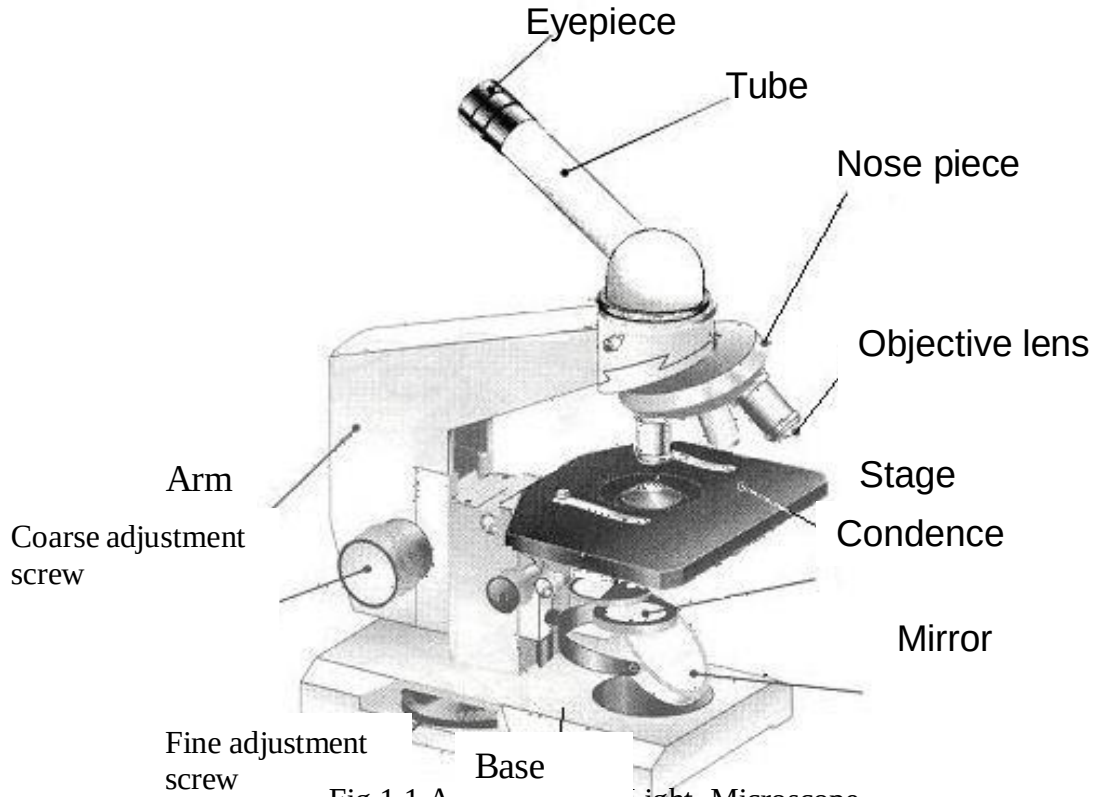


Fig 1.1 A Compound Light Microscope

HOW TO WORK WITH A COMPAUND MICROSCOPE

1. Always use 2 hands to carry a microscope: one on the arm, and one - supporting the base.
2. Take a microscope and place it on your desk at least 10 cm from the edge. Position of the microscope with the arm facing you.
3. Look through the eyepiece. The white circle of the light you see is the field of view. Turn the mirror to catch the light rays until the range becomes bright and even.
4. Place a slide on the stage so that it is central over the stage opening. Always use the lowest power objective lens for bringing specimen into focus, so turn the low power objective into place. Look at the microscope from the side and turn the coarse adjustment so that the low-power objective is close to the stage without touching it (focus distance is about 10 mm).
5. Look through the eyepiece and turn the coarse adjustment to move the low-power objective away from the stage until the objective comes into focus. **Never lower the objective forwards the stage while looking trough the eyepiece.**

6. To shift the magnification lifts the objective lens. Rotate the low-power objective into position and use the coarse adjustment to place it as close to the stage as low as possible (focus distance is less then 1 mm).
7. Look through the eyepiece and turn the coarse adjustment to move the low-power objective away from the stage until the objective comes into focus. Bring specimen into focus by first using coarse adjustment, and then use fine adjustment. **Never lower the objective forwards the stage while looking trough the eyepiece.**

TECHNIQUE FOR PREPEARING A WET MOUNT

1. Place slide on a flat surface.
2. Place a drop of water on the slide. Add the specimen to the drop of water.
3. Hold the cover slip by its sides and lay its bottom edge on the slide close to the specimen, holding the coverslip at a 45^0 angle helps.
4. Slowly lower the coverslip so that is spreads the water out. If you get air bubbles (looking like little black doughnuts), gently press on the coverslip to move them to the edge. If there are dry areas under the coverslip, add a little more water at the edge of the coverslip. Too much water can be dabbed off with a piece of paper towel (filter paper).
5. Place a prepared slide on the stage so that it is central over the stage opening. Study specimen under the lower and high magnification.
6. Take apart the wet mount. Clean the slide and coverslip.

Biology is a science about life. **Characteristics of living matter are:**

Unity of chemical composition; Metabolism; Reproduction; Homeostasis; Response and irritability (sensitivity); Heredity and variation; Growth and development.

Level of organization in living organisms

1. Molecular-genetic level. Its elementary structure is macromolecules (DNA, RNA, proteins). Elementary phenomena of this level are DNA replication, protein biosynthesis. Such medical problem as mutations and it accumulation in populations is studied by a group of sciences as molecular biology, molecular genetics.

2. Cellular level. Its elementary structure is a cell. The cell cycle is an elementary phenomenon. Cellular pathology, tumor growth are studied by cytology, histology.

3. Organismic level. Its elementary structure is the organism, having organ system. Elementary phenomenon of this level is a complex of physiological processes that provides functioning of an organism. Reduced adaptive capabilities of organisms are studied at this level by histology, anatomy, morphology, physiology, medical genetics.

4. Population and species level. Its elementary structure is a population. Evolution of species on the basis of natural selection is an elementary phenomenon. Decreasing of demographic data of population is studied by population genetics and ecology.

5. Biogeocenotic. . Its elementary structure is populations of different kinds and environmental factors. Biochemical cycling of matter and energy flow, life-sustaining are elementary phenomena. Violation of dynamic equilibrium between living organisms and the abiotic environment is studied by biocenology and ecology at this level.

6. Biospheric. Its elementary structure is biogeocenosis and anthropogenic factors. Biological global cycling of matter and energy is elementary phenomenon. The negative effects of human biogeochemical activity on the biosphere are studied by ecology.

Practical work. OPTICAL SYSTEMS IN BIOLOGICAL STUDIES.

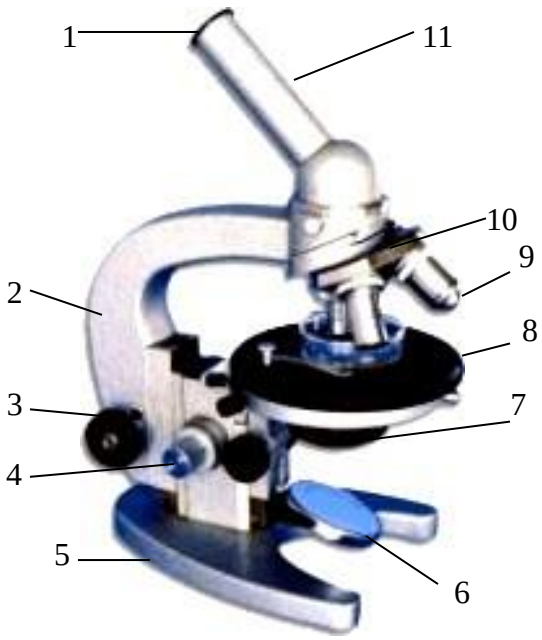
TASK 1. Study how to work with the light microscope:

- While starting the procedure the eyepiece and the mirror are to be clean with a smooth cloth and so should be done after the end of the work.

- The studying of the slide is to be started with low magnification.
- To light the range of view turn the mirror to catch the light rays until range of view becomes throughout clear and lightened.
- Put the preparation slide on to the stage by cover slip up.
- By the control of vision lower the objective lens using coarse adjustment screw. Distance between lens and slide should be about 5 mm. After this lift the lens slowly looking in the eye-piece until your see the subject of studying.
- Turn the nose-piece to put the high magnification objective lens. By the control of vision lower the objective lens using coarse adjustment screw. Carefully touch the slide with the lens. After this lift the lens slowly looking in the eye-piece until your see the subject of studying.Use fine adjustment screw to get fine image.
- After finishing the work return the low magnification lens to it position.
- Microscopes are carried by right hand holding the handle and the left one supporting the base.
- Never unscrew the objective lenses.

Possible Mistakes:

-Improper illumination of visible area.
-Dusty optics.
-Disposition of slide.
-Water on cover slip and objective lens.



Mark the parts of optical microscope

1- _____
2 - _____
3 - _____
4 -_____
5 - _____
6-_____
7- _____
8-_____
9- _____
10-_____
11-_____

TASK 2. Make a temporary slide of cotton fibers.

1. Drop water on the slide.
2. Put some cotton fibres in the drop of water on the slide.
3. First put one edge of the cover slip in the water drop and then slowly put it down to avoid air bubbles under the cover-slip.
4. Soak the excess of water with filter paper if needed.

TASK 3. Study the slide of cotton fibers under small and high magnification, sketch it, and point out a general magnification of the microscope.

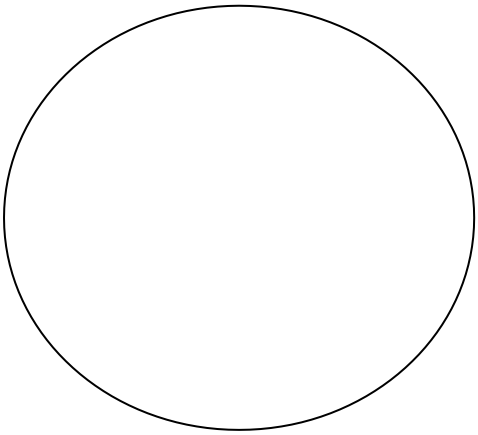


Fig.1. Cotton fibers under the low magnification.

Total magnification = ____(... x ...).

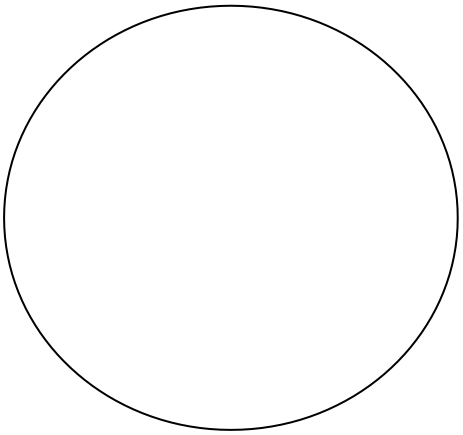


Fig. 2. Cotton fibers under the high magnification.

Total magnification = ____(... x ...)

TASK 4. Fill a table of levels of organization of living matter.

Hierarchical level	*Elementary unit*	*Elementary function*	*Science studying this level*	*Importance for medicine*
Molecular-genetic				
cellular				
Organism				
Population - species				
Biogeocenotic				
Biospheric (global)				

TASK 5. Compare the various characteristics of life between that of a rabbit and stalactites in a cave by marking "+" if it could occur and "-" if it cannot occur.

Characteristic of life	Rabbit	Stalactites in a Cave
Exchange of the material and energy with the environment		
Homeostatic		
Respond to stimuli		
Reproduce		
Grow and develop		
Adaptation		

C. ANSWER MULTIPLE CHOICE QUESTIONS

1. The term "Biology" for the study of living things was introduced by
   A. Aristotle
   B. B. Morgan
   C. J.B. Lamarck and Treviranus
   D. Purkinje
   E. Leeuwenhoek
2. The levels of biological organization in microsystem:
   A. Molecular, subcellular, cellular
   B. Cellular, tissue
   C. Organ, organism
   D. Subcellular, tissue
   E. Tissue, organ, organism
3. Name the levels of biological organization in mesosystem:
   A. Molecular, subcellular, cellular
   B. Subcellular, cellular, tissue
   C. Organism, population-species
   D. Tissue, organ, organism
   E. Population- species, biocenosis, biosphere
4. Name the levels of biological organization in macrosystem:
   A. Molecular, subcellular, cellular
   B. Subcellular, cellular, tissue
   C. Organism, population-species
   D. Tissue, organ, organism
   E. Population- species, biocenosis, biosphere
5. Main parts of optical microscope includes:
   A. Mechanical
   B. Mechanical and optical
   C. Optical
   D. Mechanical, optical and illuminating
   E. Illuminating
6. Mechanical part of optical microscope includes:
   A. Base
   B. Tube
   C. Nose-piece (revolver)
   D. Coarse and fine adjustment screws
   E. All of the above
7. Illuminating part of optical microscope includes:
   A. Mirror, base, arm
   B. Condenser, diaphragm, tube
   C. Diaphragm, tube, arm
   D. Mirror, condenser, diaphragm
   E. Mirror, condenser, revolver (nose-piece)
8. Optical part of optical microscope includes
   A. Eye piece lenses
   B. Eye piece lenses and diaphragm
   C. Objective and eye piece lenses
   D. Objective lenses and stage
   E. Condenser, eye piece and objective lenses
9. Eye piece occupies a superior position on a tube and gives magnification
   A. 7×, 40×, 15×
   B. 8×, 10×, 15×
   C. 10×, 40×, 90×
   D. 7×, 10×, 15×
   E. 8×, 40×, 90×
10. Objective lenses are attached to nose piece and give magnification
   A. 7×, 10×, 40×
   B. 8×, 40×, 90×
   C. 10×, 40×, 90×
   D. 7×, 10×, 15×
   E. 7×, 40×, 90×
11. Calculate the total magnification of microscope if eye piece gives 10× magnification and objective lens gives 40× magnification
   A. 10×
   B. 40×
   C. 50×
   D. 200×
   E. 400×
12. Resolving power of human eye is
   A. 50 mμ
   B.100mμ
   C. 150 mμ
   D. 200 mμ
   E. 250 mμ
13. Main possible mistakes during the microscoping are:
   A. Improper illumination ofrange of view
   B. Dusty optics
   C. Disposition of the slide
   D. Water on the cover slip and objective lens
   E. All of the above
14. The ability to move is an example of
   A. Homeostasis
   B. Reproduction
   C. Growth and development
   D. Adaptation
   E. Response to stimuli
15. The amount of sugar in our blood is always maintain 3.5 – 6.1 mmol/l. It is an example of
   A. Homeostasis
   B. Reproduction
   C. Growth and development
   D. Adaptation
   E. Response to stimuli
16. Organs such as the heart are composed of _____, which is the next lower level of biological organization
   A. Tissue
   B. Organ system
   C. Cells
   D. Atoms
   E. Molecules
17. The next higher level of biological organization above the cell is
   A. Organ
   B. Tissue
   C. Organ system
   D. Molecule

E. Atom

18. Which sequence is correct regarding increasing complexity?

A. Atoms, molecules, cells, organs, tissues

B. Molecules, atoms, cells, organs, tissues

C. Atoms, molecules, cells, tissues, organs

D. Atoms, molecules, tissues, organs, cells

E. Atoms, molecules, organs, tissues, cells.

Practical class 2.

Biological membranes. Transport across the cell membrane. Structural components of cytoplasm

Practical class 2. Biological membranes. Transport across the cell membrane

The Purpose of the Lesson: To study the importance of biological membranes and transport across the membranes for activities of the cells

TOPIC CONTENT

1. Modern model of plasma membrane organization.
2. Chemical composition of plasma membrane.
3. Structure and function of glycocalyx.
4. Functions of plasma membranes.
5. Active and passive transport across the plasma membrane.
6. Endocytosis (phagocytosis and pinocytosis). Exocytosis.

TEST QUESTIONS for individual work

№ №	Questions	Answers
1	Name the modern model of cell plasma membrane structure:a	
2	List the organic substances that compose plasma membrane: a,b	
3	What are the main functions of cell membrane? a,b,c,d,e	
4	Name the types of a) passive transport: a,b,c b) active transport: a,b,c,	
5	Which kind of transport requires ATP energy?	
6	Through which membrane components and by which mechanisms passes • water • water-soluble substances • fat-soluble substances • glucose • amino acids • ions	
7	What is • pinocytosis • phagocytosis • exocytosis	

The cell membrane or plasma membrane is described according to the fluid mosaic model.

Chemical composition: phospholiopids, proteins and cholesterol.

Organization of cell membrane.

Membrane consists of two layers of phospholipids. The hydrophilic (water-soluble) heads of phospolipids are toward the water. The hydrophobic (insoluble) tails are toward each other. Proteins are on the surface of the lipids or cross the phospolipid layer.

On the outer surface some lipids and proteins combine with carbohydrates (glycolipids and glycoproteids). Glycolipids and glycoproteids form glycocalyx.

Functions of membrane

A. isolates the cytoplasm from the exterior environment;
B. regulates the transport of molecules into and out of the cell;
C. allows communication with other cells;
D. reception of the signals from outer environment .

Transport across the cell membrane

Cell membrane is selectively permeable. Selectively permeability means that some molecules are allowed to pass through the cell membrane while other cannot.

There are two types of transport:

1) Passive transport is transport without energy use. It occurs from area with high concentration to low concentration (down the concentration gradients).

2) Active transport is the transport, that takes energy. It occurs against the concentration gradients.

Passive transport

- Simple diffusion – the movement of particles from an area where their concentration is high to an area that has low concentration. It is transport of ions, gases (O_2, CO_2), fat-soluble molecules (cholesterol, Vitamin D)
- Osmosis – diffusion of water
- Facilitated diffusion - passage of molecules through transmembrane transport proteins. It is transport of amino acids, glucose, some ions

Active transport

A. It requires energy in the form of ATP.
B. Ion pomps (active transport). It is special transport protein of the cell membrane, that supplies energy for transport of ions against a chemical gradient. Example is the sodium pump for the transfer of sodium and potassium ions across a cell membrane.

C. Endocytosis. It is a process by which cell get large molecules from outside.

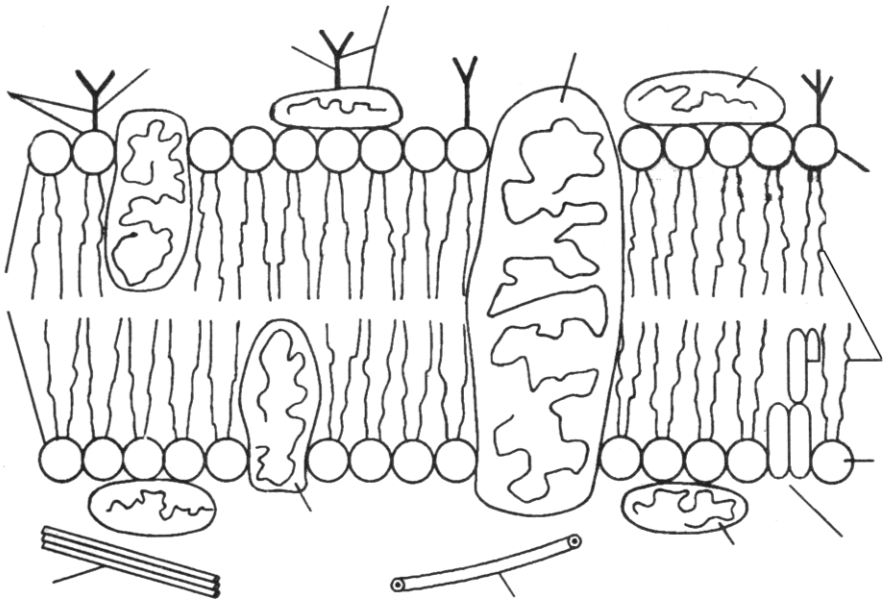
a) phagocytosis is the engulfment of the solid particles. Example is phagocytosis of bacteria by leukocytes.

b) pinocytosis is the engulfment of the liquid (solution of macromolecules)

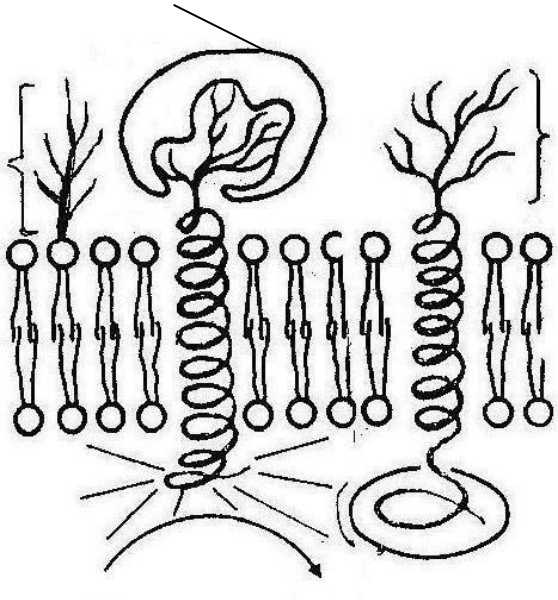
Exocytosis. It is a process by which cell excrete large molecules to outside.

Practical work. **CELL MEMBRANES. TRASPORT ACROSS BIOMEMBRANE**

TASK 1. Study fluid mosaic model of plasma membrane. Label hydrophilic heads, hydrophobic tails, proteins (integral, semi integral and peripheral), glycoproteids.

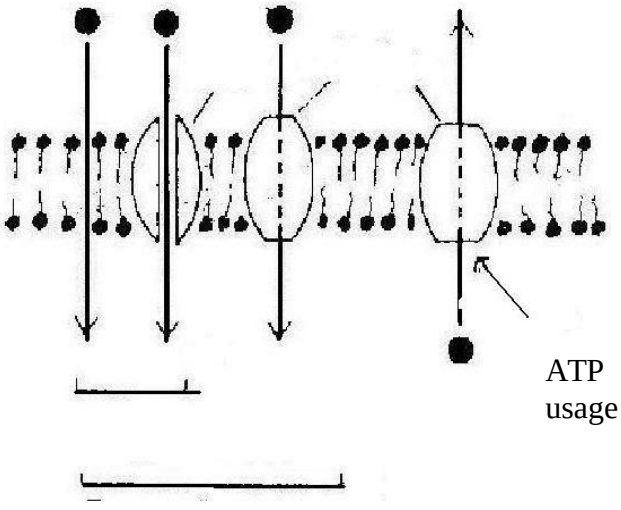


TASK 2. Study receptor function of glycocalyx. Label glycopipids, glycoproteids, hormone.



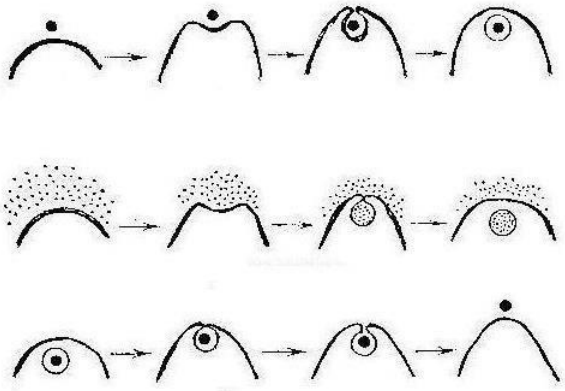
ATP cAMP

TASK 3. Study scheme of transport across the plasma membrane. Label simple and facilitated diffusion, active transport. Give the examples of substances that enter the cell by each way.

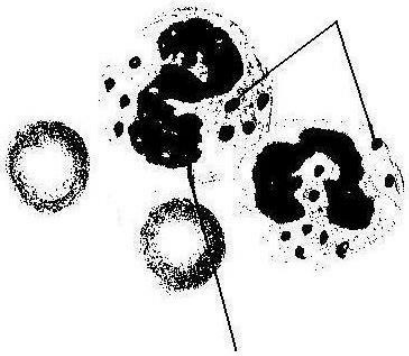


ATP usage

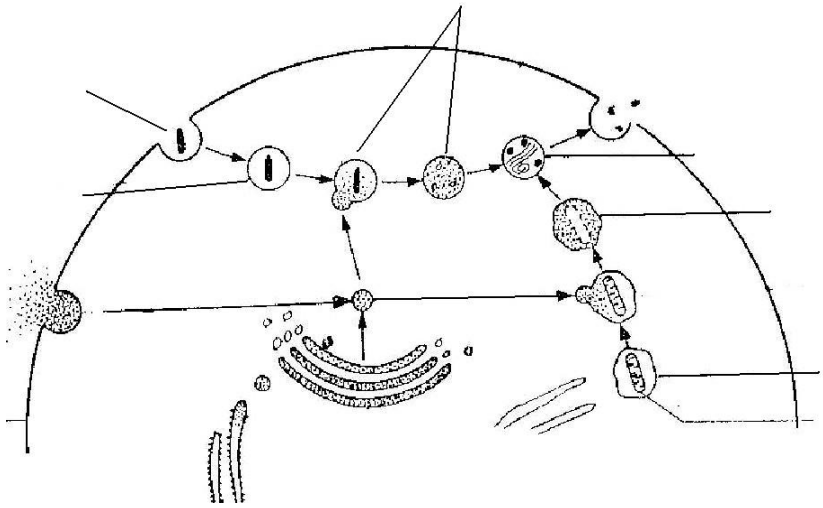
TASK 4. Study the mechanisms of endo- and exocytosis. Label phago-, pino- and exocytosis. Write down the substances that pass across cell membrane by each mechanism



TASK 5. Study a blood smear under the light microscope. Mark leukocytes, erythrocytes and engulfed bacterial cells.



TASK 6. Study the scheme of hetero-, auto and exocytosis. Mark Golgi complex, lysosomes, phagolysosomes, autophagosomes, residual bodies, exocytosis.



TASK 7. Compare passive and active transport across plasma membrane

Characteristic	Passive transport	Active transport
1. Concentration gradient 2. Energy requirement 3. Shape of protein (if protein is involved)		

4. Types of transport		

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. The latest model about the molecular structure of biomembrane is
A. Fluid mosaic model;
B. Sandwich model hypothesis;
C. Lipid model;
D. Protein model;
E. Unit membrane hypothesis.

2. It has been cleared that animal and human cells have specific outer coating - glycocalyx. It consist of
A. Lipids;
B. Carbohydrate-rich molecules;
C. Proteins;
D. Glycogen;
E. Nucleic acids.

3. In laboratory experiment leukocyte culture was mixed with staphylococci. Neutrophile leukocytes engulfed and digested bacterial cells. This process is termed
A. Pinocytosis;
B. Diffusion;
C. Exocytosis;
D. Phagocytosis;
E. Copulation.

4. The concentration of calcium in a cell is 0.3%. The concentration of calcium in the surrounding fluid is 0.1%. How could the cell obtain more calcium?
A. Passive transport;
B. Diffusion;
C. Active transport;
D. Osmosis;
E. Any of the above.

5. Red blood cells were immersed in a hypotonic solution. The cells gained water, swelled and lysed. What transport mechanism works in this case?
A. Electro diffusion;
B. Exocytosis;
C. Osmosis;
D. Phagocytosis;
E. Facilitated diffusion.

6. Phagocytosis provides feeding in some protozoan like amoeba. In which human cells this mechanism is not the way of nutrition but provides defense of an organism?
A. Erythrocytes;
B. Leukocytes;
C. Epithelium of digestive tract;
D. Epithelium of respiratory tract;
E. Epithelium of excretory tract.

7. Electron micrograph of a cell shows that cell membrane consists of lipids and proteins. Some proteins are peripheral, some are semi-integral and some are integral. Through which of membrane components transport of ions takes place?
A. Lipids;
B. Peripheral proteins;
C. Glycoproteins;
D. Glycolipids;
E. Integral proteins.

8. Electron micrograph of a pancreatic cell shows well developed Golgi complex and lot of secretory vesicles. Some vesicles are secreted outside by mechanism of
A. Diffusion;

B. Phagocytosis;
C. Exocytosis;
D. Ion pomp;
E. Osmosis.

9. Plasma membrane was partially destroyed by action of ultraviolet rays. Which cell organelle will provide its restoration?
A. Lysosome;
B. Mitochondrion;
C. Golgi complex;
D. Smooth endoplasmic reticulum;
E. Centriole.

10. Electron micrograph of a cell shows outer membrane coating – glycocalix, which consists of carbohydrates covalently bonded to membrane proteins and lipids. The main function of this structural component is
A. Structural;
B. Protective;
C. Passive transport;
D. Receptor;
E. Phagocytosis.

11. Pediatrician examined the patient with rickets and administered vitamin D. This vitamin enters the cells by
A. Active transport;
B. Osmosis;
C. Diffusion through the lipids;
D. Diffusion through the proteins;
E. Phagocytosis.

12. Intravenous injection of glucose is indicated in treatment of different disorders. How does this substance pass through the cellular membranes?
A. Active transport;
B. Osmosis;
C. Diffusion trough the lipids;
D. Fagocytosis;
E. Facilitated diffusion.

13. Movement of materials across a membrane against electrochemical gradient occurs by
A. Active transport;
B. Osmosis;
C. Facilitated diffusion;
D. Diffusion;
E. All of these.

14. Cell recognition and adhesion is facilitated by certain components of cell membrane. These components are generally
A. Proteins and lipids;
B. Glycoproteins and glycolipids;
C. Lipids only;
D. Proteins only.

15. Fluid mosaic model of cell membrane states that it has lipid bilayer with
A. Proteins on both the surfaces;
B. Proteins on the outer surface only;
C. Proteins embedded in it only;
D. Some proteins embedded and some on the surface;
E. Membrane consists of proteins only.

16. If a solution outside a cell is made more concentrated, so the cell loses water to its environment and shrinks, the external solution is said to be
A. Hypotonic;
B. Isotonic;
C. Hypertonic;
D. In equilibrium.

17. The thyroid gland contains a high concentration of iodine This is an example of
A. Passive transport;
B. Active transport;
C. Facilitated diffusion;
D. Endocytosis;
E. Osmosis.

18. Which of the following is actively transported across cell membrane?
A. Carbon dioxide;
B. Oxygen;
C. Water;
D. Amino acids;

E. Sodium ions.

19. Golgi complex exports substances from a cell due to the fusion of the membrane saccule with the cell membrane. The saccule content flows off. What process is it?

A. Exocytosis;
B. Active transport;
C. Facilitated diffusion;
D. Endocytosis;
E. All answers are false.

Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

Practical class 3. Morphology of eukaryotic cell. Structural components of cytoplasm

The Purpose of the Lesson: To study the morphology of the cell as elementary life unit. To get an association between structure and functioning of eukaryotic cell as basis for studying of other morphological and medical disciplines. To understand importance of organelles studying in medicine.

TOPIC CONTENT

1. Cellular and non-cellular forms of life.
2. Prokaryotes and eukaryotes.
3. Principle differences in morphology of animal and plant cell
4. Importance of scientific works of R. Hooke, A. Leeuwenhoek, M. Malpighi, R. Brown, J. Purkinje, M.Schleiden, T. Schwann in development of the cell theory.
5. Modern postulates of the cell theory.
6. Structure and function of the main structural components of the cytoplasm: hyaloplasm (cytosol), cell organelles, inclusions, nucleus.
7. Classification of cell organelles: general function organelles (double-membranous, single-membranous, non-membranous) and special function organelles.

TEST QUESTIONS for individual work

	Questions	Answers
1	Cell was discovered by … in ….. year	
2	Cell theory was formulated by … in …..year	
3	List cell organelles of – general function: a,b,c,d,e,f – special function: a,b,c,d	
4	Name the primary functions of 1) lysosomes: a,b,c,d,e 2) mitochondria: a,b 3) smooth endoplasmic reticulum: a,b,c, 4) rough endoplasmic reticulum: a,b 5) ribosomes: a	
6	6) Golgi complex: a, b, c, d	

7	7) centrioles: a Proteins that are produced for inner cell needs are synthesized in … Proteins that are exported from the cells are synthesized in ….	
8	Dysfunction of which organelles leads to the "storage disorders"?	
9	Name the organelles that provide main processes of 1) synthesis of organic substances: a, b,c 2) disintegration of organic substances: a, b	

There are two types of the cell

1. **Prokaryotic cell.** This is bacterial cell. It has no nucleus and membranous organelles.
2. **Eukariotic cell.** This is cell of animals, plants and fungi. Eukaryotic cell has nucleus and membranous organelles.

Eukaryotic cell

Eukaryotic cell has

1) **membrane**

2) **cytoplasm**

3) **nucleus**

Cytoplasm

Cytoplasm has:

1) hyaloplasm or cytoplasmic matrix. It is a fluid portion of cytoplasm.

It contains **water, proteins, sugars, amino acids, and ions and other important substances.**

2) cytoskeleton. It is a network of protein filaments. It determines cell shape and enables movement. Main components are microfilaments (actin protein), microtubules (tubulin protein), and intermediate filaments

3) inclusions. These are temporary cytoplasm components like fat droplets, glycogen granules and others.

4) Cell organelles. These are permanent structural components of the cytoplasm with certain structure and function.

Cell organelles

I. Organelles with double membrane.

1. Mitochondria are the energy organelles of the cell. Each mitochondrion has an outer and inner membrane. The inner membrane forms **cristae**. The interior spaces of the mitochondrion is filled with a **matrix**. Matrix contains circular DNA molecules and ribosomes.

The function of mitochondria is

- production of energy (ATP). It occurs as a result of oxidation of organic substances (mitochondria use O_2)
- cytoplasmic inheritance. As it has DNA, it transfere some hereditary characters for next generation
- synthesis of some mitochondrial proteins

II Organelles with single membrane

1. Endoplasmic reticulum (**ER**) is an membranous system of cell. It has tubules and sacs. There are two types of endoplasmic reticulum:

a) **rough endoplasmic reticulum**. It has ribosomes. Function of the rough ER is synthesis and transport of proteins Proteins from rough ER go to the Golgi complex.

b) smooth endoplasmic reticulum. Function of the smooth ER is synthesis and transport of lipids and carbohydrates. In liver cells the smooth ER contains enzymes that detoxify toxic substances.

2. Golgi complex is a set of flattened sacs, tubules and vesicles. Functions of Golgi complex are

- to accumulate, pack and release proteins and lipids produced in the cell.
- to form complex organic substances (for example, glycoproteins).
- to produce lysosomes.

3. Lysosomes are vesicles with digestive enzymes. Functions of lysosomes are

D. intracellular digestion of food substances
E. breakage of macromolecules, accumulated in the cell (for example glycogen)
F. digestion of aged or damaged organelles.

If lysosomes rupture and release their enzymes into the cytoplasm, it causes digesting the whole cell (autolysis)

4. Peroxisomes are vesicles with different enzymes. Function of peroxisomeis metabolism of fatty acids and detoxication of peroxides (H_2O_2)

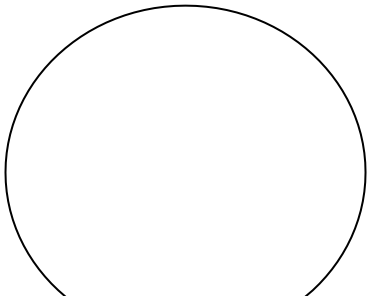
III Organelles without membrane

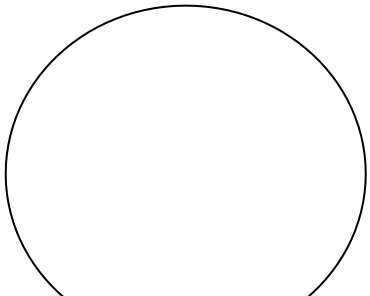
1. Ribosomes has two subunits – a large subunit and a small subunit. Each subunit consists of proteins and rRNA. Function of ribosomes is protein synthesis.

In eukaryotic cells ribosomes are formed in the nucleolus.

2. Centrosome (Centrioles) are two cylindrical structures that lie at right angles to one another near the nucleus. Each centriole is composed of nine triplets of proteins fibers (tubulins). The centrioles are important in cell division. They organize formation of spindle fibers, which move the chromosomes.

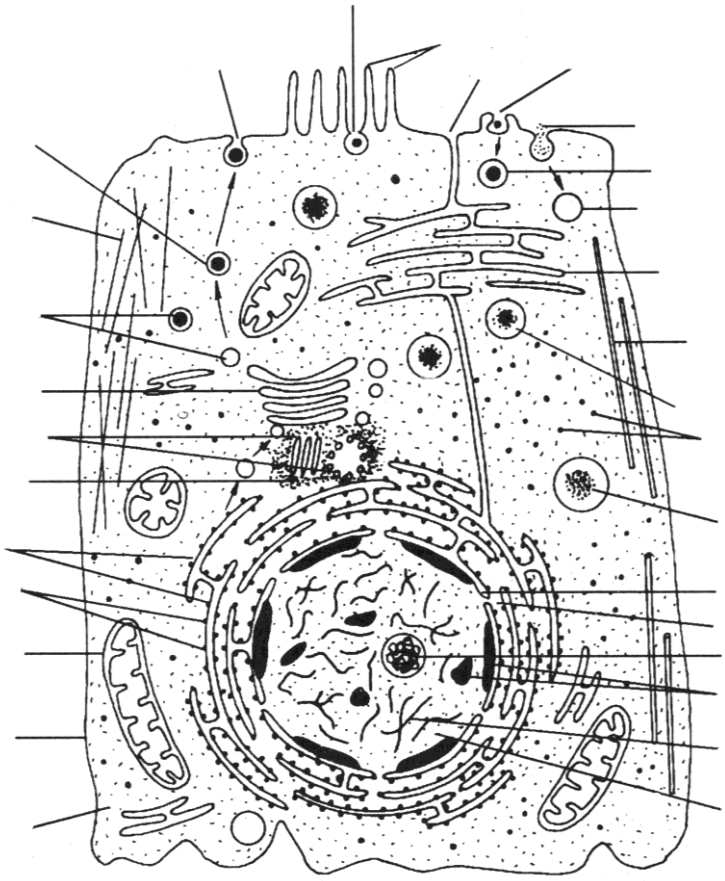
TASK 1. Study under a microscope samples of A) human blood; B) blood of a frog . Sketch the erythrocytes.

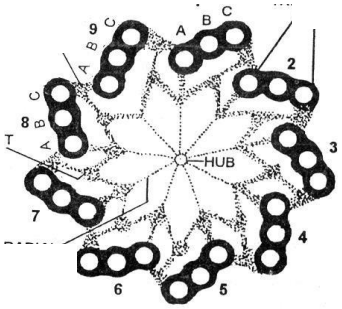


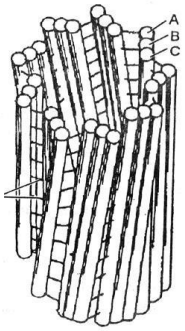


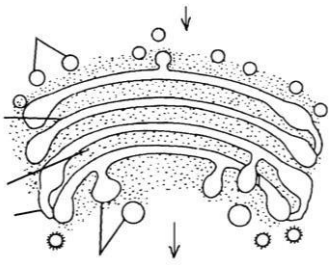
A. B.

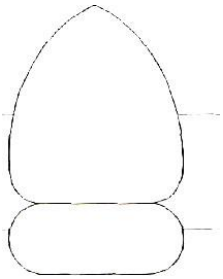
TASK 2. Study a scheme of eukaryotic cell. Point out structural components.

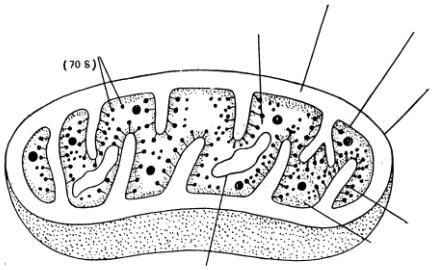












TASK 3. Fill the table

Organelle	Structural components	Function
Mitochondrion EPC a) smooth b) rough		

Golgi complex Lysosome Peroxysome Ribosome Centrioles		

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. The cell theory was enunciated by
A. Robert Hooke
B. Anton Van Leeuwenhoek
C. I. Metchnikoff
D. T. Schwann
E. R.Brown

2. The prokaryotic cells differ from eukariotic cells in structure and way of division. Their typical features are
A. Presence of cell membrane
B. Absence of nucleus
C. Absence of membrane-limited organelles
D. Presence of ribosomes
E. All of the above

3. The eukaryotic cells differ from prokariotic cells in structure and way of division. Specific feature of eukaryotic cell is
A. Single circular double strand of DNA
B. Absence of linear chromosomes
C. Cell membrane
D. Absence of membrane –limited organelles
E. Nuclear membrane around the nuclear material

4. The latest model about the molecular structure of biomembrane is
A. Fluid mosaic model
B. Sandwich model hypothesis
C. Lipid model
D. Protein model
E. Unit membrane hypothesis

5. It has been cleared that animal and human cells have specific outer coating - glycocalyx. It consist of
A. Lipids
B. Carbohydrate-rich molecules
C. Proteins
D. Glycogen
E. Nucleic acids

6. Some human disorders is a result of dysfunction and structural defects of cell membranes. Which property of cell membrane is most important in cell metabolism
A. Plasmolysis
B. Semi permeability
C. Presence of micrivilli
D. Structural function
E. Cell communication

7. In laboratory experiment leukocyte culture was mixed with staphylococci. Neutrophile leukocytes engulfed and digested bacterial cells. This process is termed
A. Pinocytosis

B. Diffusion
C. Metagenes
D. Phagocytosis
E. Copulation

8. Cells of most organisms have organelles of special and general function. Example of latter is
A. Endoplasmic reticulum
B. Ribosomes
C. Lysosomes
D. Mitochondria
E. All of the above

9. There are two types of endoplasmic reticulum: smooth and rough. Which function is common for both?
A. Protein biosynthesis
B. Biosynthesis of carbohydrates
C. Lipid biosynthesis
D. Synthesis of glycogen
E. Transport

10. Electron photomicrograph of the cell shows a network of internal membranes studded with ribosomes. This is
A. Golgi complex
B. Smooth endoplasmic reticulum
C. Rough endoplasmic reticulum
D. Microtubules
E. Mitochondria

11. Electron photomicrograph of the cell shows a network of internal membranes which manufacture and transport lipids and carbohydrates. This is
A. Golgi complex
B. Smooth endoplasmic reticulum
C. Rough endoplasmic reticulum
D. Microtubules
E. Mitochondria

12. Electron photomicrograph of the cell shows a network of internal membranes studded with ribosomes. The function of ribosomes is
A. Protein biosynthesis
B. Lipid biosynthesis
C. Transport
D. Biosynthesis of carbohydrates
E. Synthesis of DNA

13. Ribosomes consist of protein and rRNA. What is the place of biogenesis of ribosomes
A. Golgi complex
B. Smooth endoplasmic reticulum
C. Rough endoplasmic reticulum
D. Microtubules
E. Nucleolus

14. Tissue sample of the patient with benign tumor was studied under the electron microscope. A lot of small (15 –20 nm) spherical bodies, consisting of two unequal subunits were detected. These are
A. Golgi complex
B. Smooth endoplasmic reticulum
C. Ribosomes
D. Microtubules
E. Mitochondria

15. Small round organelles measures 0.2 – 1.0 μm and participates in intracellular digestion. They originates from Golgi complex and are divided into groups under different contents and function. Destruction of these organelles result in autolysis. Name the organelle
A. Rough endoplasmic reticulum
B. Lysosomes
C. Centrioles
D. Ribosomes
E. Mitochondria

16. While studying human cell culture under the light microscope one saw production of small vesicles by Golgi complex cistern. Biochemical analysis showed digestive enzymes in its contents. Which cell organelle were formed?
A. Centriole
B. Lysosome
C. Plastid
D. Ribosome
E. Mitochondrion

17. Lysosomes are the small sacs containing proteases, nucleases, lipases and other enzymes. What is the function of lysosomes?

A. Protein biosynthesis
B. Synthesis of lipids
C. Synthesis of carbohydrates
D. Synthesis of glycogen
E. Intracellular digestion

18. Different cell organelles have different enzymes because of different functions. Which organelle contain digestive enzymes only?

A. Golgi complex
B. Smooth endoplasmic reticulum
C. Rough endoplasmic reticulum
D. Lysosome
E. Mitochondrion

19. One saw destroying of round cell organelles followed by cell destruction after ultraviolet irradiation. What are these organelles ?

A. Golgi complex
B. Lysosomes
C. Rough endoplasmic reticulum
D. Ribosomes
E. Mitochondria

20. Some human disorders are characterized by destruction of lysosomes in the cells. It leads to the

A. Dysfunction of mitosis
B. Abnormal translation
C. Abnormal transcription
D. Accumulation of certain biochemical compounds
E. Autolysis

21. In electron micrograph are seen oval and round organelles with double wall. Outer membrane is smooth, inner membrane folded into cristae; contain enzyme ATPase synthetase. These are

A. Golgi complex
F. Lysosomes
B. Centrioles
E. Ribosomes
G. Mitochondria

22. As a rule DNA in eukariotyc cells is in chromosomes. Some cell organelles contain DNA also. These are

A. Lysosomes
B. Golgi complex
C. Endoplasmic reticulum
D. Ribosomes
E. Mitochondria

23. There are semi autonomic organelle, historical origin of which is explained by symbiotic theory. These organelles are

A. Nucleus
B. Mitochondria
C. Golgi complex
D. Endoplasmic reticulum
E. Lysosomes

24. Mitochondria are semi autonomic organelles. They contain hereditary information, which is present in

A. Chromosomes
B. Ribosomes
C. Inner membrane
D. Circular DNA
E. Outer membrane

25. Mitochondria are double membrane organelles; lysosomes, complex Golgi are single membrane organelles. Which organelles are nonmembranous?

A. Ribosomes
B. Smooth endoplasmic reticulum
C. Rough endoplasmic reticulum
D. Platsids
E. Digestive vacuoles

26. It is known that DNA is present in some organelles. These are

A. Lysosomes
B. Golgi complex
C. Ribosomes
D. Endoplasmic reticulum
E. Mitochondria

27. Organic substances breaks down into simple molecules during the cell respiration. This process is accompanied by ATP biosynthesis. It takes place in

A. Lysosomes
B. Ribosomes
C. Mitochondria
D. Golgi complex
E. Endoplasmic reticulum

28. Cell organelles which are able to self renewing were separated by centrifugation. Biochemical analysis showed high level of ATPase synthetase. These organelles are

A. Golgi complex
B. Ribosomes
C. Endoplasmic reticulum
D. Microtubules
E. Mitochondria

29. One of the cell organelles provides accumulation and secretion of organic substances, have structural and some other functions. That is why it well expressed in secretor cells. This is

A. Mitochondria
B. Golgi complex
C. Lysosomes
D. Ribosomes
E. Endoplasmic reticulum

30. Golgi complex consists of clusters of tubules, vesicles, and flattened sacs or cisternae. It produces

A. Chromosomes
B. Ribosomes
C. Primary lysosomes
D. Secondary lysosomes
E. Mitochondria

31. Cell center (centiole) was removed from the cell by micromanipulator. Which cell process is destroyed?

A. Protein biosynthesis
B. Cell respiration
C. Carbohydrates metabolism
D. Cell division
E. Fat metabolism

32. Electron micrograph of the cell shows cell organelle, which is situated near the nucleus and composed of microtubules and cisternae. It is known that lysomes arise from it. This organelle is

A. Golgi complex
B. Smooth endoplasmic reticulum
C. Rough endoplasmic reticulum
D. Microtubules
E. Mitochondria

Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

Practical class 4. Nucleus. Chromosomes morphology. Human karyotype

The Purpose of the Lesson: To study the morphological characteristics of the chromosomes. To characterize normal human karyotype and importance of its studying for the diagnosis of hereditary disorders.

TOPIC CONTENT

1. Chemical composition of the chromosomes.
2. The levels of chromatin condensation.
3. Notion of the euchromatin and heterochromatin
4. The autosomes and heterosomes (sex chromosomes). Homologous and non-homologous chromosomes.
5. Shape of the metaphase chromosome.
6. Karyotype and ideogram. Characteristics of the normal human karyotype.

7. International classification of the chromosomes.
8. The rules of the chromosomes.

TEST QUESTIONS for individual work

№ №	Questions	Answers
1	Name the main components of the nucleus: a,b,c,d	
2	What are the main functions of the nucleus?(a,b,c)	
3	Where does the nucleolus form?	
4	What is the function of the nucleolus?	
5	What is the chemical composition of the chromosomes? (a,b,c)	
6	What are the functions of histones and non-histone proteins?(a,b)	
7	Which kind of chromatin (euchromatin, heterochromatin) posesses active genes?	
8	What is the state of chromosomes (condensed, decondensed) during the interphase(a); metaphase of mitosis(b)	
9	When and where the first international classification of chromosomes has been adopted?	
10	Classification of the human chromosomes is based on: a,b,c	
11	What are the shapes of human metaphase chromosomes: a, b, c (normal),d (pathological)?	
12	Give the definition of: a) metaphase plate b) karyotype c) ideogram	
13	Human karyotype in studied in practical medicine for….	
14	Which cells are taken for karyotyping? a,b,c	
15	How many autosomes (a) and sex chromosomes (b) are in normal human karyotype?	
16	The length of the chromosomes is measured in ….	
17	Which human chromosome is the largest (a) and the smallest (b) in size?	
18	Name the rules of the chromosomes (a,b,c,d)	

Functions of a nucleus

1. it contains hereditary information
2. it regulates all activities of cell

Structure of the nucleus

The **nucleus** has

1) nuclear envelope (nuclear membrane);
2) nucleoplasm.
3) chromosomes.
4) nucleolus.

1. T**he nuclear envelope** separates the nucleoplasm from the cytoplasm. It is double membrane perforated with large pores.
2. N**ucleoplasm** is a liquid that consists of different types of RNA, nucleotides, enzymes, ATP, lipids and ions such as phosphorus, potassium, sodium, calcium and magnesium.
3. Nucleolus is composed of DNA, RNA and proteins. Function of nucleolus is the formation of ribosomes.
4. Chromosomes. Chromosome is composed of a single DNA double helix molecule and proteins (basic histone proteins and non-histone proteins). Chromosomes contain hereditary (genetic) information

Chromosomes

During the interphase chromosomes are dispersed (decondensed). They look like long **chromatin threads.**

The condensation of chromatin during the interphase differs. Less condensed portions of chromatin are light. It is **euchromatin**. It is genetically active. More condensed portions of chromatin are dark. It is **heterochromatin.** It is genetically inert.

During the cell division chromosomes are highly condensed. The look like X-shaped bodies. During the metaphase level of condensation is maximal.**Morphology of metaphase chromosome.**

Metaphase chromosome consists of two **sister chromatids** (future daughter chromosomes). Chromatids attach to each other at the site of **primary constriction** or **centromere**. The microtubules of the spindle fibers atteches to the centromere.

The centromere divides the chromosome into two parts, each part is called **ar**m.

The tips of the chromosomes are called **telomeres**.

Some chromosomes have **secondary constriction or nucleolar organizer region.** It has genes for rRNA and participates in the formation of nucleolus during interphase. The terminal part of the chromosome beyond secondary constriction is called **satellite.** The chromosomes with satellite are known as sat-chromosomes.

Shapes of the chromosomes

The position of centromere determines shape of metaphase chromosome.

1. **Metacentric** have centromere in the middle of chromosome so that the two arms are equal.
2. **Submetacentric** are chromosomes with slightly unequal arms.
3. **Acrocentric** are chromosomes with one small and one large arm.
4. **Telocentric** are chromosomes with one arm. In humans telocentric chromosomes are absent.

Karyotype

Karyotype is diploid (double) set of the chromosomes. It is characterized by the number, size and shape of the chromosomes.

There are **46 (or 23 pairs)** of chromosomes in **human karyotype.** Chromosomes same in man and woman are **autosomes**. There are 44 (22 pairs) of autosomes in humans. Chromosomes that determine sex are **sex chromosomes**. **Man** has **XY** sex chromosomes, **woman** has **XX** sex

chromosomes.

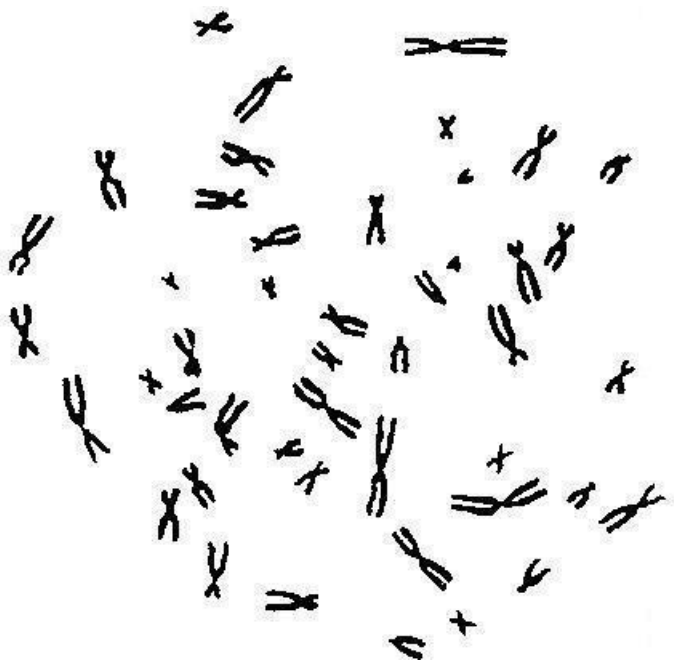
Sperm and egg has haploid set of chromosomes (23 chromosomes)

Karyotyping

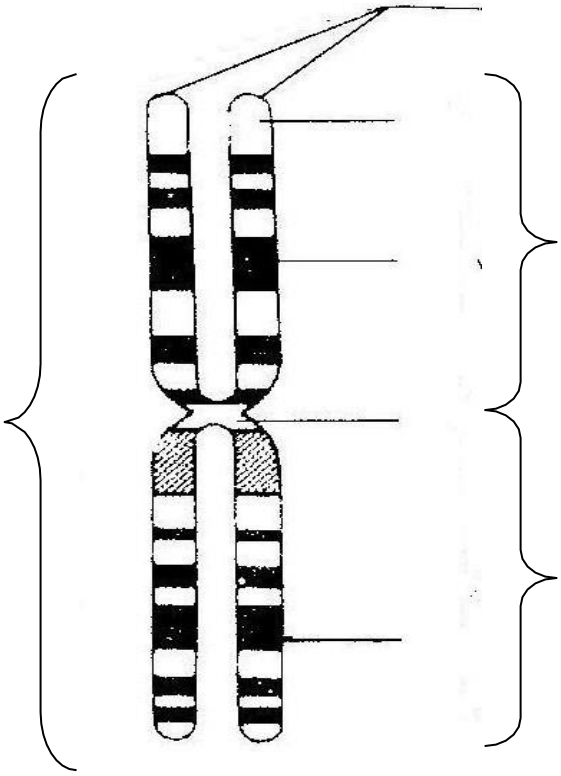
Laboratory investigation of the karyotype is karyotyping. The most commonly used cells are leukocytes (lymphocytes).

Practical work. **MORPHOLOGY OF CHROMOSOMES. HUMAN KARYOTYPE.**

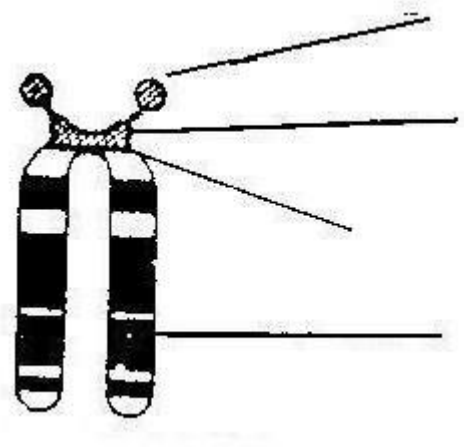
TASK 1. Study the metaphase plate of a man. Mark the chromosomes of metacentric, submetacentric and acrocentric shape.



TASK 2. Study schematic structure of a metacentric chromosome. Label daughter chromatids, centromere, arms, telomeres, euchromatin, heterochromatin.



TASK 3. Study schematic structure of a acrocentric chromosome. Label centromere, long and short arms, secondary constriction, satellite.



TASK 4. Define the types of metaphase chromosomes in human karyotype. Mark each group, characteristic of the group (shape and size) and number of each pair. Detect sex of the person.

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. In somatic cells of most species each chromosome has a pair. How we term the double set of chromosomes, specific for the species?

A. Genome
B. Idiogram
C. Genofond
D. Karyotype
E. Genotype

2. Metaphase plate is studied for diagnosis of chromosomal disorders. Which cells are studied usually?

A. Yellow bone marrow
B. Red bone marrow
C. Lymphocytes
D. Erythrocytes
E. Epithelial cells

3. Each species is characterized by certain number of chromosomes. This is a rule of

A. Constant number
Double number
B. Individuality
C. All of the above

4. Some chromosomes have nucleolar organizer region, which is responsible for the formation of nucleolus. These chromosomes are

A. Telocentric
B. Submetacentric
C. Metacentric
D. Satellite chromosome
E. Acrocentric

5. Set of the chromosomes of species, which is characterized by certain number and morphology of the chromosomes is

A. Genotype
B. Genome
C. Karyotype
D. Phenotype
E. Genofond

6. There are several types of the chromosomes inhuman karyotype. Chromosomes with slightly unequal arms are

A. Submetacentric
B. Centromeric
C. Acrocentric
D. Metacentric
E. Telocentric

7. There are three types of the chromosomes in human karyotype. After mutation one of the chromosomes has one arm only. This chromosome is

A. Metacentric
B. Submetacentric
C. Acrocentric
D. Satellite chromosome
E. Telocentric

8. There are different types of the chromosomes in photo of metaphase plate. Which of them have equal arms?

A. Metacentric
B. Submetacentric
C. Acrocentric
D. Telocentric
E. Centromeric

9. Majority of species have diploid set of the chromosomes. This is a rule of

A. Constant number
B. Double number
C. Individuality
All of the above

10. Each species of plants and animals has certain constant number of chromosomes. How many chromosomes are in normal human karyotype?

A. 40
42
B. 44
C. 46
D. 48

11. Which cell structures contain hereditary information?

A. Ribosomes
B. Lysosomes
C. Microtubules
D. Chromosomes
E. Biomembranes

12. By recent technology human chromosomes are differentially stained demonstrating specific banding pattern. Graphic systematic arrangement of the chromosomes according to their size, shape and staining is

A. Genotype
B. Genome
C. Karyotype
D. Genofond
E. Idiogram

13. There are different types of the chromosomes in photo of metaphase plate. Which of them have one long and one very short arm?

A. Metacentric
B. Submetacentric
C. Acrocentric
D. Telocentric
E. Centromeric

14. There are different types of the chromosomes in photo of metaphase plate. Which of them have one arm and terminal position of centromere?

A. Telocentric
B. Submetacentric
C. Acrocentric
D. Metacentric
E. Sat-chromosomes

15. Chemical composition of the chromosomes is

A. Polypeptides
B. Amino acids
C. Glycolipids
D. Glycoproteids
E. Nucleoproteids

16. Each pair of the chromosomes have certain morphological peculiarities. This is a rule of

A. Constant number
B. Double number
C. Individuality
D. All of the above

17. International Denver classification if the chromosomes classify the chromosomes by
A. Shape, size, staining
B. Size, staining, number
C. Shape, staining, number
D. Size, shape, number

18. There are three types of the chromosomes in normal karyotype. Mutation may result in loss one arm of the chromosome. Such chromosome is termed as
A. Metacentric
B. Telocentric
C. Acrocentric
D. Submetacentric
E. Sat-chromosome

19. Method of differential staining causes dark and light banding if the chromosome along its lengths. Dark stained regions are termed
A. Euchromatin
B. Telomeres
C. Centromeres
D. Heterochromatin

20. Chromatin is stained by basic dyes nuclear substance, which consists of
A. DNA
B. mRNA
C. Protein + DNA
D. Protein + mRNA
E. Protein + tRNA

21. Chromosomal parts which are lightly stained and are completely decondensed during the interphase is
A. Euchromatin
B. Telomeres
C. Centromeres
D. Heterochromatin
E. Satellite

22. Each organism inherits chromosome from mother and from father. Such paired chromosomes are
A. Metacentric
B. Acrocentric
C. Homologous
D. Non-homologous
E. Telocentric

23. In males and females the majority of the chromosomes are similar. These are
A. Autosomes
B. Sex chromosomes
C. Heterosomes
D. Homologous
E. Nonhomologous

10. Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

Practical class 5. Characteristics of nucleic acids.

The Purpose of the Lesson: To study the characteristics of nucleic acids, structure of genes, classification of eukaryotic and prokaryotic genes for understanding of molecular mechanisms of inheritance.

TOPIC CONTENT

1. Nucleic acids as biological polymers.
2. DNA. Structure, composition of nucleotides, functions.
3. RNA. Structure, composition of nucleotides, functions.
4. Principle of complementarity. Chargaff's rule. The coefficient of DNA specificity.
5. Role of DNA in transmission of hereditary information. Transformation, transduction, conjugation.
6. Organization of eukaryotic genome. Unique, moderately repetitive and highly repetitive sequences.
7. DNA replication. Initiation, elongation, termination.
8. DNA repair. Types of repair.

9. Structural and regulatory genes. Genes for rRNA and tRNA. Mobile genes (transposones).
10. Split genes. Exon-intron organization of eukaryotic genes.

TEST QUESTIONS for individual work

№	Questions	Answers
1	Point out location in a cell of 1) DNA – a,b,c; 2) rRNA-a,b; 3) mRNA – a,b; 4) tRNA- a,b.	
2	Which space organization has 1) DNA molecule; 2) RNA molecule?	
3	What is the chemical composition of 1) DNA nucleotide – a,b,c; 2) RNA nucleotide – a,b,c.	
4	What is the difference between DNA and RNA nucleotide?(a,b)	
5	Where are all the types of RNA formed?	
6	What are the functions of 1)DNA – a,b; 2) tRNA – a; 3) mRNA – a; 4) rRNA – a,b	
7	What are the main functional centers of tRNA molecule? (a,b)	
8	Which components participate in formation of amino-acyl-tRNA complex ?(a,b,c,d)	
9	Replication is….	
10	List main components participating in	
11	DNA replication – a,b,c.	
12	Name main stages of DNA replication – a,b,c.	
13	DNA repair is….	
14	An importance of DNA repair is	
15	The main difference in organization of prokaryotic and eukaryotic genes is – (a)	
16	Exon is…..	
17	Intron is…	

Nucleic acid

Nucleic acid is a biological polymer, which consists of **nucleotides**.
Each nucleotide consists of 3 components (Fig.1):

- phosphate group,
- pentose sugar
- nitrogenous base.

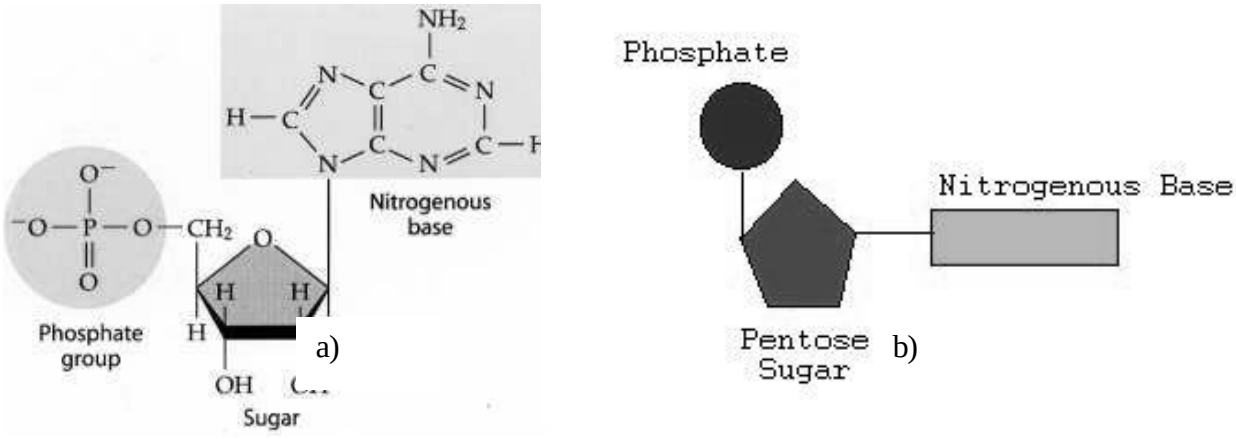


Fig1. Structure (a) and schematic representation (b) of the nucleotide.

There are two types of nucleic acids:

1) **deoxyribonucleic acid or DNA**
2) **ribonucleic acid or RNA.**

DNA

Function. DNA stores and transfers hereditary information.

Location. DNA is located i**n the nucleus** in the chromosomes.

DNA also occurs in mitochondria as a circular molecule (like in prokaryotes)

Structure. DNA is a biological polymer that consists of nucleotides.

Each deoxyribonucleotide (Fig.2) has:

G. phosphate group,
H. deoxyribose sugar
I. nitrogenous base.

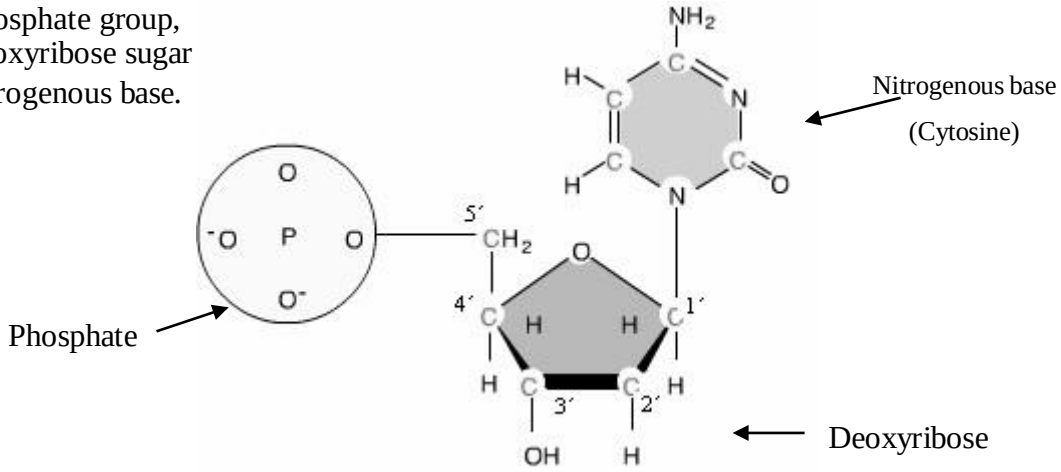


Fig.2. Nucleotide of DNA molecule

The nitrogenous base may be **adenine (A), guanine (G**), **cytosine (C)** and **thymine (T)** (Fig 3). Adenine and guanine are purines, cytosine and thymine are pyrimidines.

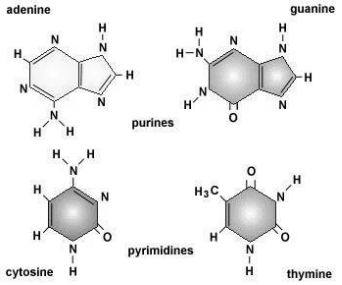
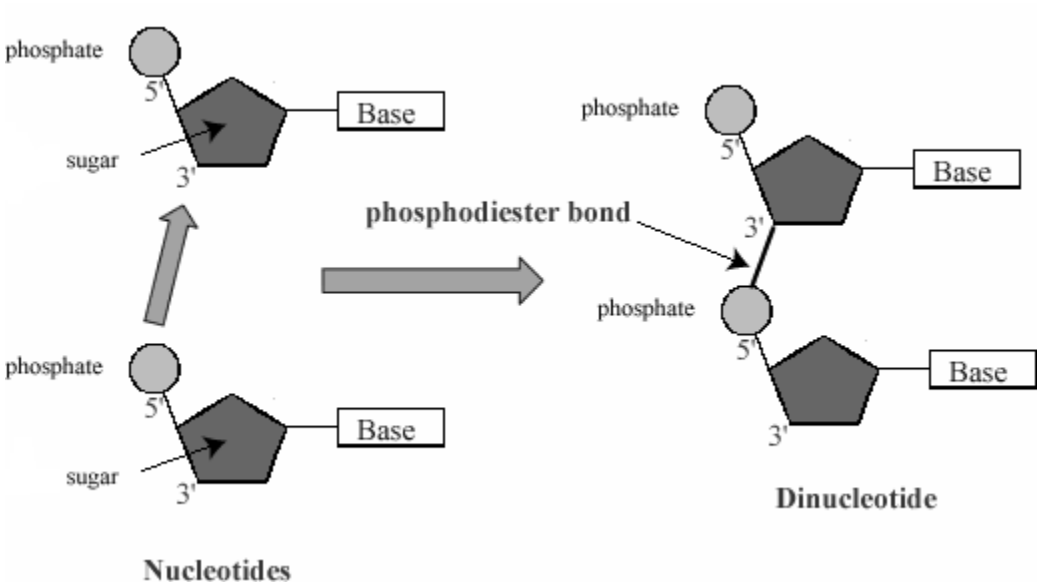


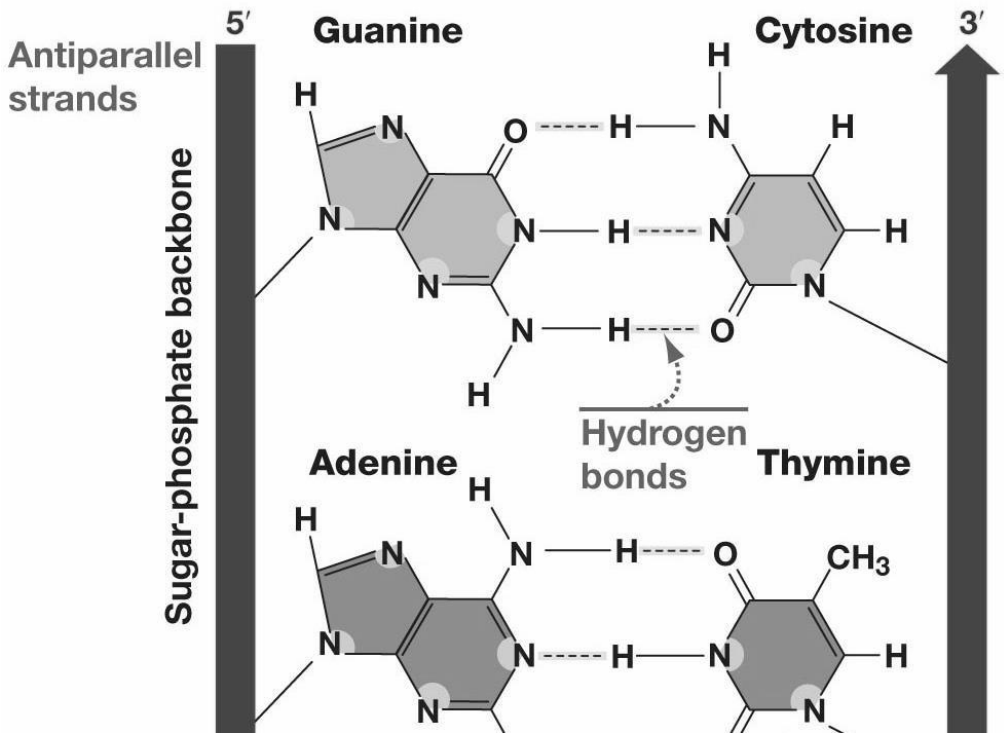
Fig. 3. Nitrogen bases in DNA molecule.

The model of DNA molecule was proposed by Watson and Crick in 1953. The main characteristics of DNA are:

- DNA is **double helix**. It has two polynucleotide strands. The helix is 20 A wide; its one turn is 34 A long and has 10 base pairs.
- The nucleotides of one strand are joined by covalent phosphodiester bonds between deoxyribose of one nucleotide and phosphate of another nucleotide.



- Two strands are held together by hydrogen bonds between nitrogenous bases. Adenine of one chain is always joined to thymine of the other chain by two hydrogen bonds and cytosine is always joined to guanine by 3 hydrogenous bonds. It is principle of **complementarity** of nitrogenous bases.



The Chargaff's rule

The Chargaff's rule states that 1) A = T; C = G;
2) A+G = T+C, so (A+G)/(T+C)=1.
The ratio (A+T)/(G+C) is different in different species. This ratio in humans equals 1.53.

DNA replication

DNA replication is **doubling of DNA molecule**. It is possible because nitrogenouse bases of the strands are complementary to each other. DNA molecule divides into two strands, and new complementary strands are formed.

Replication of DNA occurs in the S (synthetic) period of interphase. In cell division each of daughter cells get one copy of the DNA molecule. Thus hereditary information is transmitted from one generation to another.

DNA repair

DNA repair is correction of mistakes in DNA molecule. Mistakes in one strand are corrected, using second strand as a template.

RNA

RNA is formed in the nucleus on the DNA template

Function. RNA provides synthesis of protein, thus provides the realization of hereditary information.

Location. RNA occurs in nucleus, cytoplasm, ribosomes.

Structure. RNA is a single strand of nucleotides.

Each ribonucleotide has:

A. phosphate,
B. ribose sugar
C. nitrogenous base. The nitrogenous base may be **adenine, guanine** , **cytosine** and **uracil**.

The main differences between chemical composition of RNA and DNA are:

1. DNA is double strand molecule, but RNA is single strand;
2. DNA contains deoxyribose , RNA – ribose;
3. DNA contains Thymine, RNA - Uracil.

Types of RNA

There are three main types of RNA

1. Messenger or template (mRNA). It carries genetic information about from DNA to ribosome.
2. Transfer (tRNA). It transport amino acids to the ribosomes. It has anticodon (three nucleotides that complementary to a codon of mRNA) and site for attachmant of amino acid)
3. Ribosomal (rRNA). It forms structural carcass of ribosomes. The rRNA participates in the initiation and termination of protein synthesis

Gene

The unit of hereditary information is **gene**.

Gene is a fragment of DNA molecule that determines the synthesis of polypeptide, rRNA, tRNA or regulates function of another gene.

Gene has two types of nucleotides sequences:

7. **Exons.** Exons code amino acids
8. **Introns.** Introns do not code amino acids

Practical work. **CHARACTERISTIC OF NUCLEIC ACIDS. PROKARYOTIC AND EUKARYOTIC GENE.**

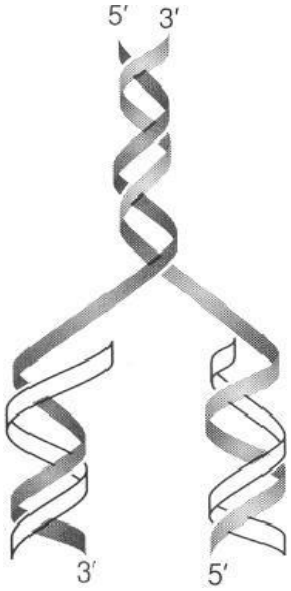
TASK 1. Label the structural components of DNA and RNA nucleotides. Mark the position of the carbon atoms in sugar molecule

TASK 2. Label a bond between two DNA nucleotides of one chain. Write down type of the bond, mark 5′ and 3′ ends of the chain.

TASK 3. Label bonds between two complementary DNA chains. Mark type of the bond, complementary nitrogenous bases, 5′ and 3′ ends of both chains.

TASK 4. Study the Watson-Crick model of DNA molecule. Mark the diameter of the helix, distance between two neighboring nucleotides,number of nucleotides in single turn, sugar-phosphate backbone, nitrogenouse bases, major and minor grooves.

TASK 5. Study the mechanism of DNA replication. Mark the type of DNA replication, parental and daughter strands, 3′ and 5′ ends of daughter strands. Replicate given DNA fragment.



DNA $_1$	**DNA$_2$**
A-	-T
C-	-G
T-	-A
T-	-A
C-	-G
G-	-C
A-	-T
G-	-C
G-	-C
C-	-G
A-	-T
C-	-G

TASK 6. Solve the problems.

1. Define second DNA chain. Calculate length and mass of given DNA fragment. (nucleotide length is 0.34 nm, mass is 345)	**DNA T-T-A-G-G-C-C-A-C-A-A-A-C-C-G-**
2. Biochemical analyses detected that in mRNA molecule Adenine contents is 22%, Uracil – 12%, Guanine – 26%. Define contents of each type of nucleotides in DNA molecule.	
3. Left strand of DNA has following nucleotide sequence. Detect a) nucleotide sequence in right chain, b) content of each type of nucleotides (in %), c) length of DNA fragment, d) number of phosphate molecules.	**DNA G-C-A-G-G-A-A-G-A-C-G-C-**
4. Length of DNA fragment is 680 nm.	

How many a) deoxyribose molecules b) nitrogenous bases are in this fragment? Detect mass of this fragment (c).

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. The majority of structural genes in eukaryotes consist of expressed sequences (exons) and intervening non-coding sequences (introns). Which molecule is formed on these genes directly after transcription?
A. Pre-mRNA;
B. mRNA;
C. snRNA;
D. tPNA;
E. rPNA.

2. DNA is a macromolecular polymer. Its monomer is
A. Amino acid;
B. Nitrogenous base;
C. Polypeptide;
D. Deoxyribose;
E. Nucleotide.

3. Structural genes of eukaryotes have exons and introns. Both portions of gene are transcribed but introns removed during the maturation of mRNA. These fragments of genes are
A. Coding amino acids;
B. Non-coding;
C. Spacers;
D. Promoter;
E. Terminator.

4. Structural genes of eukaryotes have exons and introns. Both portions of gene are transcribed but mature mRNA consists of exons only. This fragment of genes serves as
A. Coding amino acids;
B. Non-coding;
C. Spacers;
D. Promoter;
E. Terminator.

5. Cell contains three types of RNA: mRNA, tRNA, rRNA. Synthesis of all these molecules occur in
A. Lysosomes;
B. Ribosomes;
C. Nucleus;
D. Smooth ER;
E. Golgi complex.

6. Which part of DNA carries an information about one protein molecule?
A. Operon;
B. Nucleotide;
C. Gene;
D. Triplet;
E. Promotor.

7. There are several types of RNA. Which of them provides transport of amino acids to the ribosome?
A. rRNA;
B. mRNA;
C. tRNA;
D. snRNA;
E. pre-mRNA.

8. Which of the RNA molecules is the shortest?
A. rRNA;
B. mRNA;
C. tRNA;
D. snRNA;
E. pre-mRNA.

9. The process of DNA unwinding was experimentally blocked experimental studying. Which step of protein biosynthesis will be affected?
A. Translation;

B. Transport of amino acids;
C. Protein modification;
D. Transcription;
E. Activation of amino acids.

10. Radioactively labeled uracil was added to the cell culture. Where it will be detected by autoradiography?
A. In centrosomes
B. In ribosomes;
C. In Golgi complex;
D. In smooth endoplasmic reticulum;
E. In lysosomes.

11. Eukaryotic gene has following sequence of functional regions: exon-intron-exon. What is the sequence of appropriate pro-mRNA molecule?
A. exon-intron-exon;
B. exon-exon-intron;
C. exon-exon;
D. exon-exon-exon;
E. exon-intron.

12. Which process provides transmission of hereditary information to the daughter generations?
A. DNA repair;
B. Replication;
C. Transduction;
D. Conjugation;
E. Transformation.

13. One of the biological template reactions is replication. Which molecule is formed during this process?
A. rRNA;
B. mRNA;
C. tRNA;
D. DNA;
E. pre-mRNA.

14. Gene is the unit of hereditary information. In which molecule it present in eukaryotes?
A. tRNA;
B. DNA;
C. protein;
D. amino acid;
E. mRNA.

15. Special enzyme activated by light restores defects in DNA molecule after UV-irradiation. This process is termed as
A. Excision repair;
B. Photoreactivation (light repair);
C. Replication;
D. Mutation;
E. Recombination.

16. One type of RNA is characterized by cloverleaf shape and has active centers for interaction with amino acid and mRNA. This type of RNA is
A. rRNA;
B. mRNA;
C. tRNA;
D. snRNA;
E. pre-mRNA.

17. Viruses can transfer fragment of host DNA from one bacterial cell to another, giving it some new properties. This process is termed as
A. Transcription;
B. Translation;
C. Replication;
D. Transformation;
E. Transduction.

18. Gene consists of 4 exons and 3 introns. Mature RNA after processing consists of
A. 4 exons;
B. 2 exons, 2 introns;
C. 1 exon, 1 intron;
D. 3 exons;
E. 4 exons, 3 introns.

19. Both DNA molecules after replication process consist of one maternal and one newly synthesized strands. This mechanism of replication is known as
A. Conservative;
B. Semi-conservative;
C. Analogous;
D. Identical;
E. Dispersed.

20. tRNA molecule has several active centers. Which center recognizes mRNA codon?
A. Codogene;
B. Codon;
C. Anticodon;
D. Nucleotide;

E. Transcripton.

21. mRNA molecule has 200 nitrogenous bases. How many nucleotides does it have?
A. 50;
B. 100;
C. 200;
D. 400;
E. 600.

22. Both DNA and RNA consist of nucleotides. RNA differ from DNA by presence of
A. Adenine;
B. Ribose;
C. Guanine;
D. Cytosine;
E. Phosphate group.

23. All types of RNA are synthesized on DNA template. Enzyme that carries out the transcription is
A. Phosphatase;
B. Lipase;
C. Nuclease;
D. Protease;
E. Polymerase.

24. mRNA molecule has 110 phosphate groups. How many nucleotides does it consist of?
A. 55;
B. 110;
C. 220;
D. 330;
E. 440.

25. Which of the following is a purine?
A. Thymine;
B. Cytosine;
C. Guanine;
D. Uracil.

26. Double helical model of as the structure of DNA molecule was given by
A. Watson and Kornberg;
B. Watson and Crick;
C. Nirenberg and Khorana;
D. Temin and Baltimor;
E. T. Chargaff.

27. The number of hydrogen bonds between guanine and cytosine is
A. 1;
B. 2;
C. 3;
D. 4;
E. 5.

28. RNA differs from DNA in the replacement of thymine with
A. Thymine;
B. Cytosine;
C. Guanine;
D. Uracil

29. The difference between RNA and DNA is because of
A. Sugar and base;
B. Sugar and phosphate;
C. Phosphate and base;
D. Sugar only;
E. Base only.

30. Nowadays about 50 minor bases have been found in the t-RNA structure besides the main four nitrogenous bases. Choose the minor nitrogenous base:
A. Thymine;
B. Cytosine;
C. Guanine;
D. Dihydrouracil;
E. Uracil

10. Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

11. A topic of the following class: Stages of protein synthesis. Regulation of gene expression in prokaryotes and eukaryotes.

Practical class 6. Organization of information flow in the cell. Regulation of gene expression.

The Purpose of the Lesson: To get notion of genetic code and its properties. To study mechanisms of storage and expression of hereditary information.

TOPIC CONTENT

1. Gene. Genetic code and its main properties.
2. Main stages of protein biosynthesis.
3. Central dogma of molecular biology.
4. Main peculiarities of protein biosynthesis in eukaryotes (transcription, processing, splicing, activation of amino acids, translation, posttranslational modifications).
5. Notion of the regulation of genes expression in prokaryotes.
6. Notion of the regu1ation of genes expression in eukaryotes.
7. The main differences in regulation of gene expression in pro- and eukaryotes.
8. International program "Human genome project". Modern notion about human genome

	Questions	Answers
1	What is • a) gene • b) genetic code	
2	List the main properties of genetic code a) b) c) d) e)	
3	Transcription is….	
4	Main stages of transcription are: a, b, c In transcription participate: a, b, c	
5	Which RNA molecule is transcribed on	
6	DNA molecule primarily?	
7	Processing is…	
8	Splicing is…	
9	Activation of amino acids is…	
10	Translation is….	
11	Main active centers of a ribosome are: a, b	
12	Main stages of translation are: a, b, c	
13	In translation participate: a, b, c	
14	Posttranslational modification is…	
15	Posttranslational modification takes place in…	
16	Write down scheme of central dogma of molecular biology	
17	Who and when did propose the scheme of operon regulation in prokaryotes?	
18	Operon is….	
19	Operon includes: a, b, c	
20	Under their functions genes are divided into: a, b	

21	Structural genes specify:a, b, c	
22	Structural genes include 1) informative portions - ... 2) non-coding portions - ...	
23	Which regulatory genes regulate structural genes in operon of prokaryotes? (a, b, c, d)	
24	Inducers are the substances, which induce synthesis of …….	
25	Gene-operator switches on or switches of protein synthesis with the help of ..... gene.	
26	Promoter is the site for attachment of enzyme ……..	
27	Terminator is the gene for….	
28	Which protein is specified by the gene-regulator?	
29	The expression of hereditary information of structural genes is suppressed when repressor protein binds to the	
30	If an inducer enters the cell and binds to repressor protein, gene ...(a) decomes free and operon …. (b)	

Gene

The unit of hereditary information is **gene**.

Gene is a fragment of DNA molecule that determines the synthesis of polypeptide, rRNA, tRNA or regulates function of another gene.

Gene has two types of nucleotides sequences:

9. **Exons.** Exons code amino acids
10. **Introns.** Introns do not code amino acids

Realization of hereditary information occurs by protein synthesis.

DNA ⟶ protein ⟶ character

Genetic code

Genetic code is a sequence of nitrogenous bases in DNA which determines the sequence of amino acids in a protein.

Main features of genetic code:

1. Triplet nature - one amino acid is specified by three adjacent nucleotides.
A group of three nucleotides that specify one amino acid is codon or triplet.

2. Degeneracy – most of the amino acids are specified by more than one codon (2-6 triplets).

3. The code is specific – each triplet codes a certain one amino acid.

4. Universality – the genetic code is the same in all living organisms.

5. Three triplets – UAA, UAG, UGA – do not specify any amino acid. These are called nonsense codons. AUG codon (Met) is called starting or initiation codon as it initiates the synthesis of polypeptide.

Protein biosynthesis

Protein synthesis goes on according to the scheme:

$$DNA \xrightarrow{\text{transcription}} mRNA \xrightarrow{\text{translation}} Protein.$$

Protein synthesis includes four steps:

E. Transcription
F. Activation of amino acids
G. Translation
H. Posttranslational modification of proteins

1. **Transcription** is synthesis of m-RNA on the DNA template. Transcription takes place in the nucleus. Enzyme, that produce mRNA is RNA-polymerase.
Result of the transcription in eukaryotes is the synthesis of precursor mRNA (pre-mRNA). Pre-mRNA has same sequence of nucleotides as DNA: exons and introns. So, it should undergo processing
Processing is the process of pre-mRNA maturation. It includes **splicing**. During the splicing special RNA cut off the introns and binds exons.
Mature m-RNA consists of exons only and is shorter then pre-mRNA.
Processing takes place in nucleus.

2. **Activation of amino acids.** It is joining of amino acid to tRNA molecule. It requires ATP. Activation of amino acids takes place in cytoplasm.

3. **Translation** is synthesis of polypeptide on the mRNA template. It takes place in ribosomes.

A. **Posttranslational modification.** The polypeptide folds, and gets its tertiary or quaternary structure. It occurs in endoplasmic reticulum and Golgi complex

REGULATION OF GENE EXPRESSION. OPERON CONCEPT

Control of protein synthesis at transcription level in prokaryotes is explained by operon concept.
Operon is a group of fuctionally related **structural genes** with common **control genes**. Structural genes code proteins. Control (regulatory) genes control the activity of structure genes.

Operon includes:
1. **Regulator gene.** It specify synthesis of repressor protein. It is a protein, which binds to the operator gene and prevent transcription.
2. **Promoter.** It is the DNA segment at which RNA-polymerase starts transcription.
3. **Operator. It** is a DNA segment next to the promoter. It can bind repressor protein.
4. **Structural** genes
5. **Terminator** is the DNA segment at which RNA-polymerase ends transcription.

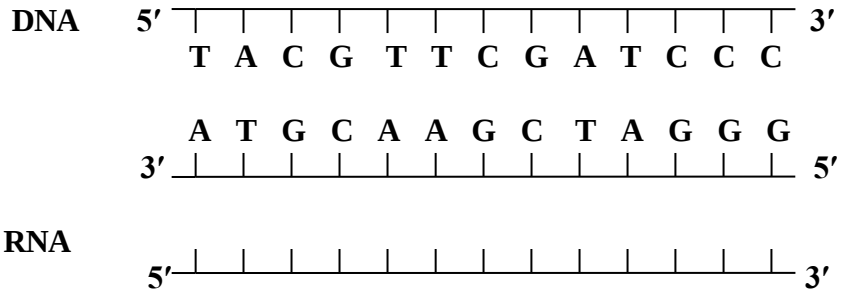
Example is lactose operon. It includes genes for lactose methabolism. If lactose is absent, repressor protein binds to the operator and prevents the transcription. So enzymes for lactose metabolism are not formed. If lactose is present, it (lactose) binds to the repressor protein and removes it from operator. Free operator allows transcription, so enzymes for lactose utilization are formed.
There is no operon organization of genes in prokaryotes.

ORGANIZATION OF INFORMATION FLOW IN THE CELLS.

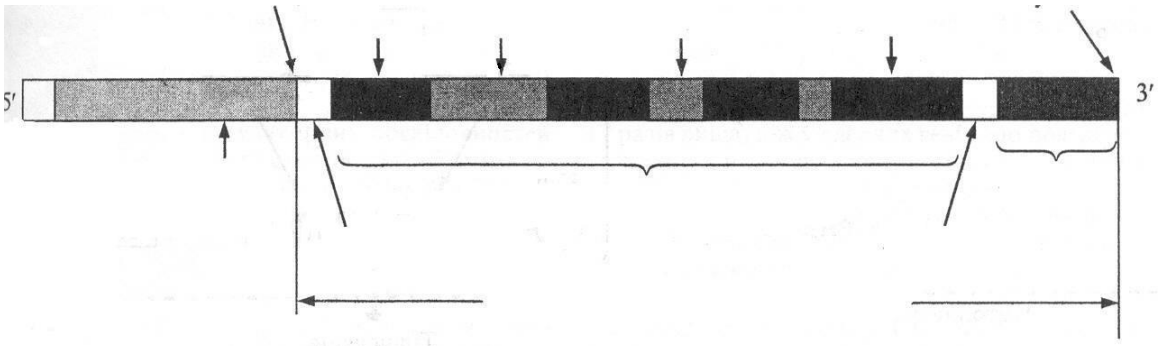
TASK 1. Fill the table

Stage of protein biosynthesis	Process	Where does it take place
1. Transcription		
2. Activation of amino acids (aminoacylation)		
3. Translation I. Initiation J. Elongation K. Termination		
4. Posttranslational modification		

TASK 2. Transcribe following DNA molecule. Label coding and template strands.



TASK 3. Study the structure of eukaryotic gene. Label promoter, terminator, transcribed sequence, translated sequence, leader, trailer, exons and introns.



TASK 4. Study the process of DNA maturation (processing). Label DNA (promoter, leader, trailer), pre-mRNA, processing, splicing, exons and introns. In mRNA molecule label cap, leader, trailer, exons, poly-A tail.

TASK 5. Analyze the process of translation. Label mRNA, subunits of ribosomes, aminoacyl tRNA, free amino acids and tRNA molecules, polypeptide chain. Find initiation, elongation and termination of translation.

TASK 6. Analyze mechanism of translation. Label functional centers of ribosome, describe the processes on each step of translation.

TASK 7. Solve the problems.

1. Fragment of template DNA strand has following sequence of nucleotides. Find sequence of amino acids in polypeptide chain and anti codons of tRNA molecules.	**DNA T-T-A-G-G-C-C-A- A-G-C-T** mRNA protein tRNA
2. Fragment of protein molecule has following sequence of amino acids. What is sequence of nucleotides in DNA? Which amino acids is specified by maximal number of codons- synonyms?	**Protein Tre-Val-Ala-Pro-Leu-Tre** mRNA DNA
3. Fragment of template DMA strand has following sequence. During the replication process 3rd nucleotide was lost. Detect sequence of amino acids, specified by normal DNA fragment and DNA after the mutation.	**Normal DNA AAAACCAAAATACTTATACAAC** mRNA protein **Mutant DNA** mRNA protein

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. There are 100 monomers in protein molecule. How many nucleotides (fragment of double strand DNA) specify this protein?
   A. 100
   B. 200
   C. 300
   D. 600
   E. 900

2. All amino acids, with the exceptions of methionine and tryptophan are encoded by more than one codon. This feature is referred to as
   A. Universality of genetic code
   B. Colinearity
   C. Degeneracy of genetic code
   D. Specificity of genetic code
   E. Triplet nature of genetic code

3. Action of some antibiotics on microorganisms is based on the arrest of translation. It means the blockage of synthesis of
   A. DNA
   B. tRNA
   C. rRNA
   D. polypeptide chain
   E. mRNA

4. Recognizing of mRNA triplets (i.e. deciphering of genetic code) during the translation occurs under the complementary principle by three-nucleotide sequence of rRNA. This sequence is

A. Anticodon
B. Codon
C. Codogene
D. Cystrone
E. Mutone

5. The majority of structural genes in eukaryotes consist of sequences coding the information (exons) and intervening non-coding sequences (introns). Which molecule is formed on these genes directly after transcription?

A. Pre-mRNA
B. mRNA
C. snRNA
D. tPNA
E. rPNA

6. In eukaryotes, pre-mRNA produced directly after transcription should transformed in mature mRNA. This process of maturation is referred to as

A. Translation
B. Processing
C. Splicing
D. Termination
E. Reparation

7. Hemoglobin molecule of adult person (Hb A) is a tetramere protein composed of two α and two β polypeptide chains. Thus it is a protein of following structure

A. Primary
B. Secondary
C. Tertiary
D. Quaternary

8. Monomer of DNA molecule is

A. Amino acid
B. Nitrogenous base
C. Polypeptide
D. Deoxyribose
E. Nucleotide

9. Three triplets (UAA, UAG, UGA) do not specify amino acids. These triplets are termed

A. Introns
B. Codons
C. Anticodons
D. Terminators
E. Exons

10. tRNA molecule has several active centers. What is the name of center that recognizes mRNA codon?

A. Codogene
B. Codon
C. Anticodon
D. Nucleotide
E. Transcripton

11. Ribosome has two active centers: aminoacyl site and peptidyl site. How many nucleotides of mRNA can they bind?

A. 1
B. 2
C. 3
D. 5
E. 6

12. mRNA molecule has 200 nitrogenous bases. How many nucleotides does it have?

A. 50
B. 100
C. 200
D. 400
E. 600

13. Both DNA and RNA consist of nucleotides. RNA differ from DNA by presence of

A. Adenine
B. Ribose
C. Guanine
D. Cytosine
E. Phosphate group

14. All types of RNA are synthesized on DNA template. Enzyme that carries out the transcription is

A. Phosphatase
B. Lipase
C. Nuclease
D. Protease
E. Polimerase

15. Ribosomes synthesize polipeptides (translation). In posttranslation period occurs

A. Replication
B. Processing
C. Splicing
D. Folding
E. Reparation

16. Which cell organelles provides formation of primary protein structure?

A. Ribosomes
B. Golgi complex
C. Lysosomes
D. ER
E. Nucleus

17. Which cell organelles provides formation of secondary and following protein structure?

A. Ribosomes
B. Golgi complex
C. Lysosomes
D. ER
E. Nucleus

18. Molecule that is synthesized during the transcription of structural genes of eukaryotes is
    A. pre-mRNA
    B. mRNA
    C. polypeptide chain
    D. tRNA
    E. rRNA

19. Cell contains three types of RNA: mRNA, tRNA, rRNA. Synthesis of all these molecules occur in
    A. lysosomes
    B. Ribosomes
    C. Nucleus
    D. Smooth ER
    E. Golgi complex

20. mRNA molecule has 110 phosphate groups. How many nucleotides does it consist of?
    A. 55
    B. 110
    C. 220
    D. 330
    E. 440

21. The result of transcription of structural genes of eukaryotes is synthesis of immature pre-mRNA. Process of its maturation is termed
    A. Translation
    B. Processing
    C. Splicing
    D. Termination
    E. Reparation

22. There are 200 amino acids in protein molecule. How many nucleotides are in the gene (double strand DNA) which encode this protein?
    A. 200
    B. 400
    C. 600
    D. 900
    E. 1200

23. Synthesis of primary protein structure is termed
    A. Transcription
    B. Translation
    C. Replication
    D. Termination
    E. Reparation

24. Structural genes of eukaryotes has exons and introns. Introns are removed during the maturation of mRNA. This process is termed
    A. Processing
    B. Splicing
    C. Reparation
    D. Termination
    E. Replication.

25. There are 100 monomers in protein molecule. How many nucleotides (fragment of double strand DNA) specify this protein?
    A. 100
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    D. Specificity of genetic code
    E. Triplet nature of genetic code

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    D. polypeptide chain
    E. mRNA

28. Recognizing of mRNA triplets (i.e. deciphering of genetic code) during the translation occurs under the complementary principle by three-nucleotide sequence of rRNA. This sequence is
    A. Anticodon
    B. Codon
    C. Codogene
    D. Cystrone
    E. Mutone

29. The majority of structural genes in eukaryotes consist of sequences coding the information (exons) and intervening non-coding sequences (introns). Which molecule is formed on these genes directly after transcription?
    A. Pre-mRNA
    B. mRNA
    C. snRNA
    D. tPNA
    E. rPNA

30. In eukaryotes, pre-mRNA produced directly after transcription should transformed in mature

mRNA. This process of maturation is referred to as

A. Translation
B. Processing
C. Splicing
D. Termination
E. Reparation

31. Hemoglobin molecule of adult person (Hb A) is a tetramere protein composed of two α and two β polypeptide chains. Thus it is a protein of following structure

A. Primary
B. Secondary
C. Tertiary
D. Quaternary

32. Monomer of DNA molecule is

A. Amino acid
B. Nitrogenous base
C. Polypeptide
D. Deoxyribose
E. Nucleotide

33. Three triplets (UAA, UAG, UGA) do not specify amino acids. These triplets are termed

A. Introns
B. Codons
C. Anticodons
D. Terminators
E. Exons

34. tRNA molecule has several active centers. What is the name of center that recognizes mRNA codon?

A. Codogene
B. Codon
C. Anticodon
D. Nucleotide
E. Transcripton

35. Ribosome has two active centers: aminoacyl site and peptidyl site. How many nucleotides of mRNA can they bind?

A. 1
B. 2
C. 3
D. 5
E. 6

36. mRNA molecule has 200 nitrogenous bases. How many nucleotides does it have?

A. 50
B. 100
C. 200
D. 400
E. 600

37. Both DNA and RNA consist of nucleotides. RNA differ from DNA by presence of

A. Adenine
B. Ribose
C. Guanine
D. Cytosine
E. Phosphate group

38. All types of RNA are synthesized on DNA template. Enzyme that carries out the transcription is

A. Phosphatase
B. Lipase
C. Nuclease
D. Protease
E. Polimerase

39. Ribosomes synthesize polipeptides (translation). In posttranslation period occurs

A. Replication
B. Processing
C. Splicing
D. Folding
E. Reparation

40. Which cell organelles provides formation of primary protein structure?

A. Ribosomes
B. Golgi complex
C. Lysosomes
D. ER
E. Nucleus

41. Which cell organelles provides formation of secondary and following protein structure?

A. Ribosomes
B. Golgi complex
C. Lysosomes
D. ER
E. Nucleus

42. Molecule that is synthesized during the transcription of structural genes of eukaryotes is

A. pre-mRNA
B. mRNA
C. polypeptide chain
D. tRNA
E. rRNA

43. Cell contains three types of RNA: mRNA, tRNA, rRNA. Synthesis of all these molecules occur in

A. lysosomes
B. Ribosomes
C. Nucleus
D. Smooth ER
E. Golgi complex

43. mRNA molecule has 110 phosphate groups. How many nucleotides does it consist of?
A. 55
B. 110
C. 220
D. 330
E. 440

44. The result of transcription of structural genes of eukaryotes is synthesis of immature pre-mRNA. Process of its maturation is termed
A. Translation
B. Processing
C. Splicing
D. Termination
E. Reparation

45. There are 200 amino acids in protein molecule. How many nucleotides are in the gene (double strand DNA) which encode this protein?
A. 200
B. 400
C. 600
D. 900
E. 1200

46. Synthesis of primary protein structure is termed
A. Transcription
B. Translation
C. Replication
D. Termination
E. Reparation

47. Structural genes of eukaryotes has exons and introns. Introns are removed during the maturation of mRNA. This process is termed
A. Processing
B. Splicing
C. Reparation
D. Termination
E. Replication.

10. Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

11. A topic of the following class: Cell life cycle. Cell division. Regulation of mitotic cycle.

Practical class 7. Cell cycle. Cell division. Reproduction and its forms.

The Purpose of the Lesson: To study the cell cycle, and the peculiarities of organization of cell genetic apparatus during the interphase and each mitotic phase. To get an importance of mitosis in maintaining of genetic stability and meiosis in genetic variability.

TOPIC CONTENT

A. Cell cycle. Mitotic cycle
B. Types of cell division: mitosis, amitosis, endomitosis, polyteny.
C. Characteristics of mitotic phases.
D. Biological significance of mitosis.
E. Mitotic index. Failure of mitosis.
F. Meiosis as a special type of cell division.
G. Characteristics of phases of meiosis.
H. Biological significance of meiosis
I. Principle differences between meiotic and mitotic divisions.

TEST QUESTIONS for individual work

	Questions	Answers
1	Give the definition of cell cycle	
2	What is the difference between	

	cell cycle and mitotic cycle?	
3	Mitotic cycle includes two periods: a, b	
4	Mitosis is	
5	List the phases of mitosis:a,b,c,d.	
6	Cytokinesis is	
7	At which mitotic phase cell division is arrested for karyotype studying?	
8	Give the examples of non-dividing cells in humans(a,b). At which period of interphase do they exist? (c)	
9	What is a mitotic index (MI)? (a)	
10	Give the examples of human cells with the high MI (a, b)	
11	What is biological significance of mitosis?	
12	What is the main difference between mitosis and amitosis?	
13	What is endomitosis?(a) polyteny?(b)	
14	Meiosis is.....	
15	Which kind of human cells divide by meiosis?	
16	The first meiotic division is termed reduction division as ...	
17	The second meiotic division is termed equationa1 division as…	
18	How many daughter cells are formed after mitosis (a) and meiosis(b)	
19	Which set of the chromosomes get daughter cells after mitosis(a), meiosis I (b), meiosis II(c)?	
20	What are the mechanisms of genetic variability of gametes due to the meiosis? (a, b)	
21	What is biological significance of meiosis?	

Fill the table Characteristics of interphase

Stage of the interphase	Main events	Number of chromosomes and chromatids	Number of DNA molecules

Fill the table Characteristics of mitosis

Phase of mitosis	Main events	Number of chromosomes and chromatids	Number of DNA molecules

MITOIC CYCLE.

Mitotic cycle (or cell cycle) is a period from the beginning of one cell division to the beginning of the next one. It includes

A. Interphase

B. Mitotic phase.

INTERPHASE.

Iterphase is period between two cell divisions/ It includes

1. **G_1-phase** (post-mitotic or pre-synthetic). Growth, differentiation of the cell, and synthesis of proteins takes place

   Set of hereditary information is **2n2c** (**n** – number of chromosomes, **c** – number of chromatids (DNA molecules)
2. **S (synthetic) phase**. Synthesis (replication) of DNA molecules occurs. Set of hereditary information is **2n4c**
3. **G_2 phase** (post-synthetic or pre-mitotic). Accumulation of energy (ATP) and synthesis of tubulin proteins takes place. Set of hereditary information is **2n4c**

MITOTIC PHASE.

Mitotic cell division occurs during mitotic phase or M phase It has 4 stages**1. PROPHASE. (2n4c)**

Nuclear envelope disappears. The nucleolus disappears.

The chromatids become shortened and thickened.

Centrioles separate and migrate towards the opposite pole of the cell. Spindle fibers appear

2. METAPHASE. (2n4c)

Chromosome are at the equator of the cell.

3. ANAPHASE. (**4n4c**)

The sister chromatids of each chromosome separate and form two daughter chromosomes. The chromosomes migrate towards the opposite poles of the cell.

4. TELOPHASE.

Chromosomes decondence, nuclear membrane and nucleolus appears. Two daughter nuclei are formed. Division of cytoplasm is **CYTOKINESIS**. Set of hereditary information in each daughter cell is **2n2c**

SIGNIFICANCE OF MITOSIS.

In mitosis each daughter cell gets equal hereditary information identical to that of the parent cell. **1 cell 2n4c** ⟹ **2 cells 2n2c**

Endomitosis is duplication of the chromosomes without division of a nucleus. It is formation of a polyploid cell . In human organism it is seen in liver cells

Polytene chromosome forms as a result of repeated replication of DNA in interphase without cell division. It produce giant chromosomes found in the salivary glands of mosquitoes and flies.

The amitosis is direct cell division of interphase nucleus. There is no exact transmission of hereditary information.

Cancer cells can multiply by amitotic division.

MEIOSIS.

Due to the meiosis four haploid cells are formed from the single diploid cell Sperm and egg are formed by meiosis

It occurs in two divisions. Both meiotic divisions include prophase, metaphase, anaphase and telophase.

First Meiotic Division is reductional**.**

Prophase I (2n4c). In prophase I there are synapsis and crossing-over. Synapsis (conjugation) is the pairing of homologous chromosomes. Pairs of homologous chromosomes are bivalents (tetrades).

The crossing-over is mutual exchange of chromatin material (allele genes) between the two homologous chromosomes.

Metaphase I (2n4c).

Bivalents (tetrads) are at the equator of the cell.

Anaphase I.(2n4c)

Homologous chromosomes with its two chromatids move towards the opposite poles of the cell. Because of this daughter cells become haploid.

Telophase I.

Cytokinesis occurs and two haploid cells are formed.

1 cell 2n4c ⟹ **2 cells 1n2c**

S-phase (DNA replication) is absent.

Second Meiotic Division is equational**.**

It is the same as mitosis. In anaphase II chromatids move towards the opposite poles of the cell.

From 1 cell 1n2c - 2 cells 1n1c are formed.

Result of meiosis

1 cell 2n4c ⟹ **4 cells 1n1c**

Significance of Meiosis.

1 Number of the chromosomes stay constant from generation to generation in sexual reproduction.

2. Genetic variation. Four daughter cells have different hereditary information

3. Learning objectives:

General aims:

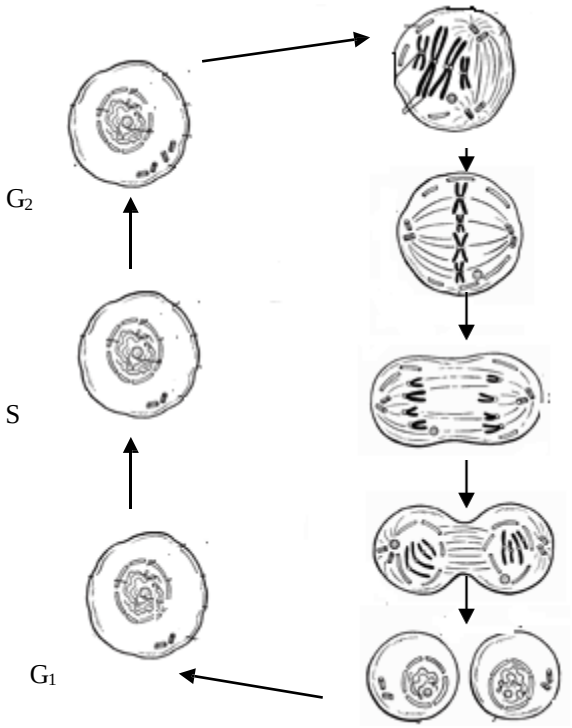
- To study the cell cycle, and the peculiarities of organization of cell genetic apparatus during the interphase and each mitotic phase.
- To get an importance of mitosis in maintaining of genetic stability and meiosis in genetic variability.

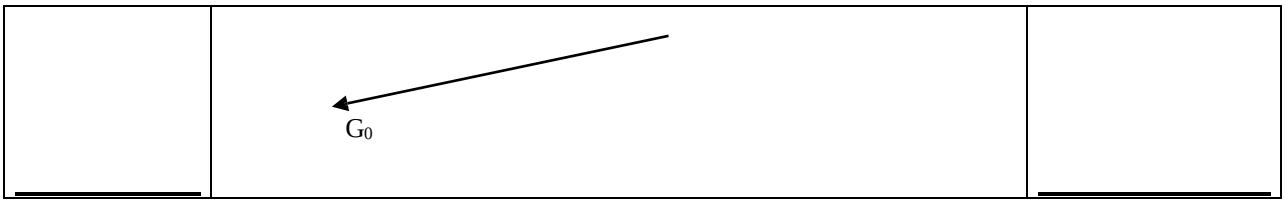
6. Materials of didactic provision of the class:

6.1. Tasks for self-examination of the initial level of knowledge and skills / with the provision of standards of answers at the end of the block of tasks - tests from the database of the Krok-1 licensed exam (http://kroktest.org.ua/)

. Practical work. **LIFE CYCLE AND CELL DIVISION. MITOSIS, AMITOSIS, MEIOSIS**

Task1. Label mitotic phases and periods of interphase, number of chromatids in chromosome, number of chromosomes (n), DNA (C).

Number of chromatids n, C	Interphase	Mitosis	Number of chromatids n, C
			



Task 2. Fill the table

Interphase period	Main events	Number of chromosomes	Number of DNA

Task 3. Fill the table

Phase of mitosis	Main events	Number of chromatids	Number of chromosomes

Task 4. Study stages of I and II meiotic divisions. Mark stages of prophase I and main events, label bivalents. Write down number of chromosomes (n) and DNA (C) at each phase of meiosis.

Task 5. Compare mitotic and meiotic divisions.

Daughter cells	Mitosis	Meiosis
1. Set of the chromosomes		
2. Hereditary information		
3. Number of daughter cells		

7. Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. Active synthesis of proteins, carbohydrates and lipids in the cell takes place in
   J. Anaphase
   K. Interphase
   L. Metaphase
   M. Telophase
   N. Prophase

2. Human somatic cells are diploid (2n), but polyploid cells of red bone marrow (megakaryocytes) may have 64 n chromosomes. What is the mechanism of its forming?
   A. Endomitosis
   B. Polyteny
   C. Mitosis
   D. Amitosis
   E. Meiosis

3. The daughter chromosomes migrates towards opposite poles of the cell in
   A. Metaphase
   Telophase
   Interphase
   B. Anaphase
   C. Prophase

4. Cytokinesis is
   D. Division of the cell nucleus
   E. Synthesis of RNA polymerase
   F. Division of cytoplasm
   G. Separation of daughter chromosomes
   H. Division of mitochondria

5. Electron photomicrograph shows the cell with separating centrioles and forming mitotic spindle. Chromatin threads are situated in cytoplasm. Nuclear envelope and nucleoli are absent. This is typical for
   – Anaphase
   – Interphase
   – Metaphase
   – Telophase
   – Prophase

6. Electron photomicrograph shows the cell with chromosomes situated on the equator. What is the stage of cell cycle?
   11. Anaphase
   12. Interphase
   13. Metaphase
   14. Telophase
   15. Prophase

7. Cell has 4n4c set of hereditary information. What is the stage of cell cycle?
   A. Anaphase
   B. Interphase
   C. Metaphase
   D. Telophase
   E. Prophase

8. Replication of DNA occurs in
   J. G_1 phase
   K. Metaphase
   L. G_2 phase
   M. S phase
   N. Prophase

9. Cell cycle includes following stages
   A. Post-mitotic period
   B. Synthetic period
   C. Premitotic period
   D. Mitosis
   E. All of the above

10. Cells in culture multiply by the division into two daughter cells with identical diploid set of the chromosomes. This type of cell division is

A. Budding
B. Mitosis
C. Meiosis
D. Amitosis
E. Endomitosis

11. Culture of tumor cells demonstrates rapid cell division by splitting of the nucleus. Formation of spindle fibers and condensation of chromatin are not seen. This type of cell division is
A. Cytokinesis
B. Karyokinesis
C. Mitosis
D. Amitosis
E. Endomitosis

12. Electron photomicrograph shows the cell with daughter chromosomes in opposite poles of the cell. This is
D. Interphase
E. Prophase
F. Metaphase
G. Telophase
H. Anaphase

13. At which phase of mitosis human cell has 92 single-chromatid chromosomes?
A. Interphase
B. Prophase
C. Metaphase
D. Telophase
E. Anaphase

14. DNA replication occurs in
A. G_1 phase
B. Metaphase
C. G_2 phase
D. S phase
E. Prophase

15. Cell in mitosis was treated by colchicine. At which stage does colchicine arrest mitosis and what set of hereditary information will have the cell?
A. Metaphase 4n
B. Metaphase 2n
C. Anaphase2n
D. Anaphase 4n
E. Telophase 2n

16. Nuclear membrane and nucleoli disappear and chromosomes became distinct in
A. Interphase
B. Prophase
C. Metaphase
D. Telophase
E. Anaphase

17. Set of hereditary information 2n4c is in
– Interphase
– Prophase
– Metaphase
– Telophase
– Anaphase

18. Spindle fibers are composed of
L. Tubulin
M. Actin
N. Miosin
O. Glycogen
P. Lipids

19. At which stage of cell cycle we usually study human karyotype for diagnosis of chromosomal disorders?
A. Interphase
B. Prophase
C. Metaphase
D. Telophase
E. Anaphase

20. In culture of liver cells some cells do not continua mitosis after chromosome replication and form nucleus with 4n4c chromosomes. This type of cell division is
1. Cytokinesis
2. Karyokinesis
3. Mitosis
4. Amitosis
5. Endomitosis

21. Chromosomes begin to uncoil and daughter nuclei are formed in
4. Interphase
5. Prophase
6. Metaphase
7. Telophase
8. Anaphase

22. Transcription and processing takes place during
A. Interphase
B. Prophase
C. Metaphase
D. Telophase
E. Anaphase

23. Accumulation of energy and synthesis of tubulins for cell division occurs in

1. G_1 phase
2. Metaphase
3. G_2 phase
4. S phase
5. Prophase

24. In post-mitotic period chromosomes consist of single chromatid. Set of hereditary information in cell during this period is

A. 46 chromosomes 92 DNA
B. 23 chromosomes 46 DNA
C. 46 chromosomes 46 DNA
D. 46 chromosomes 23 DNA
E. 23 chromosomes 92 DNA

25. In salivary gland of drosophila fly are seen giant chromosomes. They are formed by constant replication of DNA without replication of chromosomes. Cell doesn't enter mitosis. This phenomenon is termed

A. Endomitosis
B. Polyteny
C. Mitosis
D. Amitosis
E. Meiosis

26. Chromosomal set 2n2c is seen in

A. Interphase
B. Prophase
C. Metaphase
D. Telophase
E. Anaphase

27. Crossing over is

A. Process of chromosome duplication
B. Exchange of allele genes between homologous chromosomes
C. Type of mutation
D. Exchange of genes between non-homologous chromosomes
E. Reparation of DNA molecule

28. Pairing of homologous chromosomes and crossing over take place in meiosis in

A) Prophase I
B) Prophase II
C) Metaphase I
D) Anaphase I
E) Anaphase II

29. Meiosis is a reduction division. What set of hereditary information has cell after second meiotic division?

A. 1n 2c
B. 1n 1c
C. 2n 1c
D. 2n 4c
E. 2n 2c

30. Prophase I of meiotic division has few substages. In which substage chromosomes appear as long, thin and uncoiled threads?

A. Leptotene
B. Zygotene
C. Pachytene
D. Diplotene
E. Diakinesis

31. Prophase I of meiotic division has few substages. At which stage homologous chromosomes moves apart at the centromere region but are still joined by telomeres?

A. Leptotene
B. Zygotene
C. Pachytene
D. Diplotene
E. Diakinesis

32. Set of hereditary information in cell after I meiotic division is

4. 1n 2c
5. 1n 1c
6. 2n 1c
7. 2n 4c
8. 2n 2c

33. The most complex and longest phase of meiosis is

A. Anaphase I
B. Prophase I
Metaphase I
C. Prophase II
Metaphase II

34. At which stage of meiosis does homologous chromosomes migrate towards the cell poles?

A. Prophase I
B. Metaphase I
C. Anaphase I
D. Metaphase II
E. Anaphase II

35. Meiosis is characterized by pairing of homologous chromosomes – conjugation. Formed bivalents (tetrads) line up at the equator of the cell during the
A. Prophase I
B. Metaphase I
C. Anaphase I
D. Metaphase II
E. Anaphase II

36. Chiasmata are first observed in
A. Leptotene
B. Zygotene
C. Pachytene
D. Diplotene
E. Diakinesis

37. Meiosis has evolutionary significance because it produces
A. Genetically similar daughter cells
B. Four daughter cells
C. Recombinations
D. Eggs and sperms

38. Meiosis is
A) Equational division
B) Reductional division
C) Double division
D) All of these

39. Chiasma represents the site of
A. Synapsis
B. Disjunction
C. Crossing over
D. Terminalization

40. In meiosis the chromatids separate during
A) Prophase I
B) Metaphase I
C) Anaphase I
D) Metaphase II
E) Anaphase II

41. In meiosis, the daughter cells differ from the parent cells as well as among themselves because of
A) Segregation
B) Independent assortment
C) Crossing over
D) All of the above

42. In meiosis crossing over occurs during
A. Prophase I
B. Metaphase I
C. Anaphase I
D. Telophase I

43. In meiosis the chromosome number is reduced to haploid state during
A. Metahase I
B. Metaphase II
C. Anaphase I
D. Anaphase II

10. Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

11. A topic of the following class: Meiosis. Gametogenesis. Fertilization.

Practical class 8. Biological peculiarities of human reproduction.Gametogenesis. Fertilization.

The Purpose of the Lesson. To study human heredity disease concept, its classification. Principles of diagnosis of the heredity pathology. Gene (molecular) diseases, mechanisms of its development and principles of laboratory diagnosis. Gene engineering. Biotechnology. Gene therapy. Population-statistic method. Low of constancy of genetic structure of the population. To practice in usage of Hardy-Wineberg's low for studying of the genetic structure of the population.

TOPIC CONTENT

1. The main forms and sense of sexual and asexual multiplication of organisms.
2. The structure of ovum and spermatozoid.
3. Stages of ovogenesis and spermatogenesis. The most important events of every stage.
4. Principal differences of spermatogenesis and ovogenesis, gamets and somatic cells.
5. The process of fecundation in human. Monospermy.
6. Peculiarities of human reproduction and human biological sociality.

TEST QUESTIONS FOR INDIVIDUAL WORK

	Questions	Answers
1	Gametogenes is … .	
2	What is a name of gametogenesis 1) In male- 2) In female -?	
3	Where does gametogenesis take place 1) In female – a; . 2) In male - a?	
4	What are the periods of gametogenesis in 1) male – a,b,c,d; 2) female - a,b,c?	
5	The period (zone) of formation is present only during …	
6	The period of growth is the most manifested during ...	
7	How many gametes are formed from one 1) primary oocyte – a; 2) primary spermatocyte – a ?	
8	What are the sizes (mcm) of human gametes: 1) ovum (diameter) – a; 2) spermatozoid (length) - a ?	
9	What is a structure of human gametes: 1) ovum - a,b,c; 2) spermatozoid - a,b,c,d.	
10	In which period of human ontogenesis does ovogenesis and spermatogenesis begin and continue?	
11	Fecundation is ...	
12	What are the stages of fecundation?	
13	In which part of female sexual system does fecundation take place?	
14	What is the biological importance of fecundation?	

6. Materials of didactic provision of the class:

6.1. Tasks for self-examination of the initial level of knowledge and skills / with the provision of standards of answers at the end of the block of tasks - tests from the database of the Krok-1 licensed exam (http://kroktest.org.ua/)

6.2. The information necessary for the formation of knowledge-skills can be found in the textbooks:

Main:

1. Medical Biology : textbook / Bazhora Yu. I., Bulyk R.Ye., Chesnokova M. M. [et al]. – 2nd ed., rev. and upd. – Vinnytsia : Nova Knyha, 2019. – pp 95 – 109.
2. Medical biology: manual for practical classes/ Bazhora Yu.I et al. - Odessa: OSMU, 2006. - pp 144-155

Additional:

1. Color atlas of genetics: third edition / Passarge Eb. – Essen, Germany, 2007.-pp 162-164.

7. Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. Formation of egg in humans takes

A. 1 month
B. 28 days
C. 1 – 2 years
D. 5 – 7 years
E. 15 – 20 years

2. In humans, mammals and other chordates sexual reproduction takes place by fusion of large immobile ovum and small motile sperm. This kind of sexual reproduction is

A. Isogamy
B. Schisogony
C. Oogamy
D. Conjugation
E. Polyteny

3. Formation of sperm in humans takes

A. 10 days
B. 30 – 35 days
C. 65 –70 days
D. 6 months
E. 1 year

3. Tissue sample of the ovary shows large cells with paired homologous chromosomes and points of crossing over in some of them. At what period of gametogenesis are the cells?

A. Multiplication
B. Growth
C. Maturation
D. Formation

4. Process of spermogenesis starts at the

A. Third month of the embryonic development
B. 2 –3 year of life
C. 5 – 7^{th} year
D. 12 - 13^{th} year
E. 20^{th} year of life

5. Oocytes in humans start to form at embryonic period, but then meiosis stops for years till fertilization. At which stage of meiosis eggs are stored in the ovaries?

A. Prophase
B. Metaphase
C. Anaphase
D. Telophase
E. Interphase

6. In some organisms ovum can start to develop without fertilization. Such way of reproduction is called

A. Gametogenesis
B. Parthenogenesis
C. Ovogamy
D. Polyteny
E. Copulation

7. Tissue sample of the ovary shows the resting cells that accumulate nutritive substances. At what period of gametogenesis are the cells?

A. Multiplication
B. Growth
C. Maturation
D. Formation

8. Process of ovogenesis starts at the

A. Third month of the embryonic development
B. 2 –3 year of life
C. 5 – 7^{th} year
D. 12 - 13^{th} year
E. 14 - 16^{th} year of life

10. Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

11. A topic of the following class: Peculiarities of the prenatal period of ontogenesis and preconditions of congenital defects in humans.

Practical class 9. Peculiuarities of prenatal and postnatal development in human.

The Purpose of the Lesson. To study ontogenesis and its periods. Embryonic period of the development, its stages. Congenital defects, its classification. Regulation of gene function in ontogenesis. Experimental studying of embryonic development. Critical periods of development. Teratogenesis. Teratogenic factors of environment. To study postembrionic period of ontogenesis, its periodisation. Growth and differentiation in postnatal period.

TOPIC CONTENT

1. Ontogenesis, its periods
2. Stages of embryogenesis.
3. Embryonic induction. Experiences of D.Gerdon and G.Shpeman.
4. Problems of differentiation.
5. Prenatal period of human development. Peculiarities and critical periods.
6. Classification of congenital malformations in human.
7. Characterize postembryonic period of human ontogenesis.
8. What are the stages of postnatal period of human development?
9. What are the peculiarities of postnatal period of human development according to the biosocial nature?
10. Proportion of processes of growth and differentiation in postnatal period.
11. Old age as normal stage of postnatal period of human ontogenesis.
12. Manifestations of old age processes at different levels of human organization.
13. Modern theories of aging.
14. Gerontology and geriatry.
15. Clinical and biological death.

TEST QUESTIONS FOR INDIVIDUAL WORK

<table>
<tr><th></th><th>Questions</th><th>Answers</th></tr>
<tr><td>1</td><td>What is ontogenesis: a.
1) from embryological point;
2) from genetic point of view.</td><td rowspan="11"></td></tr>
<tr><td>2</td><td>What are the periods of ontogenesis?</td></tr>
<tr><td>3</td><td>Embryologic development begins from ... and finishes ...</td></tr>
<tr><td>4</td><td>What is a type of ovum according to a quantity and a position of a yolk in a cytoplasm? (a,b,c,d)</td></tr>
<tr><td>5</td><td>The nutrition of an embryo is done by ...</td></tr>
<tr><td>6</td><td>Fill a table
<table>
<tr><th>Stage</th><th>Stage of human embryo genesis</th><th>It finishes by formation</th></tr>
<tr><td>I</td><td></td><td></td></tr>
<tr><td>II</td><td></td><td></td></tr>
<tr><td>III</td><td></td><td></td></tr>
<tr><td>IV</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>7</td><td>Blastula is ...</td></tr>
<tr><td>8</td><td>Which type of blastula is formed in human? a</td></tr>
<tr><td>9</td><td>Gastrula is ...</td></tr>
<tr><td>10</td><td>What are the types of human embryo gastrulating during the period of
1) Early gastrulating – a;
2) Late gastrulating – a.</td></tr>
</table>

11	What are the derivates of 3 embryonic layers in human?	
12	What are the functions of provisory organs? (a,b,c,d)	
13	What are the provisory organs of human? (a,b,c,d)	
14	What are the critical periods of embryogenesis?	
15	What are the critical periods in human embryogenesis? (a,b,c,d)	
16	What is an embryo?	
17	Fetal period continues from ... week till ...	
18	What is 1) teratology 2) Teratogenesis 3) Teratogenic factors?	
19	Embryonic induction is ...	
20	What are the examples of tissues -inductors?	

	Questions	Answers
1	Postembryonic development of human begins from ... and finishes.	
2	What is a type of human development?	
3	What are the periods of human postnatal ontogenesis according to the ability for fertilization?	
4	Study periods of human postnatal ontogenesis according to morphological, physiological, biochemical, psychological and other indices.	
5	What is the main criterion of human development?	
6	What are the peculiarities of human growth according to 1) its duration – a; 2) its proportionality – a.	
7	Which factors make influence on a quickness of human growth? (a,b,c)	
8	Acceleration is ...	
9	What are the possible reasons of acceleration? (a,b,c,d,e,f)	
10	What are the types of human constitution according to morphological indices? (a,b,c)	
11	Oncology is a science ...	
12	What are the types of tumor growth? (a,b)	
13	What is a classification of tumors according to a type of cells growth and a stage of atypy? (a,b)	
14	What are cancerogenic factors?	

Literature: Medical biology: manual for practical classes / Bazhora Yu.I. et al. – Odessa: OSMU, 2006.-pp 156-171;
Color atlas of genetics: third edition / Passarge Eb. – Essen, Germany, 2007.-pp 116-122.

Embryonic development

Ontogenesis **- individual development of an organism from fertilization to death.**

It is divided into two periods:

- **Embryonic (embryogenesis).** It starts after fertilization and finishes with birth. In man this period is often termed as prenatal.
- **Postembryonic** (in man – postnatal) from birth to death.

I. Fertilization is the fusion of male and female gametes to form diploid zygote. In humans the sex of a chills is determined at the moment of fertilization.

Fertilization in humans takes place in fallopian tubes.

II. Cleavage. It includes the rapid mitotic division of the zygote to form a blastula. Blastrula is an embryo from one layer of the cells and has cavity inside.

These divisions are not accompanied by cell growth, so they subdivide the large zygote into many smaller daughter cells called blastomeres.

Cleavage in human zygote occurs during its passage through the fallopian tube to the uterus. Type of the cleavage is complete, equal, asynchronic. A solid ball that consists of 16 go 32 blastomeres is known as **morula**. Than blastula is formed. Blastula in mammales is blastocyst. It consists from the inner cell mass – **embryoblast,** and outer cell mass or **trophoblast**.

Implantation. Implantation is the attachment of the blastocyst to the uterine wall. It takes place about five to seven days after ovulation.

III. Gastrulation.

Gastrulation is formation of germ layers. There are three germ layers: ectoderm, mesoderm and endoderm. Each germ layer gives rise to specific tissues, organs and organ-systems .

Gastrulation in human is the major event of the third week. It occurs by delamination and migration of the cells.

III.Organogenesis. It includes the formation of specific organ systems from three primary gem layers.

1. Ectoderm gives rise to skin epidermis and epidermal derivatives (glands, hair, nails), nervous system.

2. Mesoderm produces dermis of skin, most muscles, connective tissues, kidneys, gonads, heart, blood and lymph vessels, skeleton.

3. Endoderm forms lungs, digestive system, liver,pancreas.

The nervous system is the first organ system to form. Formation of the neural tube is called neurulation, embryo in this stage – neurula.

After the nineyth week all organs are formed and embryo is termed fetus

The term during which the development occur is called the gestation period and is approximately 266 from fertilization.

Embryonic or fetal membranes (provisory organs) include the amnion, yolk sac, allantois and chorion.

The amnion is form an amniotic sac that is filled with amniotic fluid. Amniotic fuid gives space for development and growth; helps to maintain consistent pressure and temperature.

The yolk sack in man contains no nutritive yolk. It produces blood for the embryo and primary germ cells form in the wall of the yolk sac.

The allantois in humans give rise to the fetal umbilical arteries and vien. The umbilical cord contains two umbilical arteries, which carry deoxygenared blood from the embryo toward the placenta, and one umbilical vein, which carryies oxygenated blood from the placenta to the embryo.

The chorion forms placenta **Placenta** is a vascular structure by which fetus is attached to the uterine wall. Placenta supplies fetus with nutrition, provides gas exchange and removing of metabolic products. It also serves as protective barrier and edocrine organ producing steroid hormons.

The **umbilical cord** forms as the yolk sac shrincs and the amnion expands to envelope the tissues on the underside of the embryo.

Postembryonic (in man – postnatal) from birth to death.

There are two principle types of postembryonic development: direct and indirect.
In the direct development nascent body is similar to the adult, but smaller in size. Direct development is possible if egg accumulates enough amount of yolk (reptiles and birds) or embryo gets nutrition directly from maternal organism (mammals). A human being has direct postembryonic development.

In the indirect development the larva, which is not like an adult, hatches of the egg. A metamorphosis – the gradual transformation of the larva into an adult occurs in the post1embryonic period. Such type of development is seen in animals with insufficient for direct development amount of yolk in eggs (insects, bony fish, amphibians)

Man has direct postembryonic development
According to the reproduction ability postembryonic period is divided into:
-Pre-reproductive
-Reproductive
-Post-reproductive

Pre-reproductive period

Neonatal – first 10 days (28 days);
-Infancy (up to 1 year);
-Childhood (early childhood 2 – 3 year, first 4 – 7 years, second – 8 – 11 years);
-Juvenile age (♀12 – 15; ♂ 13 – 16);
-Youth (♀16 – 20; ♂ 17 – 21).
Pre-reproductive period is characterized by active growth and differentiation

Growth

1)- Limited (restricted)
- Unlimited (unrestricted)
2)Isometric
- Allometric
3) Even
- Uneven (irregular)

Human growth is limited, allometric, irregular

Reproductive period

Mature:
Mature I (22 – 35 years ♂, 21 – 35 ♀)
Mature II 36 – 55 years (60 ♂)

Postreproductive period

- Middle age (60 – 74 ♂, 55 – 74 y ♀)
- Old age (75 - 90)
- Longivity period – older than 90

Materials of didactic provision of the class:

Task1. Write down types of cleavage according to the type of egg. Give the examples.

Type of the egg	Isolecital	Telolecital	Centrolecital

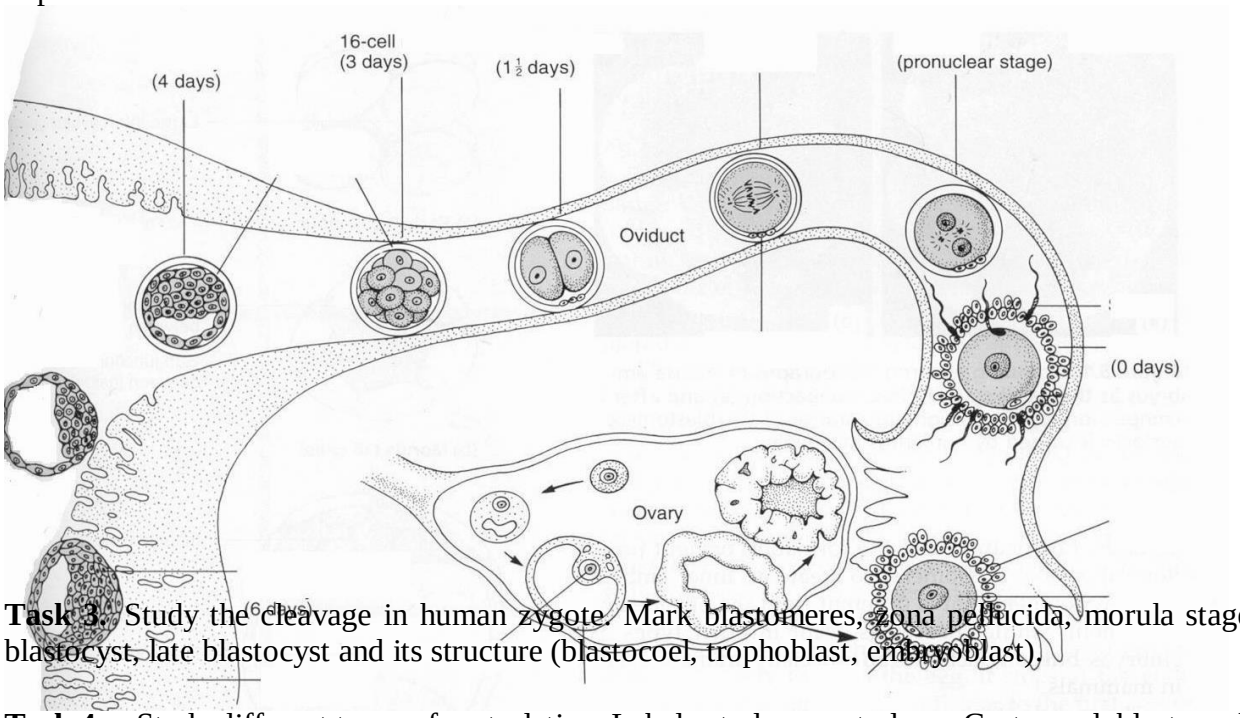
moderately extremely

Type of cleavage _____ _____

_____ _____ _____ _____

Example _____ _____ _____ _____

Task 2. Study the scheme of first week of human development. Label egg, follicule, secondary oocyte, zona pellucida, corona radiata, polar body, fertilization, zygote, cleavage, morula, early blastocyst, implantation.



Task 3. Study the cleavage in human zygote. Mark blastomeres, zona pellucida, morula stage, early blastocyst, late blastocyst and its structure (blastocoel, trophoblast, embryoblast).

Task 4. Study different types of gastrulation. Label ectoderm, entoderm. Gastrocoel, blastocoel. Study the structure of early and late human gastrula and neurula.

Task 5. Write down the derivatives of germ layers in humans.

Ectoderm	Entoderm	Mesoderm
		Dermatome→ Myotome→ Sclerotome→ Nephrotome→ Gonotome→ Splanchnotome→ Mesenchyme→

Task 6. Label the provisory organs of human being. Choose the derivatives of embryoblast and trophoblast.

Embryoblast	Trophoblast
a) b) d)	a) b)

Task 7. Give the classification of congenital defects according to the period of formation

Congenital defect	Stage of embryogenesis	Temporal period of formation	Example
Gametopathy			
Blastopathy			
Embryopathy			
Phetopathy			

Task 8. Give the classification and examples of teratogenic factors

Physical	Chemical	Biological

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. Placenta is formed in:
   1) Reptiles
   2) mammals
   3) birds
   4) none of these

2. Fetus gets nourishment and oxygen through
   1) yolk sac
   2) allantois
   3) placenta
   4) amnion

3. Fertilization in human female occurs in the
    1) Fallopian tube
    2) vagina
    3) uterus
    4) ovary
4. Mesoderm gives rise to
    1) Epidermis
    2) liver
    3) intestinal lining
    4) muscles
5. Morula is enclosed by
    1) corona radiate
    2) Zona pellucida
    3) both of above
    4) none of above
6. Ectoderm produces
    1)dermis
    2) lining of urinary bladder
    3) nervous tissue
    4) peritoneum
7. Embryo reaches the uterus from the Fallopian tube in about
    1)24 hours
    2) 2 days
    3) 7 days
    4) 14 days
8. In human parturition usually takes place… after the last menstrual period
    1) 10 months
    2) 30 weeks
    3) 365 days
    4) 40 weeks
9. Germ layers are formed during
    1) copulation
    2) cleavage
    3) gastrulating
    4) fertilization
10. At the time of ovulation in the human female, all the following are true except that
    1) meiosis I has just been occurred
    2) first polocyte has just been expelled
    3) Zona pellucida has broken down
    4) fertilization is possible
11. Foetal membrane that participates in the formation of placenta in human female is
    1) allantois
    2) amnion
    3) yolk sac
    4) chorion
12. Cleavage of the zygote gives rise to
    1) blastula
    2) morula
    3) gastrula
    4) foetus
13. Gonads develop from embryonic
    1) ectoderm
    2) endoderm
    3) mesoderm
    4) both mesoderm and endoderm
14. Human eggs are
    1) alecital
    2) mesolecital
    3) microlecital
    4) macrolecital
15. Blastopore is
    1) Opening of neural tube
    2) opening of gastrocoel
    3) further anterior end of embryo
    4) found in blastula
16. Amount of yolk and its distribution are changed in the egg. Which one is affected?
    1) pattern of cleavage
    2) formation of zygote
    3) number of blastomeres
    4) fertilization
27. Which one is produced by mesoderm?
    1) heart and notochord
    2) heart and brain
    3) spinal cord and notochord
    4) brain and notochord
18. Extra embryonic membranes of the mammalian embryo are derived from
    1) inner cell mass
    2) formative eggs
    3) trophoblast
    4) follicle cells
19. Coelom is formed by splitting of
    1) mesoderm
    2) endoderm
    3) ectoderm
    4) all the above
20. When do the three germinal layers differentiate?
    1) Blastula
    2) gastrula
    3) cleavage
    4) fertilization
21. Which is derived from ectoderm?
    1) Epidermis
    2) retina
    3) spinal cord
    4) all the above

Module section 3. Regularities of inheritance and variation. Methods of human genetics.

Practical class 10. Peculiarities of human genetics. Mendelian human characters (mono- and dihybrid, polyhybrid crossing).

The Purpose of the Lesson. To study subject and tasks, periods; main terms and notions of genetics. Mendelian characters in human. Principles of hybridological analysis. Monohybrid cross: low of dominance, low of segregation. Low of "gamete purity". Cytological basis of the lows. Test cross and its practical usage. Lethal genes. Deviations from the expected ratio. Di- and polyhybrid cross: low of independent assortment and its cytological basis. Dominant and recessive modes of inheritance of normal and pathological characters. Intermediate inheritance in humans.

TOPIC CONTENT

1. The science of genetics. Medical genetics. Human genetics.
2. Hybridologic method. What about it's using in human genetics?
3. Monohybrid crossing. I and II Mendel's lows.
4. Dihybrid crossing. III Mendel's low.
5. Cytological improvement of the hypothesis of "gametes purity".
6. Test-crossing and its using.
7. What are mendelian characters? Examples

TEST QUESTIONS FOR INDIVIDUAL WORK

	Questions	Answers
1	When did Mendel discover his lows of heredity?	
2	What is the year of genetics birth? Who did rediscovered Mendel's lows? Inheritance is ...	
3	Variability is …	
4	Allelic genes are – 1)2)3)	
5	Alternative characters are …	
6	Homozygote organism is … 9. with allelic genes …; 10. how many types of gametes are formed?	
7	Genotype is …	
8	Phenotype is …	
9	Phenotype depends on 1)2)	
10	What are the peculiarities of hybrydologic method? 1)2)3)	
11	I Mendel's low is …	
12	II Mendel's low is …	
13	What is the segregation 1) by genotype Q. by phenotype	
14	III Mendel's low is …	
15	What is the segregation 1) by genotype R. by phenotype	
16	In the case of complete dominance	

17	– dominant gene is … – segregation by genotype is … – segregation by phenotype is … In the case of incomplete dominance – dominant gene is ... – segregation by genotype is ... – segregation by phenotype is …	
18	What is a hypothesis of "gametes purity"?	
19	Analyzing crossing is used for …	
20	Lethal genes are ...	

Genetics is a science about heredity and variation.

BASIC TERMS OF GENETICS:

Heredity is the transmission of characters from generation to generetion.

Variation is an ability of organism to change

Genotype is the set of genes in diploid set of chromosomes.

Phenotype is the external and internal features of an organism. Phenotype depends on genotype and environment.

Allele genes are the genes located at the same locus of homologous chromosomes and determining one character.

Alternative characters - contrasting features controlled by allele genes.

Homozygous – organism has same allele genes

Heterozygous - organism has different allele genes

Dominant gene (A) is the allele gene that expresses itself in the homozygous and heterozygous state.

Recessive gene (a) is the allele generation that expresses itself just in the homozygous state.

So, there are **three types of genotype**:

AA – dominant homozygotes
Aa – heterozygotes } Both have dominant phenotype
aa - recessive homozygotes, have recessive phenotype

Example: Brown eyes is a dominant character (**A**) Person with brown eyes might be homozygous (**AA**) or heterozygous (**Aa**). Blue eyes is recessive character. Person with blue yes is always homozygous(**aa**)

LAWS OF HEREDITY

Laws of heredity were discovered by Gregor Mendel in 1865. He studied inheritance of the characters in pea plants. He studied inheritance of one character (**monohybrid cross**)

I Mendel's law is the law of dominance: In crossing between homozygous organisms that differ in one pair of contrasting characters all the hybrids of first generation will manifest just one of the characters. All hybrids will have same phenotype and genotype.

For example, Mendel crossed pea plants with yellow and green seeds and got all offspring with yellow seeds

Parents - "P" (lat . parents).
female is ♀
male is ♂ ;
"x" - crossing
offspring generation - "F"
(from Latin - filia **-children**)

P: ♀ AA x ♂ aa
yellow green
Gamets: A a
F_1: Aa – 100% yellow

Then Mendel crossed the hybrids of first generation (self-pollination of F_1 hybrids) He got plants with yellow and green seeds in 3 to 1 ratio.

II Mendel's law is the law of segregation. The hybrids of F_1 generation produce offspring with 2 contrasting characters in phenotypic ratio 3:1 and genotypic ratio 1:2:1.

F_1: ♀ Aa x ♂ Aa
yellow yellow
G : A,a A,a
F_2: AA , Aa , Aa , aa
yellow yellow yellow green

The F_2 ratio by phenotype is 3:1 (3 yellow : 1 green). Genotype ratio in is 1:2:1 (1 dominant homozygote : 2 heterozygotes : 1 recessive homozygote)

Dihybrid cross is the cross in which inheritance of 2 pairs of contrasting characters is studied simultaneously.

Law of independent assortment is the III Mendel's law. When parents differ in 2 or more pairs of contrasting characters the inheritance of each pair occurs independently, if genes are situated in different pairs of chromosomes.

Mendel cross the plants with **yellow (A) round (B) seeds** with the plant with **green (a) wrinkled (b) seeds.**

P: ♀ AABB x ♂ aabb
yellow, round green, wrinkled
G : AB ab
F1: AaBb
yellow, round

After F_1 self-pollination:

P: ♀ AaBb x ♂ AaBb
yellow, round yellow, round
G : AB, Ab, aB, ab AB, Ab, aB, ab

Punnett square helps in calculation of F_2 ratio**:**

F2 ♂ / ♀	**AB**	**Ab**	**aB**	**ab**
AB	**AABB** yellow round	**AABb** yellow round	**AaBB** yellow round	**AaBb** yellow round
Ab	**AABb** yellow round	**AAbb** yellow wrinkled	**AaBb** yellow round	**Aabb** yellow wrinkled
AB	**AaBB** yellow round	**AaBb** yellow round	**aaBB** green round	**aaBb** green round
ab	**AaBb** yellow round	**Aabb** yellow wrinkled	**aaBb** green round	**aabb** green wrinkled

F_2 phenotypic ratio is **9:3:3:1** in diheterozygous individuals.

So, the phenotype variants are:

9 A_B_ yellow round**;**
3 A_bb yellow wrinkled**;**
3 aa B_ green round**;**
1 aabb green wrinkled**.**

The complete ratio by genotype is: 1AABB: 2AABb: 2AaBB: 4AaBb: lAAbb: 2Aabb: 1aaBB: 2aaBb: 1aabb

The ratio of each character taken separately is 3:1 (12 yellow and 4 green; 12 round and 4 wrinkled), so segregation of each pair of characters occurs independently.

Incomplete dominance.

Mendel's laws do not occur universally. For example, when a **red** flowered 4 o'clock plant (AA) is crossed with **white** flowered plant (aa) the F_1 hybrids are found to have **pink flowers**.

P: ♀ AA x ♂ aa
red white
Gametes: A a
F_1: Aa x Aa
pink pink
Gametes: A;a A;a
F_2: AA , Aa , Aa , aa
red pink pink white

The manifestation of intermediate character in F_1 generation is incomplete dominance. **The ratio by phenotype and genotype in F_2 is the same in case of incomplete dominance (1:2:1).**

The crossing of hybrids with parental forms is used in **the hybridologic analysis**. It's called **the backcross,** offspring are called F_b.

Test cross is the cross of hybrids with the recessive homozygote. It helps to define the genotype of individual with dominant phenotype. If F_1 generation is uniform the genotype of dominant parent is AA; if the ratio is 1:1, the genotype of dominant parent is Aa.

P:	♀ AA x ♂ aa	P:	♀ Aa x ♂ aa
F_1:	Aa	F_1:	Aa; aa
	100%		50% 50%

Characters following Mendel's laws are termed as Mendelian characters. Example in humans are **brown and blue eyes**

Some hereditary disorders are also Mendelian characters.

dominant disorders are **polydactyly, achondroplasy (dwarfism);**

recessive disorders are albinism, sickle-cell anemia

TASK 1. Solve following problems.

1. Mother with light hair and father with dark hair have five children with dark hair. Define the genotypes of all family members.
A - _____
a - _____

2. Both parents have brown eyes. Two among their five children are with blue eyes. Define the genotypes of all family members.
A - _____
a - _____

P ♀ x ♂

G

F_1

Ratio in phenotype is _____

Ratio in genotype is _____

P ♀ x ♂

G

F_1

Ratio in phenotype is _____

Ratio in genotype is _____

3. Polydactyly (six fingers) is a dominant character. Man with polydactyly and normal woman has one normal child and one child with polydactyly. Define the genotypes of all family members.

A - _____

a - _____

P ♀ x ♂

G

F_1

Ratio in phenotype is _____

Ratio in genotype is _____

4. Polydactyly (six fingers) is a dominant character. Man with polydactyly and normal woman has four children with polydactyly. Define the genotypes of all family members.

A - _____

a - _____

P ♀ x ♂

G

F_1

Ratio in phenotype is _____

Ratio in genotype is _____

5. Anophtalmos (absence of eyeballs) is a recessive character. Heterozygous individuals have abnormally small eyeballs. Normal man got married to woman with anophtalmos. Detect the phenotype of their **a) children**

A - _____

a - _____

P ♀ x ♂

G

F_1

Ratio in phenotype is _____

Ratio in genotype is _____

b) **grandchildren** if both parents are heterozygous

A - _____

a - _____

F_1 ♀ x ♂

G

F_2

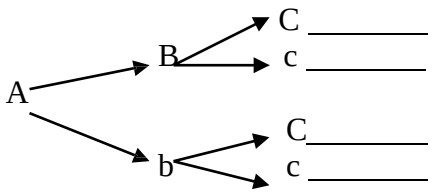
Ratio in phenotype is _____

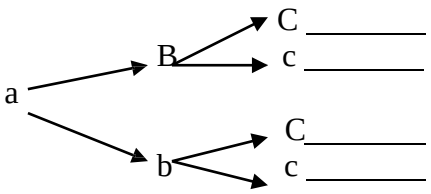
Ratio in genotype is _____

6. Write down the gametes produced by individuals with following genotypes

Genotype	AABB	AaBB	aaBb	AaBb	AABbcc
N of gametes					
Gametes					

7. Write down the gametes produced by individuals with following genotype AaBbCc





Totally _____types of the gametes

8.

Parents with brown eyes and normal hearing have two deaf children: daughter with brown eyes and son with blue eyes. Define the genotypes of family members. What is the chance to have next child deaf with blue eyes?

A_____ P ♀ x ♂

a _____ G

B_____

b_____

Genotypic and phenotypic ratio

Chance to have next child deaf with blue eyes is _____%

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. Man is homozygous with brown eyes, his wife has blue eyes. Their childrens' phenotype is the example of

A. Low of dominance
B. Low of segregation
C. Lw of independent assortment
D. Hypothesis of purity of gametes
E. Linked inheritance

2. Auricle-dental displasia is autosomal dominant disorder, which is characterized by absence of molars and some other defects. There is a normal child in family where mother is healthy and father is ill. What is the risk to have second child with displasia?

A.50%
B. 100%
C. 75%
D. 25%
E. 0%

3. Normal parents have the child with microcephaly, cleft lip and palate. What is the recurrence risk in this family, if disease is of autosomal recessive inheritance?

A.50%
B. 100%
C. 75%
D. 25%
E. 0%

4. One of the ectodermal displasia syndromes is characterized by defects of hair, teeth and bones and is of autosomal dominant pattern of inheritance. What is the chance to have normal children if both parents are ill and heterozygous?

A. 25%
B. 50%
C. 75%
D. 100%
E. 0%

5. Healthy parents have deaf child with albinism (two recessive characters). What is the genotype of the parents?

A. AABB and AABB
B. AaBb and AABB
C. aaBB and aaBB
D. AaBb and AaBb
E. AABb and AaBb

6. Normal woman and man with aniridia (absence of iris, autosomal dominant character) have five children with aniridia. What is the chance to have normal child in this family?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

7. Albinism is the recessive character. In which marriage risk to have affected child is 50%?

A. AA and aa
B. Aa and aa
C. Aa and Aa
D. Aa and AA
E. AA and AA

8. Healthy couple have child with microcephaly (recessive character). What is the chance to have next child healthy?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

9. Man with achondroplasia (dwarfness) got married with normal woman. What is the chance for child to inherit this desease if father is heterozygous?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

10. Woman has night blindness (dominant character). Her husband and child are healthy. What is the chance to have next child healthy?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

11. One of the couple is normal, another with albinism. They have fraternal twins: normal and with albinism. What is the risk to have affected child in this family?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

12. Anophtalmos (absence of eyeballs) is the recessive character. Heterozygotes have small eyeballs (incomplete dominance). Couple is heterozygoes. What is the chance to have a child with normal eyes?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

13. Father is deaf and has albinism (recessive characters). Mother is healthy and diheterozygous. Which ratio will help to calculate the chances of their children to be healthy?

A. 3 : 1
B. 1 : 1
C. 1 : 1 : 1 : 1
D. 9 : 7
E. 9 : 3 : 3 : 1

14. Parents are healthy heterozygous carriers of recessive genes for diabetes and defect of lenses. What ratio will help to calculate the risk of having affected child?

A. 1 : 1
B. 3 : 1
C. 9 : 3 : 3 : 1
D. 15 : 1
E. 9 : 7

Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

Practical class 11. Multiple alleles. Blood groups genetics. Interaction of genes.

The Purpose of the Lesson. To study gene interaction and its manifestations in different types of inheritance. Multiple alleles. Inheritance of blood groups of ABO and MN antigen systems. Rh-factor. Rh-conflict. Immunogenetics: subject and tasks. Tissue and species specificity of the proteins, its antigen properties.
To study gene interaction and its manifestations in different types of inheritance. Interaction of the allele and non allele genes. Polygenic inheritance of quantitative traits. Primary and secondary pleiotropy.

TOPIC CONTENT

1. Notion of allele genes. Mechanisms of multiple alleles formation.
2. Inheritance of blood groups of the ABO antigen system in humans
3. Importance of ABO blood groups detection in clinical practice and forensic medicine
4. Notion of universal donor and universal acceptor
5. Inheritance of Rh-factor
6. Development of hemolytic disease in newborns (erythroblastosis fetalis) as a result of Rh-conflict.
7. What means the interaction of allelic and nonallelic genes?
8. Complementary interaction of genes, its manifestation and practical importance.
9. Epistasis.
10. Polygeny. Mechanisms, biological and practical importance.
11. Molecular mechanism of pleiotropy. Variants of actions of pleiotropic genes. Practical importance of primary and secondary pleiotropy.

TEST QUESTIONS FOR INDIVIDUAL WORK

	Questions	Answers
1	In homologous chromosomes usually are situated ….. allele genes.	
2	In case of multiple alleles there are …….allele genes	
3	Multiple alleles are formed as a result of …….	
4	ABO blood groups are characterized by presence (or absence) of 1) ……..(……) in the membrane of ……. 2) ……(……..) in blood …….	
5	How we term the ABO proteins 1) antigens – a, b 2) antibodies – a, b	
6	How many allele genes specify human ABO blood groups 1) in population 2) in somatic cell 3) in gamete?	
7	What is the difference of I(0) blood group from other groups? (a, b)	
8	What antigens (a) and antibodies (b) has a person	

	with II blood group?	
9	What kind of gene interactions is in following genotypes 1) ii 2) $I^A I^A$ 3) I^A i 4) $I^B I^B$ 5) I^B i 6) $I^A I^B$	
10	Rh – positive blood is defined by presence of ……in the membrane of erythrocyte	
11	Blood transfusion of the Rh-positive blood to the Rh-negative acceptor leads to the ….. of the erythrocytes	
12	Rh-factor is important in following clinical situations: a,b	
13	……fetus can develop hemolytic disease of the newborn if mother is ……	
14	What are the genotypes of a person with 1)Rh-positive I(0) blood 2)Rh-negative IV(AB) blood?	
	Questions	Answers
1	What are the types of genes interaction: 1) Allelic genes – 1,2,3 2) Nonallelic genes – 1,2,3. Codominance is …	
2	Write down a ratio of segregation by phenotype in F2 in a case of: 1) Complementary interaction ofvgenes – a; 2) Epistasis – a; 3) Polygeny – a.	
3	In the case of complementary interaction of genes a character manifests when …	
4	Make examples of complementary interaction of genes in human: 1,2,3.	
5	Epistasis is such a type of genes interaction …	
6	Polygeny is …	
7	Make examples of polygeny in human: 1,2,3,4.	
8	Pleiotropy is …	
9	Write down a scheme of	
10	1) primary pleiotropy – 1; 2) secondary pleiotropy – 1.	
11	Make examples of human disorders in a case of: 1) primary pleiotropy – 1; 2) secondary pleiotropy – 1.	

Multiple alleles. Blood groups genetics.

If there are **more than 2 alleles responsible for a single character in population,** these are **multiple alleles**. Multiple alleles are the result of mutation of a gene. Multiple alleles increases variation

Example in humans is inheritance of ABO system.

ABO BLOOD GROUPS

AB0 antigen system determines the blood groups **- 0(I), A(II), B(III), AB(IV)**.
Each has specific proteins **(antigens)** on erythrocytes and **antibodies** in blood plasma.
Gene I^A specifies antigen A;
gene I^B specifies antigen B;
gene I^O is recessive, it doesn't specify antigen

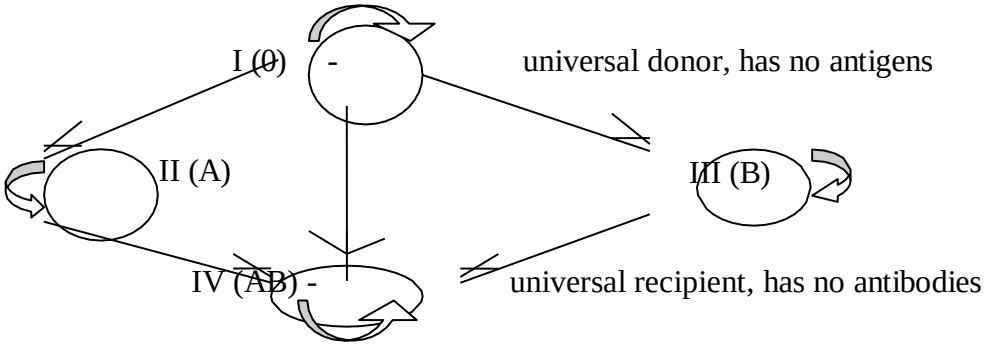
Blood Group	Antigen of erythrocytes	Antibodies of plasma	Gene	Genotype
0(I)	*None*	α,β	I^O (recessive)	I^OI^O
A(II)	A	β	I^A (dominant)	I^AI^A, I^AI^O
B(III)	B	α	I^B (dominant)	I^BI^B, I^BI^O
AB(IV)	A,B	*None*		I^AI^B

Genes I^A and I^B genes are codominant. Codominance means both the genes are equally dominant and both expressed in the phenotype. Presence of I^A and I^B genes determines presence of **two antigens (A and B) of IV blood group.**

Importance of ABO blood groups in medicine

1. Blood groups are important in blood transfusions. If antigen A meets antibody α or antigen B meets antibody β, it causes agglutination of donor erythrocytes. It can cause death.

The theoretical scheme of blood transfusion is:



2. Studying of blood groups inheritance can help in cases of **disputed parentage**. If a child has a blood group, which is not likely to be inherited from parents, child is adopted.

RH-BLOOD GROUPS

Rhesus-factor (Rh-factor) is antigen in human erythrocytes. 85% of Caucasians have it and are Rhesus-positive (Rh+), 15% don't have it and are Rh-negative (Rh -).

Positive Rh-factor is controlled by the dominant gene (D),
negative Rh-factor is controlled by the recessive gene (d).

Blood Group	Antigen of erythrocytes	Antibodies of plasma	Gene	Genotype
Rh+	**+**	**-**	**D**	**DD,Dd**
Rh-	**-**	**-**	**d**	**dd**

Importance of Rh-factor in medicine

11. **Transfusion of Rh-positive blood to Rh-negative recipient**. The first transfusion leads to immunization of the recipient and production of anti-Rh antibodies. The second transfusion of Rh-positive blood results in hemolysis of donor erythrocytes and even death of the patient.
12. **Pregnancy of Rh-negative women with Rh-positive child**. When women is Rh-negative and man is Rh-positive their children are Rh-positive.

P ♀ dd x ♂DD or P ♀ dd x ♂ Dd
G d D G d D,d
F Dd F Dd, dd
Rh + Rh + Rh-

The first pregnancy usually ends with delivering a healthy child. But during the labor erythrocytes of the child get into the maternal blood. Mother's organism start to produce antibodies against Rh+ factor. In the next pregnancy anti-Rh antibodies pass through placenta and destroy Rh+ erythrocytes of the fetus. Hemolysis of erythrocytes leads to jaundice of the newborn, edema, anemia and even death of the child **("erythroblastosis fetalis"**).

Gene interaction is interaction between protein products of the genes.

There are:

13. Allelic interaction is between the allelic genes (**A** and **a)**
- complete dominance,
- incomplete dominance,
- codominance.

14. **Non allelic** interaction is between non-allele genes (**A** and **B**)
- Complementarity,
- epistasis
- polygenic traits.

The Allelic Interactions:

Complete dominance is the case when dominant allele completely suppress the manifestation of recessive one. Dominant character is completely present in phenotype. Examples are

O. inheritance of eye color: dominant homozygotes (AA) have brown eyes, heterozygotes (Aa) have brown eyes, recessive homozygotes (aa) have blue eyes;
P. number of fingers: AA – polydactyly (six fingers), Aa - polydactyly (six fingers), aa - norm (5 fingers).

Incomplete dominance is the case when dominant allele doesn't suppress the manifestation of recessive gene completely. So heterozygotes (Aa) have an intermediate phenotype. Examples are

F. sickle-cell anemia: dominant homozygotes (AA) are healthy, recessive homozygotes (aa) have severe disease, heterozygotes (Aa) have mild disease.
G. Anophtalmos (congenital absence of the eye balls): dominant homozygotes (AA) have normal eyes, recessive homozygotes (aa) have no eyes, heterozygotes (Aa) have small eyes.

Co-dominance is the case when two allele genes are equally expressed in phenotype. Example is

- AB (IV) blood group: Gene I^A determines presence of antigen A, and gene I^B determines presence of antigen B. Person with genotype I^AI^B(AB blood group) has both antigens A and B on the erythrocytes.

The Non-Allelic Gene interactions

1. Complementary interaction means that two non-allele genes produce new character if present together in genotype (complement each other)

gene **A** gives one character gene **B** gives another character
A + B = new character

Examples in humans are:

H. Normal hearing: 2 dominant gene are required for normal hearing. Gene A determines normal cochlea and gene B determines normal acoustic nerve.
I. Human hemoglobin: Hemoglobin molecule consists of 2 α and 2 β chains (totally 4 globules), so 2 genes (for α and β chain) are required for normal molecule.

2. Epistasis is the suppression of one gene by another non-allele gene.

gene **A** gives a character gene **B** suppresses this character, so
A + B = no character

The gene that suppresses another one is called epistatic gene (inhibitor or supressor). The gene which expression is suppressed is termed as hypostatic gene.

3. Polygenic inheritance (polymeria) or quantitative inheritance is a case when several non-allelic genes controls same character. The more dominant genes are present, the more expressed is the character.

Gene A (A_1) gene B(A_2) gene C(A_3) gene D(A_4)
⇩
same (common)character

Such **genes are called polygenic (cumulative) genes** and the **feature they determine is polygenic.** These genes are marked by the same letter with different indices (A_1,A_2,A_3).

Examples in humans are: skin color, height, body weight, intelligence, blood pressure.

Pleiotropy

Pleiotropy is a case when many features depend on one gene.

1 gene
⇩
Many characters

Example in humans is: Marfan disease (arachnodactyly). Gene of the disease controls the connective tissue protein. If protein is abnormal all systems that have this protein are also abnormal: high height, arachnodactyly (spider fingers), congenital heart defects, dislocation of lenses and shortsightedness.

MULTIPLE ALLELES. BLOOD GROUPS.

TASK 1. Analyze phenotypic characteristics and inheritance of ABO blood groups. Fill the table

ABO blood group	Antigen H	Antigens (A , B)	Antibodies (α, β)	Possible genotypes

O (I)				
A (II)				
B (III)				
AB (IV)				

TASK 2. Solve the problems

2.1 Parents have AB and O blood groups. Will children inherit their ABO blood groups?

P ♀ x ♂

G

F_1

Phenotypes (in %)

2.2 Woman with A blood group, whose father has O blood group got married to man with B blood group (has mother has O blood group). Detect blood groups possible in their children

P ♀ x ♂

G

F_1

Phenotypes (in %)

2.3 Two new born boys were not properly registered in obstetric department. Is it possible to define the parentage if boys have A and B blood groups, first couple has O and AB blood groups and second one – A and B blood groups?

1st case P ♀ x ♂

G

F_1

Phenotypes (in %)

2nd case P ♀ x ♂

G

F_1

Phenotypes (in %)

2.4 Solve problem 2.3 if boys have A and B blood groups, first couple has O and AB blood groups and second one – A and O blood groups.

1st case P ♀ x ♂

G

F_1

Phenotypes (in %)

2nd case P ♀ x ♂

G

F_1

Phenotypes (in %)

2.5 Parents have A and B blood groups. Define the genotypes of the parents if the have six children with following blood groups:

a) all with AB blood groups

b) three with AB and three with A

P ♀ x ♂

G

F_1

Phenotypes (in %)

c) two with O, three with b and one with AB

P ♀ x ♂

G

F_1

Phenotypes (in %)

P ♀ x ♂

G

F_1

Phenotypes (in %)

2.6 Mother has O blood group, child has A group, and suspected father has B one. Is the man biological father of the child? Which ABO blood groups are possible in biological father of the child?

P ♀ x ♂

G

F_1

TASK 3. Analyze phenotypic characteristics and inheritance of Rh-factor. Fill the table.

Rh -factor	Antigen	Antibody	Genotype
Rh+			
Rh-			

TASK 4. Fill the table. In wich cases there is a high risk of "erythroblastosis fetalis" (haemolytic desease of a newborn)

A. P ♀ DD x ♂ dd

G

F_1

Phenotypes (in %)

B. P ♀ Dd x ♂ dd

G

F_1

Phenotypes (in %)

C. P ♀ dd x ♂ DD

G

F_1

Phenotypes (in %)

D. P ♀ dd x ♂ Dd

G

F_1

Phenotypes (in %)

TASK 5 Solve the problems.

5.1 Man having AB Rh- blood group got married to woman having B Rh+ blood group. Woman's father has O Rh- blood group. There are two children in the family having B Rh– and O Rh+ blood

groups. Forensic expert detected that one of the children is illegitimate. How we can exclude the paternity?

P ♀ x ♂

G

F_1

Phenotypes (in %)

5.2. Rh negative woman with O blood group got married to Rh positive man with AB blood group. What is the chance to have Rh-negative child with B blood group in this family? At which case there is a risk of "erythroblastosis fetalis" (haemolytic desease of a newborn)?

P ♀ x ♂

G

F_1

Phenotypes (in %)

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. Woman with Rh-negative B (III) blood has newborn child with AB (IV) blood group and hemolytic disease because of Rh-conflict. What type of ABO and Rh blood group does her husband have?

A. A(II) Rh (+)
B. A(II) Rh (–)
C. AB (IV) Rh (–)
D. B (III) Rh (-)
E. B (III) Rh (+)

2. Man with AB (IV) Rh (-) blood has a wife with B (III) Rh (+) blood. Her father has O (I) Rh (-) blood. There are children with B (III) Rh(-) and O (I) Rh (+) blood groups in this family. Forensic expert determined that on child is illegitimate. Which character permits to exclude the paternity?

A. ABO blood groups
B. ABO and Rh blood groups
C. Rh factor
D. Plasma proteins
E. Rh factor and plasma protein.

3. Parents has A (II) and B(III) ABO blood groups. What is the chance to have a child with type O (I) blood if they are homozygous?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

4. Man has type AB (IV) blood, his wife has type I(0) blood. What is the chance to have a child with type B (III) blood?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

5. Children have O(I) and AB (IV) blood types. Their parents should have

A. O(I) and A(II) blood types
B. O(I) and B(III) blood types

C. A(II) and B(III) blood types
D. A(II) and AB(IV) blood types
E. AB (IV) and O (I) blood types

6. Parents has A (II) and B (III) ABO blood groups. What is the chance to have a child with type O (I) blood if they are heterozygous?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

7. Both parents have A (II) and are heterozygous? What is the chance to have a child with type A (II) blood?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

8. Healthy parents with A (II) and B (III) blood types have child sick with phenylketonuria (recessive character) and O (I) blood type. What is the genotype of this child?

A. $I^0 I^0$ aa
B. $I^A I^0$ aa
C. $I^B I^0$ aa
D. $I^A I^B$ Aa
E. $I^0 I^0$ AA

9. ABO blood groups are controlled in population by three alleles I^0 , I^A and I^B. I^A and I^B are equally expressed in phenotype when present together. What is the type of interaction of these genes?

A. Complete dominance
B. Incomplete dominance
C. Over-dominance
D. Co-dominance
E. Complementarity

10. ABO blood groups are controlled in population by three alleles I^0 , I^A and I^B. What is the genotype of the parents if their children have all possible ABO blood groups?

A. $I^A I^A$ x $I^0 I^0$
B. $I^A I^A$ x $I^B I^B$
C. $I^A I^O$ x $I^B I^B$
D. $I^A I^O$ x $I^B I^0$
E. $I^A I^O$ x $I^A I^B$

11. ABO blood groups are controlled in population by three alleles I^0 , I^A and I^B. How many allele genes controlling ABO groups are in human somatic cell?

D. A. 1
B. 2
C. 3
D. 4
E. 5

12. ABO blood groups are controlled in population by three alleles I^0 , I^A and I^B. How many allele genes controlling ABO groups are in human sex cell?

E. A. 1
B. 2
C. 3
D. 4
E. 5

13. Rh factor inheritance is very important in obstetrics practice. In which situation there is a chance of hemolytic disease of a newborn because of Rh-conflict?

A. First pregnancy of Rh (+) woman with Rh (-) fetus
B. First pregnancy of Rh (-) woman with Rh (+) fetus
C. Second pregnancy of Rh (+) woman with Rh (-) fetus
D. Second pregnancy of Rh (-) woman with Rh (+) fetus
E. Pregnancy of Rh (-) woman with Rh (-) fetus

14. Both parents have A (II) Rh negative blood and are homozygous. What is the chance to have a child with type A (II) Rh negative blood?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

15. Both parents have A (II) Rh negative blood and are homozygous What is the chance to have a child with type A (II) Rh positive blood?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

16. Both parents have A (II) Rh negative blood and are homozygous. What is the chance to have a child with type B (III) Rh negative blood?

A. 0%

B. 25%
C. 50%
D. 75%
E. 100%

17. Parents have Rh negative blood and are heterozygous with A (II) and B (III) blood groups. What is the chance to have a child with type AB (IV) Rh-negative blood?
A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

18. Gene that specifies MN-system blood groups has two allele states. Gene M is considered to be of wild type. Which process provided formation of allelic gene N?
A. Crossing over
B. Mutations
C. Replication
D. Recombination
F. E. Reparation

Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

Practical class 12. Chromosomal theory. Linked inheritance.

The Purpose of the Lesson. To study chromosomal theory of heredity. Mechanisms of crossing over: cytological proves, biological importance. Genetic maps of human chromosomes. Methods of human chromosome mapping. Modern state of human genome studying. Non-chromosomal heredity. Inheritance of sex in humans. Inheritance of sex-linked diseases in humans. Sex-linked, sex-influenced and sex-limited characters. Hemizygocity. Genetics of sex. Mechanisms of genetic differentiation in humans and its failure. Bisexual nature of humans. Psychosocial aspects

TOPIC CONTENT

1. What are the main points of chromosomal theory of heredity?
2. What is sex of human and mammals is determined by?
3. Which characters of human are inherited linked with sex?
4. Groups of genes linkage. Complete genes linkage.
5. Incomplete genes linkage. Crossing over. Morgan's low and his experiences.
6. Principles of genetic and cytological maps making.

TEST QUESTIONS FOR INDIVIDUAL WORK

	Questions	Answers
1	Sex in human and mammals is inherited as … character.	
2	What is 1) autosome – a 2) heterosome (allosome) – a	
3	Sex chromosomes are located in … and … cells.	
4	In human somatic cells there are … autosomes and … sex chromosomes.	
5	In human somatic cells there are … autosomes and … sex chromosomes.	
6	Make examples of organisms with heterogametous 1) female sex – a,b; 2) male sex – a,b.	

7	Count types of gametes (%) formed 1) in woman's organism – a, 2) in man's organism – a.	
8	Which parent determines sex of a child?	
9	Where are located genes of linked with sex characters?	
10	What are the human characters which are inherited with 1) X-chromosome – a,b; 2) Y-chromosome – a,b.	
11	Where are located gene, which determines holandric characters?	
12	What is the Morgan's low (low of genes linkage)?	
13	Give examples of complete genes linkage in human.	
14	The number of groups of genes linkage is equal …	
15	What are the groups of genes linkage in 1) woman – a; 2) man – a.	
16	Crossing over is …	
17	In which period of cell cycle does crossing over take place?	
18	The percentage of crossing over is proportional …	
19	The unit of crossing between genes is named ... in honor of …	
20	Genes in chromosome are located in … order.	
21	What are the methods of genetic and cytological maps of chromosomes making: 1) for human – a,b; 2) for drosophilae – a,b.	

Chromosomal theory of heredity. Genetics of sex.

Autosomes (A) are the same CHROMOSOMES in male and female organisms.

Sex chromosomes determine the sex of an organism.

In humans female has XX, male has XY chromosomes.

P ♀44A+XX x ♂44A + XY

G 22A+X 22A + X, 22A + Y

F 44 + XX, 44A + XY

50% females 50% males

Inheritance of genes located in sex chromosomes is <u>sex-linked inheritance</u>.

Characters determined by genes of sex chromosomes are <u>sex-linked characters</u>.

Examples in humans are hemophilia (slow blood clotting), red-green colour blindness. Problem:

X^H – normal blood clotting

X^h - hemophilia

If normal woman marry man with hemophilia all their children are healthy.

healthy woman man with hemophilia

P ♀ X^HX^H x ♂X^hY

G X^H X^h, Y

F_1 X^HX^h, X^HY

healthy daughter healthy son

In next generation healthy daughters(the carriers), give birth to the sons with hemophilia.

healthy mother (carrier) healthy father

P ♀ X^HX^h x ♂ X^HY

G X^H, X^h X^H, Y

F_1 X^HX^H, X^HY, X^HX^h, X^hY (50% of sons)

healthy daughter; healthy son; healthy daughter sick son
(carrier)

If mother is carrier and father is sick, there may be affected daughters.

healthy mother (carrier) hemophilia

P ♀ X^HX^h x ♂ X^hY

G X^H, X^h X^h, Y

F_1 X^HX^h, X^HY, X^hX^h, X^hY (50% of children)

healthy daughter; healthy son; hemophilia hemophilia
(carrier)

X linked dominant characters(vitamin D resistant rickets) is inherited by half of the daughters and sons from affected mother (X^AX^a) and by daughters only from affected father (X^AY).

Y chromosome controls the differentiation of testis and influences the male traits. **Features determined by Y chromosome** genes are **holandric.** They are transmiited from father to all his sons and never to the daughters. Example of the Y-linked condition is hairy ears (hypertrichosis of pinna).

All the genes located on the same chromosome are linked genes. The genes of linkage group have a tendency to be inherited together but independently of the genes of other linkage groups.

Experiment done by Morgan showed the main regularities of autosomal linkage (inheritance of genes of the same autosome). He crossed of drosophila flies with the gray body (A), long wings (B) and black body (a) without wings (b). F_1 flies were gray with long wings.

P ♀ AB x ♂ ab

AB ab

grey winged black wingless

G AB ab

F_1 AB

ab

grey winged

The test cross of F1 males produced following offspring:

F_1 ♀ ab x ♂ AB

ab ab

black wingless grey winged

G ab AB, ab

F2 AB ab

ab ab

grey winged 50% black wingless 50%

Male organisms have A and B genes in one chromosome and show complete linkage of genes without crossing-over.

Test cross of F_1 females gives another result:

F_1 ♀ AB x ♂ ab

ab ab

grey winged black wingless

G AB, Ab, aB, ab ab

	AB	Ab	aB	ab
F_2	ab	ab	ab	ab
	grey winged 41.5%	grey wingless 8.5%	black winged 8.5%	black wingless 41.5%

The ratio in F_2 does not follow Mendelian inheritance (expected ratio is 1:1:1:1). 17% of recombinants occur as the result of crossing-over.

Based on the results of his experiments **T.H.Morgan in 1925** enunciated the **chromosomal theory of heredity**. It was a result of studying the cellular mechanisms of heredity.

Postulates of Chromosomal Theory of Heredity:

15. Genes are situated in the chromosomes in the linear order. Each gene occupies a certain place (locus).
16. Genes of one chromosome form a group of linkage and are inherited together. The number of linkage groups is equal to the number of haploid set of chromosoms.
17. The exchange of allele gene between chromosomes (crossing-over) occurs.
18. The distance between genes is directly proportional to the percentage of crossing-over.

The more is the distance between the genes, the more is the percentage of crossing-over. Closer the genes are on the chromosome, more likely they will stay together, or less likely that crossing over occurs between them. When crossing over between genes does not occur it is considered as a complete linkage of genes.

For convenience cross over frequency of 1% is taken as a distance of 1 unit (1 Morgan) on a chromosome.

CHROMOSOMAL THEORY OF HEREDITY

TASK 1. Write down the scheme of inheritance of sex in humans.

P ♀ x ♂
G
F

Theoretical ratio is _____

Real ratio is _____

Make a conclusion: Sex of a child is defined at the moment of _____and depends on_____

TASK 2. Analyze inheritance of sex linked characters in humans.

2.1. Write down the scheme of inheritance of hemophilia.

Gene Character

_____ _____

_____ _____

a) Mother is healthy homozygote and father is sick P ♀ x ♂ G F	b) Mother is healthy heterozygote and father is healthy P ♀ x ♂ G F
c) Mother is healthy heterozygote and father is	*Make a conclusion*: For X-linked recessive

sick P ♀ x ♂ G F	inheritance is characteristic: _____ _____ _____ _____

2.2 Write down the scheme of inheritance of vitamin D-resistant rickets

Gene Character

_____ _____

_____ _____

a) Mother is sick and heterozygote and father is healthy P ♀ x ♂ G F	b) Mother is healthy and father is sick P ♀ x ♂ G F

Make a conclusion: For X- linked dominant inheritance is characteristic:

_____

_____

2.3 Write down the scheme of inheritance of hypertrichosis

Gene Character

_____ _____

c) Mother is healthy and father is sick P ♀ x ♂ G F	*Make a conclusion*: For Y-linked inheritance is characteristic: _____ _____ _____ _____

TASK 3. Solve the problems.

3.1 Healthy woman, whose mother suffered from red-green color blindness and father from hemophilia, got married to normal man. What is the chance to have normal children in this family?	3.2 Healthy couple have a son sick with phenylketonuria (autosomal - recessive character) and hemophilia. Define the genotypes of the parents. What is the chance to have normal child in this family?
Gene Character _____ _____ P ♀ x ♂ _____ _____ G F_1 P ♀ x ♂ G F_2 Phenotypes	

TASK 4. Study the autosomal-linked inheritance in Morgan's experiments with drosophila fly

Gene	Character
_____	_____
_____	_____
_____	_____
_____	_____

a) homozygous winged female with gray body and wingless male with black body

P ♀ x ♂

G

F_1

b) recessive homozygous female and F_1 hybrid male

P ♀ x ♂

G

F_2

Phenotypic ratio is

b) recessive homozygous male and F_1 hybrid female

P ♀ x ♂

G

F_2

Phenotypic ratio is

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. Healthy couple has son sick with hemophilia. Grandfather from maternal side has hemophilia also. What is the mode of inheritance of this trait?

A. X-linked recessive
B. Autosomal recessive
C. X-linked dominant
D. Autosomal dominant
E. Y-linked

2. Healthy woman marries man sick with hemophilia. There were no cases of hemophilia in her family history. What is the risk for their child to be affected?

A. 0
B. 25%
C. 50%
D. 75%
E. 100%

3. Hypertrichosis (excessive hair growth) of auricles is determined by Y-linked gene. What is the chance for affected father to have affected son?

A. 0
B. 25%
C. 50%
D. 75%
E. 100%

4. All of the males and none of females in families with hereditary hypertrichosis of auricles have this trait. This character is called

A. Holandric
B. Dominant
C. Recessive
D. Lethal
E. X-linked

5. There is a recessive X-linked gene in humans that cause death of the embryo on early stage of development. What zygote will be eliminated?

A. $X^a Y$
B. $X^A X^a$
C. $X^A Y$
D. $X^A X^A$

6. Father, his son and daughter has no premolar teeth. Same defect has grandfather on father's side. What is the pattern of inheritance of this

characteristic.

A. Autosomal dominant
B. Autosomal recessive
C. Dominant X-linked
D. Recessive X-linked
E. Y-linked

7. Hypoplasia of dental enamel is X-linked dominant disorder. Mother has normal teeth (X^hX^h), father is affected. This feature is inherited by

A. Daughters only
B. All children
C. Sons only
D. Half of the daughters
E. Half of the sons

8. Absence of molars is autosomal dominant character. If mother is affected and homozygous the feature is inherited by

A. Daughters only
B. All children
C. Sons only
D. Half of the daughters
E. Half of the sons

9. Ahydrotic ectodermal dysplasia (absence of sweat glands, dental defects) is X-linked recessive character. What is expected phenotypes of the offspring if man is affected and woman is healthy but has affected father.

A. Half of the daughters and sons are affected
B. All children are healthy
C. All children are affected
D. All daughters are affected
E. All sons are affected

10. While studying of the pedigree was seen that hypertrichosis of auricles is transmitted from the fathers to the sons and only men are affected. What is the pattern of inheritance in this family?

A. Autosomal dominant
B. Autosomal recessive
C. Dominant X-linked
D. Recessive X-linked
E. Y-linked

11. A couple came for medical genetic counseling. Man has hemophilia, woman is healthy and there were no cases of hemophilia in her family. What is the risk to have sick child in this family?

A.100%
B. 75%
C. 50%
D. 25%
E. 0

12. Healthy couple has son with hemophilia. Grandfather on mother's side is sick with hemophilia. Genotypes of the parents is

A. X^HX^H, X^HY
B. X^HX^h, X^HY
C. X^HX^h, X^hY
D. X^HX^H, X^hY
E. X^hX^h, X^HY

13. Healthy woman gets married with healthy man. Her father is sick with hemophilia. What are the expected phenotypes of their children?

A. 100% healthy
B. 75% healthy, 25% sick
C. 50% healthy, 50% sick
D. 25% healthy, 75% sick
E. 100% sick

14. Man with color blindness got married with healthy woman, heterozygous carrier of the disease. What is the chance to have normal child in this family?

A. 0
B. 25%
C. 50%
D. 75%
E. 100%

15. Man with hypertrichosis of auricles asks about the chance to have a normal son. The possibility is

A. 100%
B. 75%
C. 50%
D. 25%
E. 0

16. Genes situated in same chromosome form a group of linkage. Number of linkage group is equal to the haploid number of chromosomes. How many groups of linkage are in healthy man?

A. 46

B. 24
C. 23
D. 22
E. 2

17. Characteristics that are inherited through the sex chromosomes are termed as sex-linked.

Choose the sex-linked characteristics
A. Rh-factor
B. Color blindness
C. ABO blood groups
D. Phenylketonuria
E. Polydactyly

18. Absence of sweat glands is X-linked recessive character. Albinism is autosomal recessive character. Healthy parents have son with both features. His genotype is

1. Aa X^bY
2. AAX^BY
3. Aa X^BY
4. aa X^bY
5. Aa X^BY

19. Genotype of the individual is AB ‖ ab; genes A and B are completely linked. Produced gametes are
D. AB : ab = 50% : 50%
E. Ab : aB = 50% ; 50%
F. AB : Ab : aB : ab = 25% : 25% : 25% : 25% ;
G. AB : Ab : aB : ab = 20% : 5% : 5% : 20%
H. AB = 100%

20. Genotype of the individual is BC ‖ bc; distance between genes B and C is 20 morganids. Produced gametes are
F. BC : Bc : bC : bc = 40% : 10% : 10% : 40%;
G. Bc : BC : bc : bC = 40% : 10% : 10% : 40%;
I. BC : bC : Bc : bc = 25% : 25% : 25% : 25% ;
H. BC : bc = 50% : 50%;
I. Bc : BC : bc : bC = 10% : 40% : 10% : 40%;

21. Genes of color blindness and hemophilia are situated in X chromosome. Distance between them is 9.8 morganids. Expected percentage of crossing over is

A. 90.2%
B. 9.8%
C. 6.53%
D. 4.9%
E. 3.26%

10. Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

***Preparation for practical class* 13. Variation. Phenotypic and genetic variation.**

The Purpose of the Lesson. To study variation, it forms and manifestations on the organism level: phenotypic and genotypic variation. Modification and norm of reaction. Mutations and its phenotypic manifestation. Classification of mutations. Mutagens: physical, chemical, biological. Genetic danger of pollution.

TOPIC CONTENT

1. Variation: Type of variation.
2. Modification.
3. Phenocopies. Morphoses. Norm of reaction. Heterosis (hybrid power).

4. Biometry. Statistic studying of quantitative characters.
5. Types of genotype variation.
6. Mechanisms and types of combination.
7. Mutation. Autogeneses. Mutagenes.
8. Somatic, generative, induced, spontaneous mutations. Classification of mutations according to changes of genetic apparatus.
9. Mechanisms of genome, gene (point) and chromosome mutations.

TEST QUESTIONS FOR INDIVIDUAL WORK

	Questions	Answers
1	What are the main type of variation? a,b	
2	What is modification?	
3	Phenocopy is … . Give examples of phenocopies in human.	
4	Genocopy is … .	
5	Give examples of genocopies in human: a,b.	
6	Norm of reaction … .	
7	Qualitative characters are inherited according to the lows of … .	
8	Which method is used for studying of quantitative characters?	
9	Combinative variation is formation of new … .	
10	What are the mechanisms of combination of genes in children: a,b,c,d,e.	
11	Biological importance of combination is … .	
12	Mutation is … .	
13	Mutations appear in different cells of a human that's why they are … and … .	
14	Classify mutation according to the character of changes in hereditary apparatus: a,b,c.	
15	What are the mechanisms and types of 1) genome mutation – a,b; 2) chromosome aberrations – a,b,c,d; 3) gene (point) mutation – a,b,c,d.	
16	Polyploidy is … .	
17	Aneuploidy is … .	
18	What is 1) trisomy; 2) monosomy; 3) nulisomy.	
19	Give examples of disorders as a result of 1) monosomy; 2) trisomy of autosomes; 3) polysomy of heterosomes in men; 4) polysomy of heterosomes in women.	
20	The smallest locus of DNA which change results in transgeneration is anmed … .	
21	Sponataneuos mutations appear as a result of … .	
22	What are the mutagens 1) chemical – a,b,c,d,e; 2) physical – a,b,c,d; 3) biological – a,b,c.	

Variation is an ability of organisms to change their features and properties.

There are two types of variations:

1. **Phenotypic variation (modifications) –** variation in phenotype **without** genotype changes (non-hereditary).
2. **Genetic variation –** variation in phenotype **caused by genotype** changes (hereditary) **.**

Phenotypic Variations or Modifications

These are the normal variants that appear due to environmental influence and do not concern genotype. Modifications provide adaptation.

Examples in humans are suntan, increase of the muscle volume after the high physical exertions

Characteristics of modifications:

- Don't shift the genes, so features are not inherited;
- are reversible;
- has unidirectional mass character;
- level of its expression depend on the strength and duration of the action of an external factor;
- limits of phenotypic variations is **norm of reaction.** Norm of reaction is determined by genotype. It might be wide (character vary greatly under the action of external factors) or narrow (character is less dependent on the environmental factors)

If external factor alter development of an organism (embryogenesis or early postembryonic stage) it can produce non-adaptive irreversible phenotypic variants. Such non-hereditary changes often are similar with genetically determined phenotypes (**phenocopy).**

A **phenocopy** is a variation in phenotype which is caused by environmental conditions, such that the organism's phenotype matches a phenotype which is determined by genetic factors. **Examples in humans are:** vitamin-D-deficient rickets (non-hereditary) and vitamin-D-resistant rickets (hereditary); congenital defects caused by rubella infection during the pregnancy (non-hereditary) and congenital defects because of chromosomal aberrations (hereditary).

Genetic Variation.

Genetic variation is a variation concerning the genotype, so it is hereditary. It is important in the evolutionary processes. There are 2 types of genetic variation - **recombination** and **mutations.**

1. Recombination is a process which makes **new combinations of genetic information**. It is provided by the following mechanisms:

- Crossing-over in prophase I of meiosis.
- The random segregation of homologous chromosomes (of maternal and paternal origin) in anaphase I of meiosis.
- Random fusion of gametes during the fertilisation.
- The chance of marriage.
- Multiple alleles.

It maintains genetic diversity of population and uniqueness of each individual. **Example in humans** is difference between the brothers and sisters in a family**.**

Genetic Variation.

Genetic variation is a variation concerning the genotype.

There are 2 types of genetic variation - **recombination and mutations.**

Recombination.

Recombination is a process which makes **new combinations of genetic information**. It is provided by the following mechanisms:

19. The random segregation of homologous chromosomes (of maternal and paternal origin) in meiosis.
20. Crossing-over.
21. Random fusion of gametes.

22. The chance of marriage.
23. Multiple alleles.

These mechanisms do not cause the impairments of genotype. It maintains genetic diversity of population and uniqueness of each individual.

Mutations are the alterations of hereditary material, sudden and non directed changes of the genotype.

Mutations occur suddenly in single individuals. They are **non adaptive** and appear **spontaneously**. Usually they are **irreversible** and are **inherited** by the following generations.

Germ mutations occur in germ cells. These mutations are **inheritable Germ mutations cause hereditary diseases in children**

Somatic mutations occur in somatic cells, so they are **not inherited** In adult organism it may cause **formation of tumors.** If somatic mutation takes place during the embryonic development, adult organism may have both normal and mutant somatic cells. Such organism is termed as mosaic. The examples of mosaics are individuals with eyes of different colour.

According to the phenotypic manifestation mutations are dominant or recessive. They may be neutral, harmful and seldom useful. Harmful mutations cause hereditary disorder or are lethal.

Depending on the impairment of genetic material mutations are subdivided into three groups

J. genome (numerical chromosomal aberrations)
K. chromosome (structural chromosomal aberrations)
L. gene

Genome mutations are the **changes in chromosome number.** There are 3 types of genome mutations - polyploidy, aneuploidy and haploidy.

Polyploidy is the state of having **more than 2 complete sets of chromosome**s. The base haploid number of chromosomes is **n**, normal diploids have **2n** chromosomes. Polyploids are triploid (3n), tetraploid (4n) etc. (5n, 6n, 7n, 8n). Mechanism of polyploidy is non disjunction of all chromosomes in meiosis. Polyploidy is beneficial in plants and a rare harmful state in animals. In humans tripolyploidy (69 chromosomes) causes severe congenital defects and death.

Aneuploidy is changing of chromosome number unequal to haploid set. There may be nullesomy, monosomy or polysomy.

Polysomy is the presence of extra-chromosomes. Genotype of polysomic organisms is the following: *2n+1* (trisomy); *2n+2* (tetrasomy); *2n+3* (pentasomy). The most well-known chromosomal disorders caused by **autosomal trisomy** are: **Patau's syndrome** (47, XX or XY, +13); **Edward's** syndrome (47, XX or XY, +18); **Down's s**yndrome (47, XX or XY, +21).

Polysomy in sex chromosomes are: **super-female syndrome** (47, XXX; 48, XXXX; 49, XXXXX); **super-male syndrome** (47, XYY; 48, XYYY; 49, XYYYY); **Klinefelter's syndrome** (47, XXY; 48 XXXY; 49, XXXXY).

Monosomy is the presence of only one copy of homologous chromosomes ***(2n-1)***. **Monosomy** in humans is lethal, except **Shereshevsky-Turner's syndrome (45, XO).**

Nullisomy is absence of the pair of homologous chromosomes ***(2n-2)***. In humans it is lethal.

Haploidy is the state of **haploid (n**) set of chromosomes. In majority of animals haploidy is lethal.

Chromosomal aberrations (structural chromosomal mutations) is a reorganization of chromosomal material.

M. Deletion - absence of a chromosomal segment.
N. Duplication - doubling of chromosomal segment.
O. Inversion – 180^0 rotation of chromosomal segment
P. Translocation - transfer of chromosomal segment to another chromosome.

Chromosomal aberrations result in chromosomal disorders. 21 to 15 translocation causes translocation type of Down's syndrome. Another example is «cat cry syndrome» - deletion of the short arm of 5^{th} chromosome. (46, XX or XY del 5^-).

Gene mutations are the changes of gene (DNA) structure.

There are: deletion of nucleotide, insertion of nucleotide, substitution of nucleotides, rearrangement of DNA segments.

single gene disorders: haemophylia, sickle cell anaemia, phenylketonuria,

Mutations are spontaneous or induced.

Spontaneous mutations occur due to natural reasons as a result of replication errors. Induced mutations are induced artificially by mutagenic agents: physical, chemical and biological ones.

Task 1. Compare the various characteristics of variation between modifications and mutations by marking "+" and "-".

Characteristics	Modification	Mutation
Inheritable		
Reversible		
Adaptive		
Individual		
Unidirectional		
Occurs in group		

Task 2. Define, which disorders are the examples of modifications and mutations by marking "+" in appropriate column.

Disease	Modification	Mutation
Scurvy		
Albinism		
Vitamin-D-resistant rickets		
Vitamin-D-deficient rickets		
Down's syndrome		
Fetal alcohol syndrome		
"Cat cry" syndrome		
Tick-born ecephalitis		

Task 3

Type of the cells	**Action of the external factors**	**Influence on the viability**	**Changes in hereditary material**
A **B**	**A** **B**	**A** **B** **C** **D**	**A** **B** **C**

Task 4. Give the different types of mutations according to changes in hereditary material

	Gene	Structural chromosomal aberrations	Numerical chromosomal aberrations (genome)
Level of the mutation			
Mechanisms	a)	a)	a) b)

	b) c) d) e)	b) c) e)	1. 2. 3. - - -
Examples of the diseases			

Task 5. Fill the table.

Disease	Karyotype	Number of		Type of mutation
		Autosomes	Heterosomes	
Healthy woman				-
Healthy man				-
Down's syndrome				
Edward's syndrome				
Patau's syndrome				
"Cat cry" syndrome				
Turner's syndrome				
Klinefelter's syndrome				
"Super-female" syndrome				
"Super-male" syndrome				

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. Endemic goiter is common in some geographical regions as a result of low iodine in diet. This is example of

A. Gene mutation
B. Recombination
C. Modification
D. Structural chromosomal aberration
E. Numerical chromosomal aberration

2. Patient has rare hereditary disorder, which has been never observed in family history. What is the primary underlying defect of the disease?

A. Failure of meiotic division in parents
B. Unfavorable environmental conditions
C. Mosaicism
D. Monosomy of somatic cells

3. In human DNA adenine was replaced by cytosine. What type of mutation took place?

A. Gene mutation

B. Deletion
C. Polyploidy
D. Translocation
E. Inversion

4. Replacement of nucleotides in DNA results in
A. Single gene disorders
B. Chromosomal disorders
C. Anomaly of autosomes
D. Anomaly of sex chromosomes

5. Two nucleotides in DNA molecule were lost after X-ray irradiation. It is an example of following mutation:
A. Deletion
B. Duplication
C. Inversion
D. Translocation
E. Replication

6. Intake of talidomid by pregnant women in fiftieth led to the birth of thousands children with congenital defects of skeleton (absence of limbs). This congenital defect is a result of
A. Modifications
B. Trisomy
C. Monsomy
D. Triploidy
E. Gene mutation

7. Woman who was sick with rubella during the pregnancy gave birth to the deaf child with hare lip and cleft palate. This congenital defect is an example of
A. Phenocopy
B. Edward's syndrome
C. Genocopy
D. Patau's syndrome
E. Down's syndrome

8. Woman who was sick with toxoplasmosis during the pregnancy has child with multiple congenital defects. It is a result of
A. Cancerogenesis
B. Teratogenesis
C. Biological mutogenesis
D. Chemical mutogenesis
E. Recombination

9. Sickle cell anemia is common hereditary disease in South Africa. Main symptom of the disease is a crescent shape of RBC because of replacement of glutamin by valin. The underlying defect of hereditary material is
A. Gene mutation
B. Structural chromosomal defect
C. Crossing over
D. Numerical chromosome mutation
E. Recombination

10. Girl with blue eyes has brown spot in the right iris. It is a result of
A. Genome mutation
B. Chromosomal aberration
C. Somatic mutation
D. Gene mutation
E. Germ mutation

11. Patient with mosaic type of Down's syndrome has about 50% cell with normal karyotype and 50% cell with trisomy 21. Disease is a result of mistake in
J. First meiotic division
A. Second meiotic division
B. Mitosis
C. Amitosis
D. Endomitosis

12. After X-ray irradiation segment of DNA molecule turns around and joins in reverse direction. It is
A. Inversion
B. Deletion
C. Duplication
D. Translocation
E. Replication

13. There are three copies of 13 chromosome in the karyotype of the child with multiple congenital defects. Type of the mutation is
A. Polyploidy
B. Trisomy
C. Nullesomy
D. Monsomy
E. Chromosomal aberration

14. Chromosome has following linear order of genes ABCDEHKTM. After the mutation there is a following order of genes CDEHKTM. Type of the mutation is
A. Inversion
B. Deletion
C. Duplication

D. Translocation
E. Monosomy

15. Cytogenetic studying of aborted embryo showed 45 chromosomes, one copy of third chromosome. Type of the mutation is
A. Chromosomal aberration
B. Point mutation
C. Nullesomy
D. Polysomy
E. Monosomy

16. Gene mutation causes following changes in hereditary apparatus
A. Number of the chromosomes in diploid set
B. Number of the haploid sets
C. Structure of the chromosome
D. Structure of the gene
E. Number of the genes

17. Polyploidy is one of the genome mutations. It is
A. Structural changes of the chromosomes
B. Duplication of chromosome part
C. Increase in the entire haploid sets of the chromosomes
D. Decrease in the entire haploid sets of the chromosomes
E. Abnormal number of the chromosomes in diploid set

18. Mutagenic effect have factors of different nature. Chemical mutagen is
A. Water
B. Ethyl alcohol
C. Nicotine
D. Colchicine
E. Sodium chloride

19. Amniocentesis showed, that karyotype of the fetus is 45, XO. Diagnosis is
F. Turner's syndrome
A. Edward's syndrome
B. Patau's syndrome
C. Cat cry syndrome
D. Super female syndrome

20. Down's syndrome is the most common chromosomal disease in humans. Underlying chromosomal defect is
A. Trisomy X
B. Trisomy 13
C. Trisomy 18
D. Trisomy 21
E. Polysomy Y

21. Mutagenic effect has factors of different nature. Biological mutagen is
A. Helminthes
B. Bacteria
C. Viruses
D. Toxoplasma

22. Example of the disease that develops as a result of gene mutation is
A. Hemophilia
B. Patau's syndrome
C. Cat cry syndrome
D. Down's syndrome
E. Klinefelter's syndrome

23. Aborted embryo has 69 chromosomes. It is an example of
A. Haploidy
B. Polyploidy
C. Trisomy
D. Monosomy
E. Duplication

Practical class 14. Methods of human genetics. Pedigree, twins, cytogenetic, population-statistic methods. Biochemical method and DNA-diagnostic.

The Purpose of the Lesson. To study basis of medical genetics. Man as a specific subject of genetic analysis. Methods of human heredity studying. Genealogic methods. Rules of pedigree composition. Pedigree analyses. Twins method. Detection of the genotype and environment influence on the manifestation of pathological characters in humans. Dermatoglyphic, immunological methods and hybridization of somatic cells. To study classification of hereditary disorders in humans. Chromosomal diseases caused by quantitative or qualitative chromosomal aberrations; mechanisms of

its formation. Cytogenetic methods. Karyotyping. Analysis of karyotypes of patients with hereditary disorders. Detection of X and Y-chromatin as method of diagnosis of chromosomal disorders.

TOPIC CONTENT

1. Human as a subject of genetics.
2. Genealogy. Stages of genealogical method.
3. Genetic symbols. Rules of pedigree construction.
4. Main characters of autosome-dominant, autosome-recessive, linked with X-chromosome (dominant and recessive), linked with X-chromosome, linked with Y-chromosome (holandric) types of inheritance.
5. Practical importance of genealogic method.
6. Peculiarities of mono- and dizygote twins' formation. Concordance and disconcordance of twin pairs.
7. Usage of twins method. Determine the coefficient of inheritance and environmental influence for a development of a character by Holtzenger's formulas.
8. Classification of cytogenetic methods? Their clinical importance.
9. Caryotyping method, its sense and technique.
10. The nature and mechanism of X-sexual chromatin formation. Hypothesis of M.Layon.
11. Amniocentesis, indications, its terms and techniques, possible complications.
12. Main chromosomal disorders of human, their cytogenetic diagnostic.

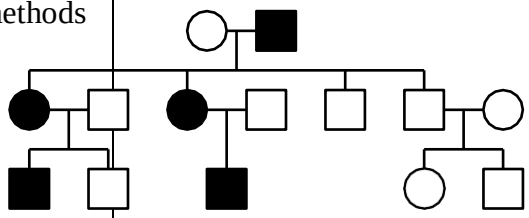
1.

TEST QUESTIONS FOR INDIVIDUAL WORK

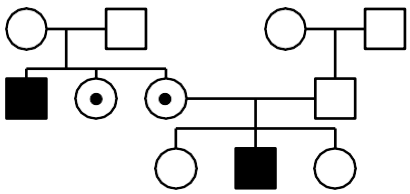
	Questions	Answers
1	What are the stages of genealogical method? a,b,c	
2	How dod we term a person whose pedigree is composed?	
3	What are the rules of pedigree charting? a,b,c,d.	
4	What are the main goals of usage of the genealogical method? a,b,c.	
5	What are the characters of types of inheritance: - Autosome-dominant one – a,b,c; - Autosome-recessive one – a,b,c; - Linked with X-chromosome dominant one – a,b,c; - Linked with X-chromosome recessive one – a,b,c; - Linked with Y-chromosome – a.	
6	Twins method uses for accounts roles of … and … in manifestation of characters.	
7	Monozygote twins are formed as a result of fusion of … and … following … .	
8	Monozygote twins are characterized by … a,b,c.	
9	Dizygote twins are formed as a result of fusion of … and … .	

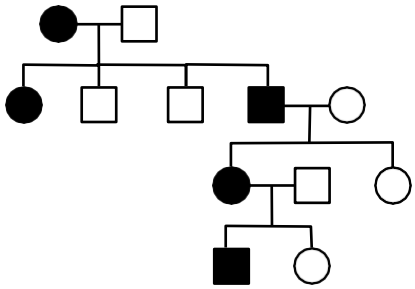
10	Dizygote twins are characterized by … a,b,c.	
11	Write formulas for counting of coefficient of: 1) pair concordance (Kn) - ; 2) role of heredity (H) - ; 3) role of environment influence – (C).	

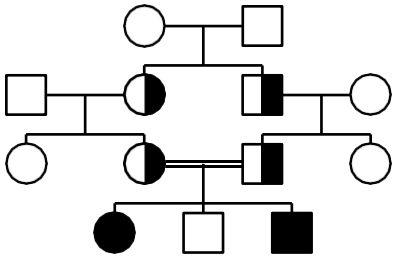
	Questions	Answers
1	Repeat topic 1.4 “Morphology of chromosomes. Human karyotype.”	
2	When was the Norman human karyotype studied?	
3	What are the cytogenetic methods? a,b.	
4	What are the main indications for karyotyping?	
5	For chromosomes indication the following methods are used: 1) Quantitative morphmetric analysis: a) Measuring of … of chromosomes; b) Accounting of … index; c) The method of … chromosome.	
6	Centromeric index is relation of a length of … arm to the length of … .	
7	Which mutations can be determined by karyotyping? a,b.	
8	Sex chromatin is … .	
9	Which chromosome disorders are determined by studying of 1) X-sex chromatin – a,b,c; 2) Y-sex chromatin – a.	
10	Which cytogenetic methods are used for prenatal (before delivery) diagnostic of chromosome disorders? a,b	
11	Which material of an embryo is taken during: 1) Amniocentesis – a; 2) Choriocentesis – a; 3) Cordocentesis – a.	
12	Which material of an embryo are concerned with a disorder of number of 1) autosomes – a,b,c; 2) heterosomes – a,b,c,d.	
13	Which types of mutations are the reasons of the main forms of Down syndrome? a,b	



Task 1. Recognize the modes of inheritance.







Task 2. Solve the problems, using twins method

2.1 There are 100 pairs of dizygotic (fraternal) twins in population, 3 pairs among them are concordant in clubfoot. Among 40 pairs of monozygotic (identical) twins 12 pairs are concordant in clubfoot. Calculate the coefficient of concordance for fraternal and identical twins and coefficient of heredity and environment.

2.2 Calculate the heritability for following features. Make a conclusion about influence of heredity and environment on manifestation of the character.

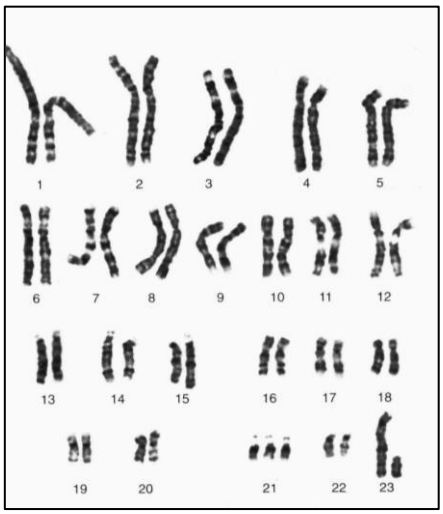
Trait or disease	Concordance rate		Heritability
	MZ twins	DZ twins	
Height	0.94	0.44	
IQ	0.76	0.51	
Tumors of the same type	0.59	0.24	
Appendicitis	0.29	0.16	
Diabetes mellitus (type1)	0.84	0.37	
Endemic goiter	0.71	0.7	
Schizophrenia	0.86	0.14	
Tuberculosis	0.69	0.25	

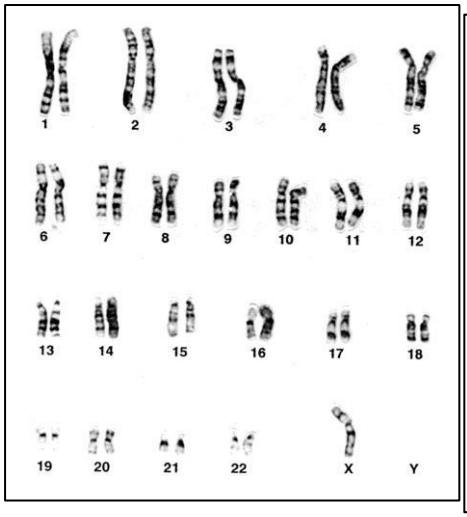
TASK 4. Analyze photokaryogrammes of healthy people and patients with different chromosomal disorders. Write down cytogenetic methods for diagnostic of these disorders.

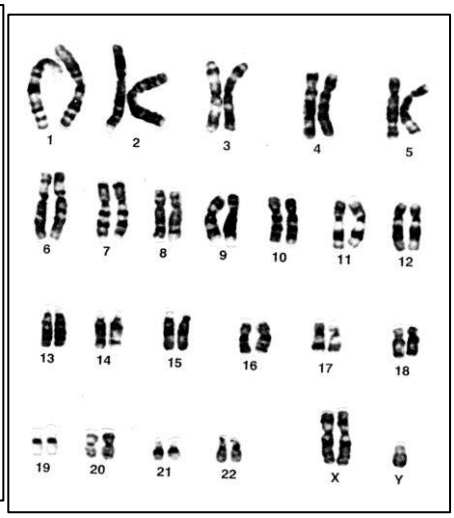
syndrome	*Type of mutation*	*Method of diagnostic*		*Result of examination*	
		karyotyping	*Sex chromatin detection*	*Probable karyotypes*	*Number of Barr bodies in nuclei*
Healthy woman	–				
Healthy man	–				
Disorders of autosomes					
Patau's syndrome					
Edward's syndrome					

Down's syndrome					
Cri du chat" syndrome					
Disorders of heterosomes					
Shereshevsky-Turner's syndrome					
"superfemale" syndrome (polysomy X)					
Klinefelter's syndrome					
"super male" syndrome (polysomyY)					

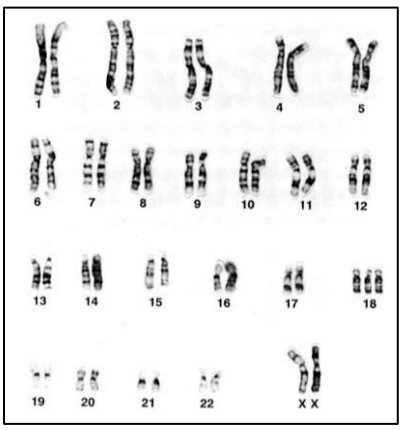
TASK 5. Detect different chromosomal disorders by analyzing karyograms.

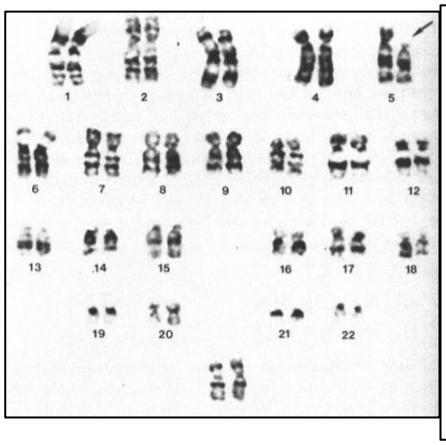


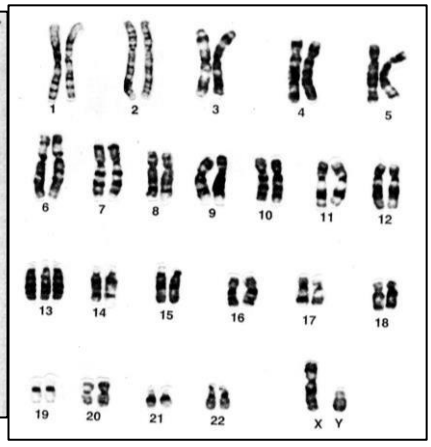




A_____ **B**_____ **C**_____







D_____ **E**_____ **F**_____

7. Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. Pedigree analysis is the method of medical

genetics used for
A. Studying of gene frequency in population
B. Detection of the pattern of inheritance of the character
C. Diagnosis of chromosomal disorders
D. Detection of the role of genetics and environment in manifestation of the character
E. Diagnosis of inborn error of metabolism

2. A person whose pedigree is composed is termed as
A. Proband (propsitus)
B. Sibling
C. Patient
D. Donor
E. Recipient

3. Sibling is
A. Person whose pedigree is composed
B. Brother or sister of the proband
C. Parent of the proband
D. Child of the proband
E. Affected individual

4. Autosomal dominant pattern of inheritance is characterized by following feature
A. Vertical inheritance of the character
B. Both men and women are affected
C. At least one of the parents of affected child is affected
D. There is a 50% risk to have affected child if one of the parents is affected and homozygous and another one is healthy
E. All of the above

5. Autosomal recessive pattern of inheritance is characterized by
A. Small number of affected individuals
B. Horizontal transmission of the disease
C. Healthy parents of affected child are heterozygous carriers of the mutant gene
D. Chance to have a healthy child for heterozygous couple is 75%.
E. All of the above

6. Analysis of the pedigree of the family with hypertrichosis of auricles showed that character in all generations is transmitted from father to all of the sons. Pattern of inheritance of this character is
24. Y-linked
25. Autosomal recessive
26. Autosomal dominant
27. X-linked recessive
28. X-linked dominant

7. Pedigree of the family demonstrates the affected individuals of both sexes in each generation. It is typical for following pattern of inheritance
Y-linked
Autosomal recessive
Autosomal dominant
X-linked recessive
X-linked dominant

8. Yong healthy couple has two children with Tey-Sacks disease (storage disorder with accumulation of lipids). It was cleared that parents are consanguineous. What is the most possible pattern of inheritance of the disease?
Q. Y-linked
R. Autosomal recessive
S. Autosomal dominant
T. X-linked recessive
U. X-linked dominant

9. A healthy couple has came for medical genetic counseling as they are cousins. What type of single gene disorder is most possible to manifest in their children?
– Y-linked
– Autosomal recessive
– Autosomal dominant
– X-linked recessive
– X-linked dominant

10. Healthy woman has affected sons with same hereditary disorder in her two marriages. Both of her husbands are healthy. What is the most possible pattern of inheritance of the disease?
– Y-linked
– Autosomal recessive
– Autosomal dominant
– X-linked recessive
– X-linked dominant

11. Pedigree of the family with brachidactyly is characterized by following: ratio between affected males and females is 1:1; chance to have an affected child is 50% if one of the parents is affected heterozygote. What is the pattern of inheritance of this character?
A. Y-linked

B. Autosomal recessive
C. Autosomal dominant
D. X-linked recessive
E. X-linked dominant

12. Healthy woman is the carrier of color blindness. Her husband is healthy. What is the risk to have an affected child in this family?
A. 0%
B. 25% of all children
C. 50% of the sons
D. 50% of all children
E. 75% of all children

13. Pedigree of the several families with deafness is characterized by following features: parents of the affected children are healthy; both sexes are equally affected; ratio between healthy and affected children in families is about 3 : 1. What is the pattern of inheritance of this disease?
6. Y-linked
7. Autosomal recessive
8. Autosomal dominant
9. X-linked recessive
10. X-linked dominant

14. Family is characterized by hereditary deafness transmitted in generations. Which method helps to detect the pattern of inheritance of the disease?
A. Genealogic
B. Twins method
C. Cytogenetic
D. Population statistic
E. Biochemical

15. Twins method of human genetics is the method of
A. Diagnosis of chromosomal disorders
B. Diagnosis of inborn errors of metabolism
C. Detection of the pattern of inheritance
D. Detection of the influence of genotype and environment on the character
E. Calculation of genes frequency in population

16. Monozygotyc twins are those who
A. Develop from different fertilized ova
B. Have same genotype
C. Are of the same or different sex
D. Share 50% of genes
E. All of the above

17. Dizygotic twins are those who
A. Develop from two fertilized ova
B. Have different genotypes
C. Are of the same or different sex
D. Share 50% of genes
E. All of the above

18. If H(coefficient of heredity) is 100% character
A. Equally depend on the genotype and environment
B. Depend on genotype only
C. Depend on environment only
D. Depend on the environment but influenced by genotype
E. Depend on genotype but influenced by environment

19. If H (coefficient of heredity) is 0 % character
A. Equally depend on the genotype and environment
B. Depend on genotype only
C. Depend on environment only
D. Depend on the environment but influenced by genotype
E. Depend on genotype but influenced by environment

20. If H (coefficient of heredity) is 55 % character
A. Equally depend on the genotype and environment
B. Depend on genotype only
C. Depend on environment only
D. Depend on the environment but influenced by genotype
E. Depend on genotype but influenced by environment

21. If H (coefficient of heredity) is 30% character
A. Equally depend on the genotype and environment
B. Depend on genotype only
C. Depend on environment only
D. Depend on the environment but influenced by genotype
E. Depend on genotype but influenced by environment

1. What karyotype abnormality have persons with Shereshevsky-Turner syndrome?
A. Absence of one X chromosome
B. Absence of one 2 Ist chromosome
C. Absence of one 15st chromsome
D. Extra 21st chromosome
E. Extra 18st chromosome

2. Parents are healthy. Amniocentesis with further karyotyping showed that fetal karyotype is 47,XX, +21. What chromosomal disease has the fetus?
A. Shereshevsky-Turner's syndrome
B. Edward's syndrome
C. Down's syndrome
D. Cat cry syndrome
E Superfemale syndrome

3. Parents are healthy. Amniocentesis with farther karyotyping showed that fetal karyotype is 45, XO. What chromosomal disease has the fetus?
A. Shereshevsky-Turner's syndrome
B. Edward's syndrome
C. Down's syndrome
D. "Cri de chat" syndrome
E. "Superfemale" syndrome

4. Karyotype of the tall young man with behavioral problems is 47, XYY. Diagnosis is
A. "Supermale" syndrome
B. Patau's syndrome
C. Klinefelter's syndrome
D. Shereshevsky-Turner's syndrome
E. Edward's syndrome

5. Diagnosis of Shereshevsky Turner's syndrome is made by
A. Twins method
B. Pedigree analysis
C. Population statistic method
D. Biochemical method
E. Cytogenetic method

6. In the epithelial cells of the male patient are two Barr bodies. It indicates the following syndrome
A. Shereshevsky-Turner syndrome
B. Klinefelter's syndrome
C. Patau's syndrome
D. Superfemale" syndrome
E. Supermale" syndrome

7. Which chromosomal disease in males is characterized by one drumstick in the nucleus of the neutrophile leukocytes?
A. Shereshevsky-Turner's syndrome
B. Down's syndrome
C. Klinefelter's syndrome
D. Superfemale" syndrome
E. "Supermale" syndrome

8. By detection of Barr bodies is possible to diagnose
A. Patau's syndrome
B. "Cri de chat" syndrome
C. Shereshevsky-Turner's syndrome
D. Edward's syndrome
F. Down's syndrome

9. Which of the following is the result of abnormal number of autosomes?
A. Klinefelter's syndrome
B. Down's syndrome
C. "Superfemale" syndrome
D. Shereshevsky-Turner's syndrome
E. Hemophilia

10. Forensic expert has made a conclusion that the blood spots at the place of crime belong to the woman. Which blood component has been studied?
A. Blood plasma
B. Blood serum
C. Platelets
D. RBC
E. Leukocytes

11. The karyotype of patient with Down's syndrome is
A. 7,+13
B. 47,+18
C. 47,+21
D. 47, XXX
E. 47,XXY

12. Chromosomal disease because of abnormal sex chromosome number in females is
A. Shereshevsky-Turner's syndrome
B. Edward's syndrome
C. Patau's syndrome
D. Klinefelter's syndrome
E. Down's syndrome

13. Chromosomal disease because of abnormal sex chromosome number in males is
A. Shereshevsky-Turner's syndrome
B. Edward's syndrome
C. Patau's syndrome
D. Klinefelter's syndrome
E. Down's syndrome

14. Person with 47, XXY karyotype has
A. Shereshevsky-Turner's syndrome
B. Edward's syndrome
C. Patau's syndrome
D. Klinefelter's syndrome
E. Down's syndrome

15. Person with 45, XO karyotype has
A. Shereshevsky-Turner's syndrome
B. Edward's syndrome
C. Patau's syndrome
D. Klinefelter's syndrome
E. Down's syndrome

16. Diagnosis of Edward's syndrome is made by
A. Twins method
B. Pedigree analysis
C. Population statistic method
D. Biochemical method
E. Cytogenetic method

17. Diagnosis of hemophilia, phenylketonuria, diabetes mellitus is made by
A. Twins method
B. Pedigree analysis
C. Population statistic method
D. Biochemical method
E. Cytogenetic method

18. What is the set of X chromosome if there are two Barr bodies in the cell
A. XXX
B. XX
C. XO
D. XXXX
E. XY

19. How many Barr bodies are in the cell of the patient with Shereshevsky-Turner's syndrome?
A. 0
B. 1
C. 2
D. 3
E. 4

20. How many Barr bodies are in the cell of the patient with Klinefelter's (XXY) syndrome?
A. 0
B. 1
C. 2
D. 3
E. 4

21. How many Barr bodies are in the cell of the patient with "superfemale" syndrome?
A. 0
B. 1
104
C. 2
D. 3
E. 4

22. How many Barr bodies are in the cell of the patient with "supermale" syndrome?
A. 0
B. 1
C. 2
D. 3
E. 4

23. How many X chromosomes has woman if there is one drumstick in her leukocytes.
A. XX
B. XXX
C. XY
D. XXY
E. XO

24. Woman has short stature, webbing of neck, underdeveloped secondary sex characters and infertility. What is the suspected diagnosis?
A. Shereshevsky-Turner's syndrome
B. Edward's syndrome
C. "Superfemale" syndrome
D. Klinefelter's syndrome
E. Down's syndrome

25. A person with chromosomal disorder has balanced translocation of long arm of 21st chromosome to 22. What disease is of high risk in his children?
A. Shereshevsky-Turner's syndrome
B. Edward's syndrome
C. Patau's syndrome
D. Klinefelter's syndrome

E.Down's syndrome

26. Man with high stature has three bodies of Y chromatin in the nucleus. What syndrome he has?
A.Shereshevsky-Turner's syndrome
B."Superfemale" syndrome
C."Supermale" syndrome
D.Klinefelter's syndrome
E.Down's syndrome

27. Detection of X-chromatin in somatic cells is used for the quick diagnosis of hereditary diseases associated with a change in the sex chromosome number. Vast majority of a man's cells have three X-chromatin bodies. What is the man's karyotype?
A. 46, XY
B. 48, XXXY
C. 47, XXY
D. 49, XXXXY
E. 45, X

28. A child presents with body shortness, mental deficiency, mongoloid palpebral fissures, epicanthal fold, enlarged grooved tongue protruding from the mouth, high palate, maldentition, diastema, cross striation of lips. What hereditary disease are this presentation typical for?
A. Patau's syndrome
B. Turner's syndrome
C. Klinefelter's syndrome
D. Edward's syndrome
E. Down's syndrome

29. An18-year-old boy applied to a geneticist. The boy has asthenic constitution: narrow shoulders, broad pelvis, nearly hairless face. Evident mental deficiency. The provisional diagnosis was Klinefelter's syndrome. What method of clinical genetics will enable the doctor to confirm this diagnosis?
A. Genealogical
B. Populational-statstic
C. Dermatoglyphics
D. Twin study
E. Cytogenetic

30. According to the phenotypic diagnosis a female patient has been provisionally diagnosed with X-chromosome polysomia. This diagnosis can be confirmed by a cytogenetic method. What karyotype will allow to confirm the diagnosis?
A. 47, XXX
B. 48, XXXY
C. 46, XX
D. 47, XXY
E. 48 XXYY

Materials for self-control of mastering knowledge and skills provided by this work: tests from the data base of the licence exam Krok-1 (http://kroktest.org.ua/).

Main literature

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Additional literature

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2. Campbell biology / Lisa Urry, Michael Cain, Steven Wasserman, [et al.].– 11th rectricted ed. – Hoboken : Pearson Higher Education, 2016. - 560 pp.

3. Chiodini P. L. Atlas of Medical Helmintology and Protozoology 4th ed. – Churchill Livingstone, 2003. 87 pp.

4. Peter Turnpenny, Sian Ellard. Emery's Elements of medical genetics.-15th ed.,– Elsevier, 2017. 400 pp.

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9. David. T. John, William A. Petri. Markell and Voge's Medical parasitology. – 9th ed. – Elsevier, 2017. 463 pp.

10. M. R. Speicher, S. E. Antonarakis, F. G. Motulsky. Vogel and Motulsky's human genetics. Problems and approaches.- 4th ed. – Springer, 2010. 981 pp.

11. Young Ian. D. Medical genetics. – 2nd ed. – Oxford university press, 2010. 304 pp.

13. Information resources:

1. Testing Center - the base of licensing test tasks "Krok" - 1: http://testcentr.org.ua/
2. OMIM (Online Mendelian Inheritance in Man) – An Online Catalog of Human Genes and Genetic Disorders http://omim.org/
3. The tech interactive: https://genetics.thetech.org/genetics-news
4. Phys.org internet news portal provides the latest news on science. https://phys.org/biology-news/
5. Sci-News.com provides the latest science news from around the world, covering breaking news in astronomy and astrophysics, archaeology, paleontology, medicine, biology, physics, genetics & morehttp://www.sci-news.com/news/biology
6. link to the most thought-provoking, well researched online items in the world of science and technologyhttps://scitechdaily.com/news/biology/
7. Web atlas of medical parasitology http://www.atlas.or.kr/about/index.html

Module section 4. Medical and biological basics of parasitology. Medical protozoology and helminthology

Practical class 15. Protozoa. Disenteric amoeba, Balantidium, giardia lamblia, trychomohas, malaria parasites, toxoplasma.

The Purpose of the Lesson. To study principles of classification of the parasites. Principles of parasite-host interaction. Morphophysiological adaptations of the parasites. Typical features of protists. To study Sarcodina. Dysenteric amoeba (Entamoeba histolytica). Infusoria. Balantidium. Geographical distribution, morphofunctional peculiarities, life cycles of dysenteric amoeba, balantidium. Ways of infection, laboratory diagnosis and prophylaxis of amebiasis, balantidiasis. Geographical distribution, morphology, life cycle of lamblia? trichomonas. Ways of infection, laboratory diagnosis and prophylaxis of lambliosis, urogenital trichomoniasis. To study geographical distribution, morphofunctional peculiarities, life cycles of malaria parasites. Ways of infection, laboratory diagnosis and prophylaxis of malaria. Methods of laboratory diagnosis of diseases caused by protists. To study geographical distribution, morphofunctional peculiarities, life cycles of toxoplasma. Ways of infection, laboratory diagnosis and prophylaxis of toxoplasmosis.

TOPIC CONTENT

1. General characteristic of Protozoa's.
2. General characteristic of class Sarcodina. Free-living and parasitic amoebas.
3. Ways of infecting of human with dysenteric amebiasis. Localization of dysenteric amoeba in human organism, its pathogenic importance.
4. Laboratory diagnostic and prevention of amebiasis.
5. Peculiarities of structure of balantidium, its pathogenic importance.
6. Laboratory diagnostic and prevention of balantidiasis.
7. Characteristics of Flagellates.
8. Lamblia. Peculiarities of morphology and cycle of development, localization, ways of invasion, methods of laboratory diagnostic and prevention of lambliose.
9. Trichomonas. Peculiarities of morphology and cycle of development, localization, ways of invasion, methods of laboratory diagnostic and prevention of urogenital trichomonose.
10. Biological peculiarities of Apicomplexa on an example of malarial plasmodiums.
11. Life cycle of Plasmodium vivax. Phenomenon of change of hosts, stages of parasite's development.
12. Ways of invasion of human by Pl. vivax,
13. Laboratory diagnostic and prevention.
14. Main morphological characters and life cycle of Toxoplasma.
15. Ways of invasion of toxoplasmosis.
16. Pathogenic influence of Toxoplasma on human organism. Congenital and acquired toxoplasmosis.
17. Ways of laboratory diagnostic and prevention of toxoplasmosis.

TEST QUESTIONS FOR INDIVIDUAL WORK

	Questions	answers
	What are the main characters of Sarcodina? 1)2)3)4)5) Which Sarcodina species are human parasites? **Dysenteric amoeba:** 1) Latin name: 2) the name of disease; 3) forms-1,2,3; 4) localization in human organism -1; 5) invasive stage -1;	

	6) the way of invasion -; 7) mechanic carriers are -1,2; 8) pathogenic effect-1; 9) laboratory diagnostic -1,2; 10) prevention –private -1,2,3,4; social -1,2. What are the characters of **forma minuta**: 1) size, mm -; 2) localization -; 3) feeding -; 4) meaning- . A person in which organism forma minuta has its inhabitance is named … What are the characters of **forma magna**: 1)size-; 2) localization -: typical – 1; out of intestine – 1; 3) pathogenic (nonpathogenic) -1. What is the difference between dysenteric and intestinal amoebas? What is the medical importance of free-living amoebas Negleria and Acantamoeba? What are the main characters of infusorias: 1)2)3)4)5)6) **Balantidium**: 1) Latin name: 2) the name of disease; 3) forms-1,2,3; 4) localization in human organism -1; 5) invasive stage -1; 6) the way of invasion -; 7) mechanic carriers are -1,2; 8) pathogenic effect-1; 9) laboratory diagnostic -1,2; 10) prevention –private -1,2,3,4; social -1,2. Why balantidiasis is concerned professional disease? 1.	

	Questions	Answers
1	Parasite is ...	
2	Definite host is ...	
3	Intermediate host is ...	
4	Reservoir host is ...	
5	Invasion is ...	
6	Invasive stage is ...	
7	Specific carriers are ...	
8	Mechanical carriers are ...	
9	What are the ways of transmission of parasitic diseases? 1)2)3)4)5)	

10	Antroponoses are ...	
11	Antropozoonoses are ...	
12	Transmissive diseases are ...	
13	Natural-focal diseases are ...	
14	What are the components of natural focus? 1)2)3)4)	
15	What are the characters of Flagellates? 1)structure-l ; 2)movement -1); 3) feeding -1); 4) Multiplication -1, 2.	
16	Lamblia: 1)Latin name-l ; 2) disease -1; 3) peculiarities -; 4) localization in human organism -1; 5)invasive stage -1; 6) a way of invasion -1. 7) pathogenic influence -1,2; 8) laboratory diagnostic -1; 9)prevention - personal -1,2; social -1,2.	
17	Trichomonas vaginalis : 1)Latin name-l ; 2) disease -1 ; 3) peculiarities -; 4) localization in human organism -1 ; 5) invasive stage -1; 6) way of invasion -1. 7) pathogenic influence -1,2; 8) laboratory diagnostic -1; 9)prevention - personal -1,2; social -1, 2.	
18	What are the other types of trichomonas-human parasites?	
19	Dermatotropic leishmanias: 1)Latin name-I; 2) disease -1; 3) localization in human organism -1; 4)forms -1,2; 5) way of invasion -1. 6) reservoir hosts -1,2,3,4; 7) their transmitter -1 ;	
20	Viscerotropic leishmanias: 1) Latin name-I; 2) disease -1; 3) localization in human organism -1; 4) way of invasion -1. 5) their transmitter -1,2;	

21	African trypanosomes: 1)Latin name-I; 2) disease -1; 3) localization in human organism -1; 4) way of invasion -1. 5) their transmitter is;	
22	Southern American trypanosomes: 1)Latin name-I; 2) disease -1 ; 3) localization in human organism -1,2,3; 4) natural reservoir hosts in human organism-I,2,3; 5) transmitters of trypanosomes are ...	

	Questions	Answers
1	Which species of plasmodiums are pathogenic for human?	
2	What are the hosts for Malarial Plasmodiums: 1) definite host -1; 2) intermediate host -1.	
3	Which type of carrier for Plasmodium (mechanical or specific) is female Anopheles?	
4	What are the possible ways of human invasion with malaria? 1,2,3.	
5	Human is infected with Malaria when …goes into his blood.	
6	What are the stages of Plasmodium's life cycle? 1,2,3	
7	Where does tissue (preerythrocytic) shisogonia take place in human organism? 1.	
8	What are the stages of plasmodium's development in human liver? 1,2	
9	What are the stages of Plasmodium development in human erythrocytes? 1,2,3,4,5	
10	How long is erythrocytic shisogonia in different species of Plasmodium? 1) Pl. vivax -1; 2) Pl.ovale -1; 3) Pl. malariae -1; 4) Pl. falciparum -1.	
11	Female of Anopheles is invaded with malaria when … goes into its blood. What are the stages of Plasmodium's life cycle in female Anopheles -1, 2? How can you explain high temperature	

	during the malaria attack? What are the stages of Malarial fever? What are the ways of laboratory diagnostic of Malaria? 1,2,3 What are the ways of Malaria prevention? 1) private 1,2; 2) social-1, 2.	
12 13 14		
	QUESTIONS	ANSWERS
1	What are the hosts of Toxoplasma: 1) definite hosts – 1; 2) intermediate hosts -1,2,3.	
2	What is localization of Toxoplasma in human and animal organisms? 1,2,3,4	
3	What is endozoit: 1) shape -1; 2) size (mkm)-1; 3) number of nuclei -1; 4) meaning of conoid -1.	
4	Pseudo cyst is …	
5	True cyst (…) is …	
6	What are the ways of human invasion by Toxoplasma:	
7	What are the ways of Toxoplasma's excretion from thick animal's organisms?	
8	1)with secrets -1,2,3,4; 2) with excretes -1,2.	
9	What is a way of Toxoplasma reproduction in intermediate hosts? 1.	
10	Which stage of Toxoplasma is stored in healthy carries? 1.	
11	How can definite hosts be invaded with Toxoplasma? 1,2 What are the stages of Toxoplasma development in Cat's organism?	

Way of invasion	Factors of invasion	Stages of invasion

Stage of development	Tissues, organs	Forming stage

12		

13 What are the forms of toxoplasmosis? 1,2

14 What are the characters of acute acquired toxoplasmosis? 1,2,3

What are the results of congenital toxoplasmosis in a case of invasion of pregnant woman:

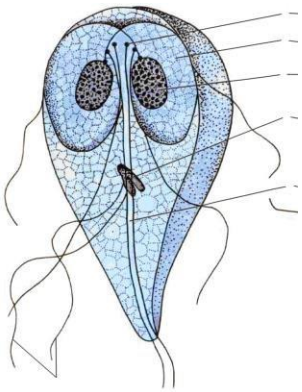
During the first months of pregnancy	During the last period of pregnancy
15	16

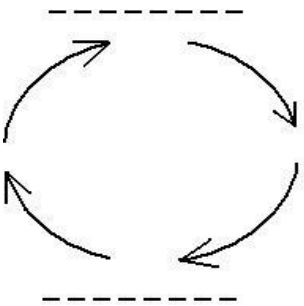
What are the methods of laboratory diagnostic of toxoplasmose?1,2,3,4,5

What are the ways of prevention of toxoplasmosis?

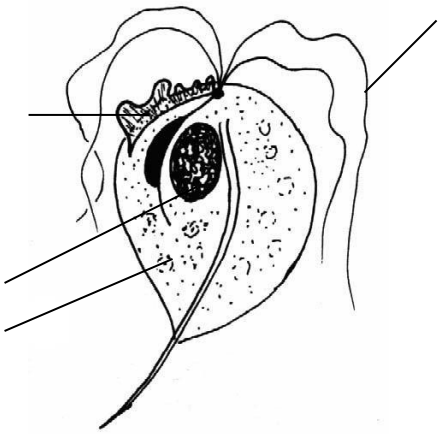
1) private -1,2,3,4;
2) social -1,2.

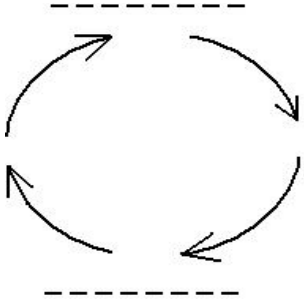
1. Study the structure of Lamblia under a microscope. Label the morphological peculiarities: nucleus, sucking disk, axostyle, flagellae. Sketch a scheme of Lamblia's life cycle.



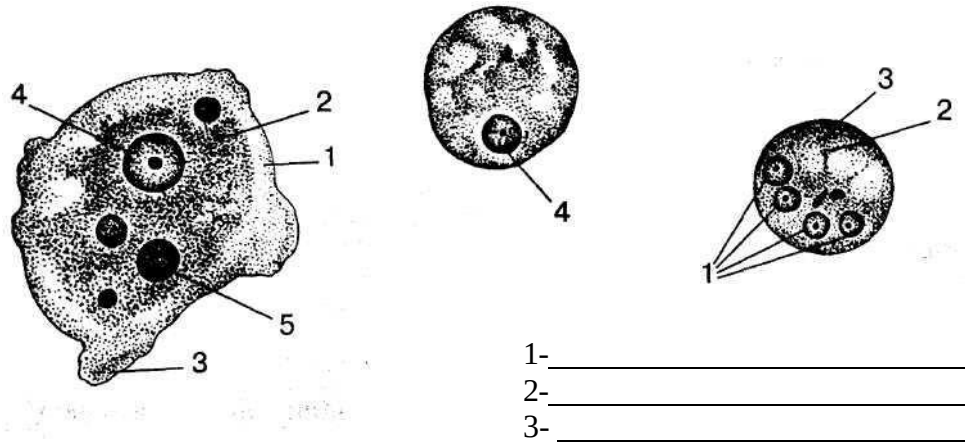


2. Study under a microscope a Trichomonas vaginalis in vaginal smear**.** Label the peculiarities of trophozoit's structure: flagella, undulating membrane, nucleus, axostyle. **S**ketch the life cycle of Trychomonas vaginalis.



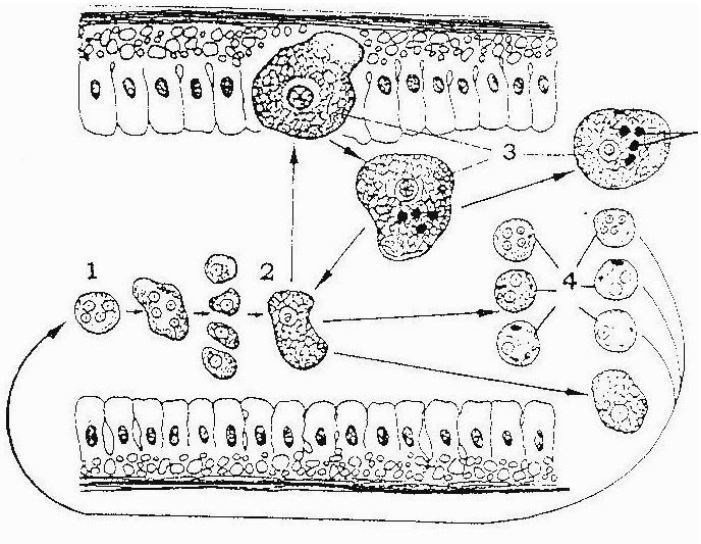


3. Study the trophozoites and cysts of dysenteric amoebae.



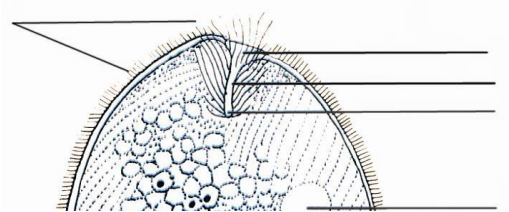
1-_____
2-_____
3- _____
4-_____
5-_____

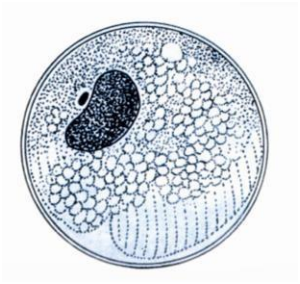
4. Study a life cycle of dysenteric amoeba. Name the forms and processes.



1 – _____
2 – _____
3 – _____
4 – _____

5. Study the trophozoite and cyst form of balantidium





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Materials for self-control of the training quality

A. Tests for self-control with standard answer.

Choose the correct answer.

1. For a humans is pathogenic the following form of Entomoeba histolytica:
a. Forma magna
b. Forma minuta
b. Cyst
d. Spore
e. Pre-cystic form

2. Forma minuta inhabits:
a. Gall bladder
b. Stomach
c. Large intestine lumen
d. Large intestine wall
e. Small intestine

3. Which material is used for balantidiasis laboratory tests?
a. Duodenum content
b. Blood
c. Feces
d. Urine
e. Vaginal discharges

4. Entamoeba histolytica is characterized morphologically by:
a. Pear-shaped body, all organoids paired, 4 pairs of flagella
b. Spindle-shaped body, one flagella, undulating membrane
c. Body shape is inconstant, 3 to 4 flagella
d. Spindle-shaped body covered with pellicle, one nucleus
e. Body shape is inconstant, covered with thickened membrane, one nucleus

5. Cysts of the following Protozoans could be discovered in feces:
a. Entamoeba histolytica
b Trichomonas hominis
c. Entamoeba gingivalis
d. Balantidium coli
e. Trichomonas vaginalis

6. Balantidium coli vegetative form is characterized by ALL mentioned below except:
a. Flagella
b. Two contractive vacuoles
c. Cytostoma and cytopharynx
d. Macro- and micronuclei
e. Covered by cilia

7. Amoebiasis is characterized by ALL mentioned below EXCEPT:
a. Entamoeba histolytica is an agent
b. Cyst carriers might be healthy
c. Fecal-oral mode of transmission
d. Flies and cockroaches are mechanical vectors
e. Vector born diseases

8. Number of nuclei in cyst of amoeba is an important criterion in discrimination between Entamoeba histolytica
and_____

a. Trichomonas hominis
b. Giardia lamblia
c. Entamoeba coli
d. Entamoeba gingivalis
e. Balantidium coli

9. Entamoeba coli is:
a. Agent of amoebiasis
b. Non-pathogenic
c. Agent of trichomoniasis
d. Agent of sleeping sickness

10. Laboratory tests for amoebiasis include:
a. Serological tests
b. Microscopy of feces
c. Microscopy of blood
d. Skin-allergic tests
e. Microscopy of duodenum content

11. Preventive measures against amoebiasis include ALL mentioned below EXCEPT:
a. Sanitary control of water supply
b. Keeping rules of personal hygiene
c. Mosquito control
d Identification and treatment of cyst carriers
e. Identification and treatment of sick

12. In water samples from the pig farm sewage rounded cysts with two nuclei, covered with thickened envelope were discovered. These are:
a. Giardia cycts
b. Amoeba cycts
c. Balantidium coli cycts
d. Leishmania cycts
e. Trichomonas cysts

13. Direct infection from the sick person is possible for:
a. Amoebiasis
b. Malaria
c. Leishmaniasis
d. Trypanosomosis
e. Balantidiasis

14. Inflammation of large intestine could be caused by:
a. Entamoeba histolytica
b. Entamoeba gingivalis
c. Entamoeba coli
d. Giardia lamblia
e. Trichomonas vaginalis

15. Human large intestine inhabit following parasites:
a. Giardia lamblia
b. Trichomonas vaginalis
c. Balantidium coli
d. Leishmania
e. Trypanosoma

16. Entamoeba gingivalis is:
a. Amoebiasis agent
b. Balantidiasis agent
c. Dental caries agent
d. Giardiasis agent
e. Non-pathogenic

17. Which of the mentioned below is an infective stage of Entamoeba histolytica?
a. Forma magna
b. Forma minuta
c. Cyst
d. Spore
e. Vegetative form

1. Which parasites from mentioned below inhabit human small intestine:
A. Balantidium coli;
B. Giardia lamblia;
C. Trichomonas vaginalis;
D. Leischmania
E. Entamoeba histolytica.

2. Giardia lamblia is characterized by all mentioned below, EXCEPT for:
A. Has several flagellae;
B. Inhabits duodenum;
C. Secrets proteolytic enzymes;
D. Exists in the form of cyst and vegetative form;
E. Affects primarily children.

3. Giardia lamblia inhabits:

A. Large intestine;
B. Stomach;
C. Bile bladder;
D. Duodenum;
E. Liver.

4. Which form of Giardia lamblia is infective for the human being:
A. Vegetative form;
B. Sporocyst
C. Sporozoit;
D. Cyst;
E. Pseudocyst

5. Morphologically Trichomonas vaginalis is characterized by:
A. Spindle-shaped body with one flagella and undulating membrane;
B. Pear-shaped body, paired organelles;
C. Pear-shaped body with axostyle and undulating membrane;
D. Spindle-shaped body with numerous flagella;
E. Unsteady body shape.

6. The ability of the parasites to produce harmful effect and to cause a disease is a:
A. Pathogenicity;
B. Mutualism;
C. Parasitism;
D. Preying;
E. Commensalism.

7. Sexual transmission is possible in:
A. Giardiasis;
B. Toxoplasmosis;
C. Trichomonosis;
D. Leischmaniasis;
E. Trypanosomosis.

8. Pear-shaped Protozoans with 5 flagella and undulating membrane are discovered in urine sample. These are:
A. Giardia;
B. Trichomonas;
C. Trypanosoma;
D. Leischmania;
E. Toxoplasma.

Preparation for practical class **16. Flat worms. Liver fluke, cat (Siberian) fluke and lung fluke.**

The Purpose of the Lesson. To study geographical distribution, morphofunctional peculiarities, life cycle of liver fluke (fasciola), cat fluke (Opisthorchis felineus), lung fluke (Paragonimus). Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis.

TOPIC CONTENT

1. Main morphological characters of Flat worms.
2. Morphology and life cycles of trematods.
3. Liver fluke: morphology, life cycle, ways of infection, pathogenic action, laboratory diagnosis, prevention.
4. Cat fluke: morphology, life cycle, ways of infection, pathogenic action, laboratory diagnosis, prevention.
5. Lung fluke: morphology, life cycle, ways of infection, pathogenic action, laboratory diagnosis, prevention.

	QUESTIONS	ANSWERS
1	Biohelminthes are	

2	Geogelminthes are	
3	Give the general characteristics of flukes a) body shape; b) body cavity; c) body wall d) digestive system e) excretory system f) nervous system g) female reproductive system h) male reproductive system	
4	Are all of the flukes hermaphrodites?	
5	Describe the trematode type of the development	
4	Which larvae is in the egg of the fluke?	
5	Which larvae develop inside the intermediate host?	

Complete the table

Latin name	Location in definitive host	Intermediate hosts	Stages of the development	Infective for the definitive host
Liver fluke				
Cat fluke				
Lung fluke				

Complete the table

	Name of the disease	Infective for the intermediate hosts	Source of infection	Laboratory diagnosis	Prevention
Liver fluke					
Cat fluke					
Lung fluke					

F. Phylum: Plathelminthes
G. Class: Trematodes
H. Species: Fasciola hepatica (the liver fluke),
Opisthorchis felineus (the cat fluke),

Clonorchis (Op. sinensis (the Chinese liver fluke),
Paragonimus ringeri (the lung fluke),
Schistosoma haematobium (the blood fluke),
S. japonicum, S. mansoni

Parasitic worms are **helminthes,** diseases are **helminthoses**.

Flatworms includes flukes (class Trematodes) and tapeworms (class Cestodes). All of them are biohelminthes.

Biohelminthes are worms that have definitive and intermediate hosts. Adult worms live and multiply sexually in the organism of **definitive host.** Larvae develop in the organism of **intermediate host**.

Class trematodes

Trematodes have flat leaf-like body. They have oral and ventral suckers for fixation. Flukes are hermaphrodites.

All flukes are biohelminthes.

Life cycle of Trematodes (trematode type of development):

1. **Adult worms produce eggs (ova). Eggs of trematodes are operculated.**
2. Th**e eggs get into water** were **miracidium** (Ist larva) hatches out**.**
3. **Miracidium** get into **intermediate host - freshwater snail (mollusk).**
4. Inside snail the **miracidium** transform into **sporocyst**, than **rediae** and **cercariae.**
5. **Cercariae come out** from mollusk and form **metacercariae,** which are **infective for definitive host. In some species metacercariae develop on water plants (adolescariae) and definitive host gets the desease with water plants. In other species cercariae get into second intermediate host. In this case definitive host gets the disease by eating meat of intermediate host with metacercariae**.

Fasciola hepatica

Fasciola hepatica or Liver fluke is an agent of fascioliasis.

Morphology. The adult worm is leaf-shaped, 30 mm long. The eggs are about 140 □m in size.

Life cycle. **Definitive hosts are herbivorous animals - sheep (main reservoir host), cattle, pigs, horses and sometimes humans.**

Intermediate host is **snail.**

Location on organism of definitive host. **Bile ducts (liver) of the definitive host.**

Man gets the disease trough water or water vegetation with adolescaria. Parasites become mature in 3-4 month.

Pathogenicity. Fasciola causes mechanical injury of the liver and **jaundice, hepatomegaly,** then **liver fibrosis and cancer**. Metabolic products of the helminthes cause **toxic-allergic reactions**.

Diagnosis. Demonstration of the e**ggs (ovoscopy) in feces or bile.**

Prophylaxis: to **boil water and to wash vegetables.**

Opistorchis felineus

Opistorchis felineus (cat fluke) and **Clonorchis sinensis** (Chinese or Oriental liver fluke) are the agents of **opistorchiasis** and **clonorchiasis**. Opistorchis species resemble C. sinensis by morphology, life cycles and medical aspects, but have different geographical distribution.

***Morphology*.** The body is 8-13 mm long.

Life cycle. Development is in 3 hosts - one definitive and 2 intermediate hosts. Definitive hosts are humans, cats, dogs, rats, pigs. ***Location*** in the organism of definitive host is the bile ducts, gall bladder, pancreatic ducts

I intermediate host is **snail**, II – **fish.** Metacercarium develops inside the fish **Infection occurs through row fish with metacercarium Parasite** live from 1 to 20 years.

Pathogenicity. Clinical manifestations is same as in fascioliasis.

Diagnosis Ovoscopy of feces or bile. Serologic tests at early stage of infection.

Prophylaxis: to cook fish properly.

Paragonimus ringeri

Paragonimus ringeri (westermani) or **lung fluke** is the agent of **paragonimiasis.**

Location. Typical location is the **lungs;** sometimes **liver, spleen, intestine, muscles, brain,** etc.

Life cycle. It passes its life cycle in **3 hosts: 1 definitive and 2 intermediate hosts. Definitive hosts are humans, dogs, cats, pigs and rodents. Intermediate host is fresh water snail**. **II host is fresh water crayfish or crab**.

The definitive host gets the disease by ingestion of raw or undercooked crayfish or crabs with metacercariae.

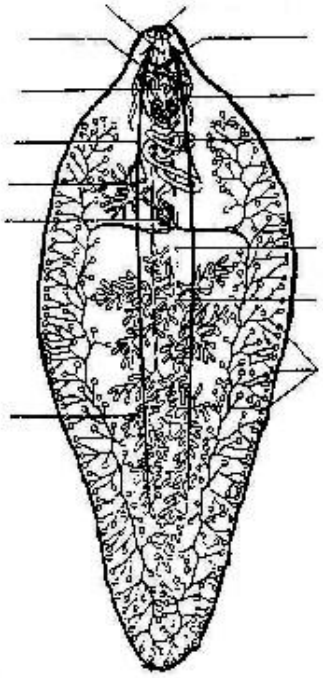
***Pathogenicity*.** A patient have **cough and blood** streaked **sputum, chest pain**. A clinical and radiological picture of chronic infection **resembles tuberculosis**.

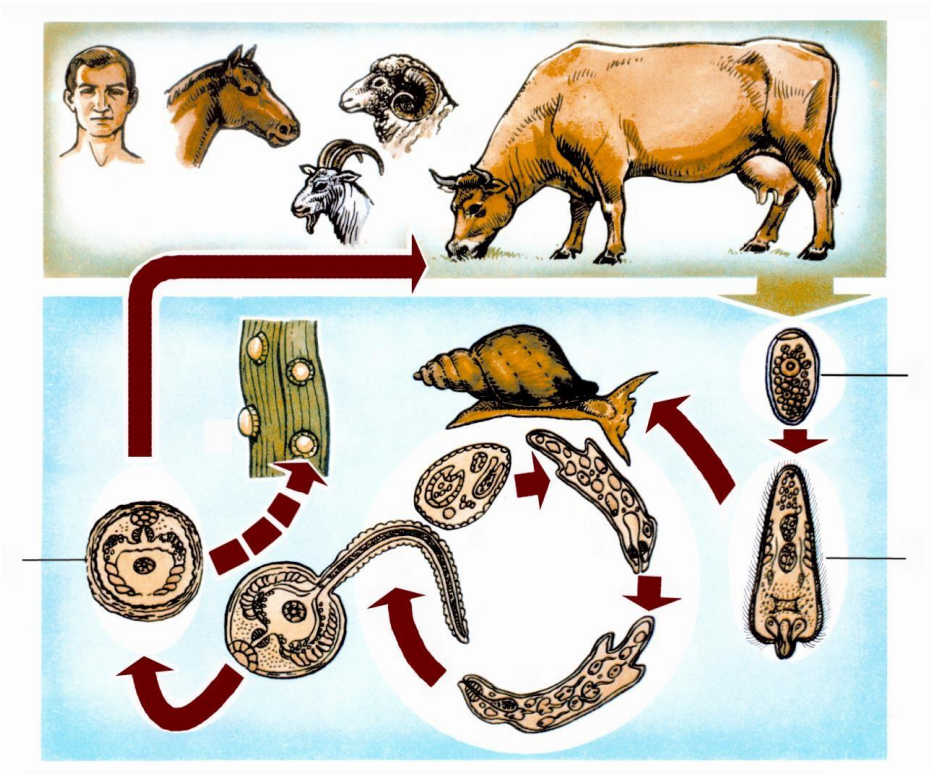
***Diagnosis.* eggs are found in sputum or feces** (ovoscopy). Serologic tests at early stage of the disease.

Prophylaxis: Personal prevention is adequate cooking of crabs and crayfish.

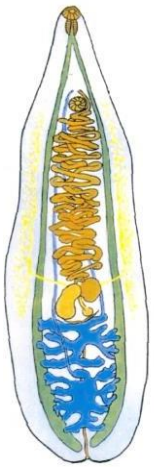
Task 1. Study under a microscope an adult form and an egg of liver fluke.

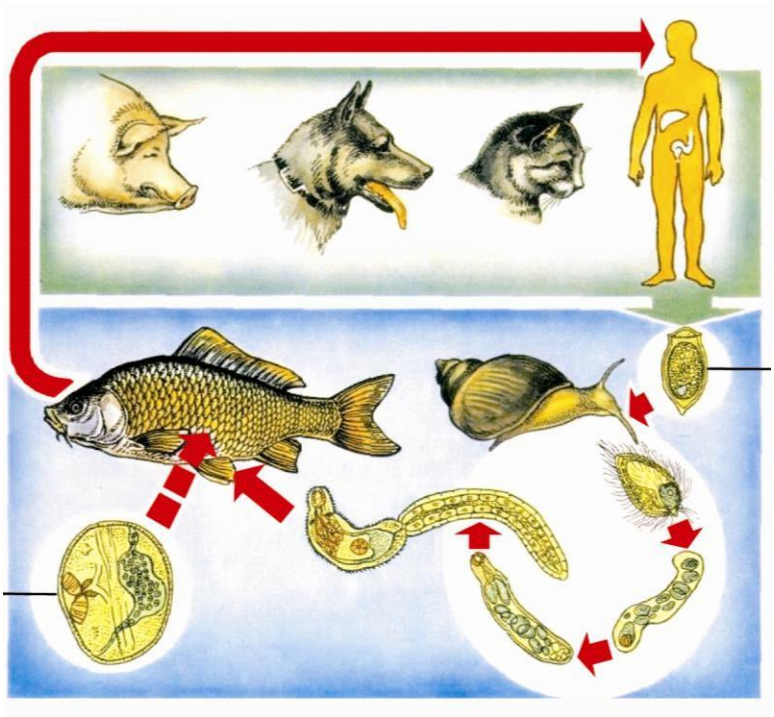
Pay attention to the shape and structure reproductive system, to shape and structure of the eggs.Study a life cycle of liver fluke development. Point out: egg, miracidium, sporocyst, redia, cercaria, adolescaria, marita of Fasciola.



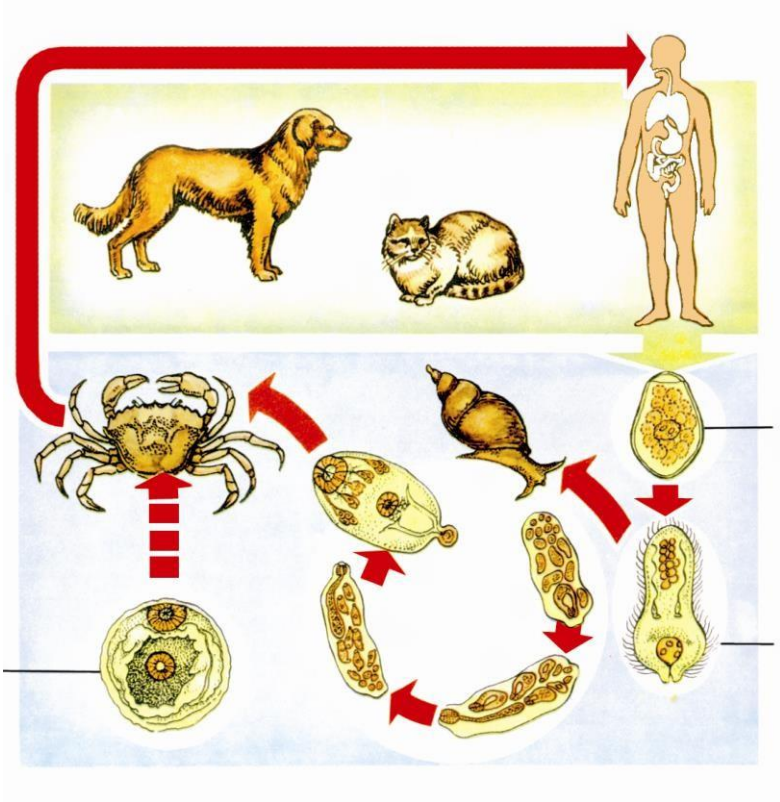


Task 2. Study under a microscope an adult form and an egg of Chinese liver fluke. Label definitive and intermediate hosts and stages of development.





Task 3. Study under a microscope an adult form and an egg of lung fluke. Label definitive and intermediate hosts and stages of development.



A. Multiple choice questions (Choose one correct answer)

1. Bile ducts and gull bladder in human are inhabited by:
a. Blood fluke
b. Beef tapeworm
c. Cat's fluke
d. Lung fluke
e. Ascaris

2. Blood vessels in human may be inhabited by:
a. Paragonimus westermanii
b. Opisthorchis felineus
c. Schistosoma haematobium
d. Fasciola hepatica
e. Dicrocoelium lanceatum

3. Human may got infected by lung fluke by:
a. Eating improperly cooked fish
b. Eating unwashed vegetables;

c. Improperly cooked crabs and crawfish
d. drinking unboiled water
e. Eating beef

4. In sputum smears from pneumonic patient eggs of helminthes were discovered. These are egg of:
a. Fasciola hepatica;
b. Opisthorchis felineus
c. Schistozoma haematobium
d. Paragonimus ringeri
e. Enterobius vermicularis

5. The following stage of liver fluke is infective for a human:
a. Egg
b. Sporocyst
c. Redia
d. Cercaria
e. Adolescaria

6. The following stage of cat fluke is infective for a human:
a. Egg
b. Sporocyst
c. Redia
d. Cercaria
e. Metacercaria

7. Paragonimus ringeri inhabits:
a. Blood vessels
b. Liver
c. Lungs
d. Muscles
e. Duadenum

8. Fasciolosis is caused by:
a. Liver fluke
b. Blood fluke
c. Lung fluke
d. Cats' fluke
e. Dicrocoelum

9. Human may get fasciolosis:
a. By drinking non-flitered contaminated water
b. By eating crabs and crawfish
c. By eating fish
d. While bathing in ponds and lakes
e. Via blood-sucking insects

10. Fill in gap: clinical manifestation of _____ is quite close to tuberculosis manifestation:
a. Opisthorchosis
b. Paragonimosis
c. Schistosomosis
d. Fasciolosis
e. Dicrocoeliosis

11. Laboratory diagnosis of fasciolosis is based on:
a. Muscles biopsies examination
b. Feces ovoscopy
c. Serologic tests
d. Sputum microscopy
e. Urine microscopy

12. Laboratory diagnosis of paragonimosis is based on:
a. Serologic tests
b. Urine microscopy
c. Sputum microscopy
d. Perianal mucous microscopy
e. Muscles biopsy examination

13. Preventive measures against opistorchosis include:
a. Washing hands;
b. Washing fruits and vegetables;
c. Patients isolation
d. Consuming well-done fish only;

e. Mechanical carriers extermination

14. Human may get cats fluke infection by eating:
a. Fish
b. Crawfish and crabs
c. Unwashed vegetables
d. Pork
e. Beef

15. Person complains of periodical vomiting, and stomachache. Liver is enlarged and dense. Microscopic examination of feces demonstrates large oval-shaped operculated eggs (140x80 μm in size). What disease may be suspected?
a. Ascariasis
b. Opistorchosis
c. Fasciolosis
d. Paragonimosis
e. Schistosomosis

16. Laboratory test for opisthorchis is:
a. Muscles biopsy
b. Serologic tests
c. feces microscopy
d. Sputum microscopy
e. Urine microscopy

17. Abdominal veins may be inhabited by:
a. Fasciola
b. Opisthorchis
c. Paragonimus
d. Schistozoma
e. Dicrocoelium

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13. Information resources:

8. Testing Center - the base of licensing test tasks "Krok" - 1: http://testcentr.org.ua/
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13. link to the most thought-provoking, well researched online items in the world of science and technologyhttps://scitechdaily.com/news/biology/
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***Preparation for practical class* 17. Tape worms. Beef, pork, dwarf worms, echinococcus, broad tapeworm.**

The Purpose of the Lesson. To study geographical distribution, morphofunctional peculiarities, life cycle of pork tapeworm, beef tapeworm, dwarf tapeworm. Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis of teniasis, cysticercosis, teaeniarhynchosis.

To study geographical distribution, morphofunctional peculiarities, life cycle of broad tapeworm, Echinococcus, Alveococcus. Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis

TOPIC CONTENT

1. Peculiarities of life cycles of tape warm.
2. Peculiarities of tape worms in their parasitic life.
3. Structure and life cycle of beef worm.
4. Structure and life cycle of pork worm.
5. Auto invasion. Cysticercosis.
6. Laboratory diagnostic of teniose, teniarhinhose, cysticercose.
7. Prevention of teniose, teniarhinhose, cysticercose.
8. Echinococcus granulosus. Peculiarities of structure, life cycle, ways of invasion, laboratory diagnostic, prevention of echinococcosis.
9. Diphyllobothrium latum. Peculiarities of structure, life cycle, ways of invasion, laboratory diagnostic, prevention of diphyllobothriosis.

	questions	answers
	Characterize adult tape worm: 1) body shape; 2) body parts -1,2,3; 3) organs of fixation on scolex-1,2,3; 4) neck is …; 5) types of proglottides -1,2,3. First larva of tape worms is named … It develops inside … The peculiarity of oncosphere is … The second larva of Cestoidea is named … Cysticercus is an invasive stage for … host. **Beef (unarmed) worm:** 1) length of mature worm (m); 2) peculiarities of scolex; 3) peculiarities of hermaphrodite segment; 4) peculiarities of mature segment; 5) pathogenic effect -1,2,3; **Pork (armed)worm:** 1) length of mature worm (m); 2) peculiarities of scolex; 3) peculiarities of hermaphrodite segment; 4) peculiarities of mature segment; 5) a way of invasion of definite host; 6) duration of life in human organism; 7) methods of laboratory diagnostic –of teniose, cisticercose;	

	In which cases human can be intermediate host for pig worm? Characterize mechanism of auto invasion during teniose. What are manifestations of cisticercose: Why it's dangerous to prescribe drugs which can dissolve an envelope of pork tape worm for patients with teniose?	

Latin name	Name of the disease	Definitive host, location in definitive host	Intermediate hosts	Stages of the development
Pork tape worm				
Beef tape worm				

	Infective for the intermediate hosts	Infective for the definitive host	Mode of infection	Laboratory diagnosis	Prevention
Pork tape worm					
Beef tape worm					

peculiarities	Pock tapeworm	Beef tapeworm	Dog warm	Broad (fish) warm
Latin name				
disease				
Is it natural-focal disease?				
Geography of habitation				
Length of strobile				
Organs of fixation on scolex				
Number of proglottides				
Shape (type) Of uterus in mature segment				
eggs				
Type of larva				
Character of larva				
Biohelminth or geohelminth				

Definite host				
Localization in an organism of definite host				
Intermediate hosts				
Localization in an organism of intermediate host				
Invasive stage for human				
Way and mechanism of human invasion				
Duration of life in human organism				
Is human a biological stop?				
Possibility of human auto invasion and auto reinvasion				
Pathogenic influence				
Methods of laboratory diagnostic				
Ways of private prevention				
Social prevention				

Phylum:Plathelminthes
Class: Cestoidea
Subclass: Cestoda
Species: Taenia solium (Armed tapeworm or pork tapeworm)
Taeniarhynchus saginatus (Unarmed tapeworm or beef tape

Cestodes have

29. Segmented tape–like body.
30. The body has small head (scolex), a short neck and trunk or strobila, composed of segments (proglottids).
31. The reproductive system is hermaphrodite.
32. All tapeworms are biohelminths.

The eggs of Cestodes contain the first stage larva - oncosphere. Egg with oncosphere is an infective stage for the intermediate host.

Phynn is the infective stage for the definitive host. The adult worm or the larval form both can cause clinical disease. The diseases caused by tapeworms have a common name cestoidoses.

Armed or pork tapeworm (Taenia solium) is an agent of
taeniasis (adult worm) and cysticercosis (larva).

Location. The adult worm lives in the human small intestine,

Morphology. The adult worm is 2 to 3 meters long

The **ovary** consists of **3 lobes.**

The **mature uterus** in the gravid segments consists of **7-12 branches**.

Eggs of Taenia solium are oval or round in shape, transparent and colorless.

Phynn is of cysticercus

Life cycle. **Definitive host is human being.**

Intermediate hosts are pigs, sometimes human being, wild and domestic dogs, cats.

Human being can be infected through inadequately cooked measly pork.

Man can also be an intermediate host for solitary tapeworm:

V. most commonly by the accidental ingestion of eggs w**ith water or vegetables;**

W. by retrograde peristalasis the segments may be regurgitated in stomach causing **autoinfection.** Eggs are digested and thousands of eggs released. **External re-infection occurring from anus to fingers to mouth is also possible.**

Cysticerci can be in **brain, eyes, and subcutaneous tissue,** , **muscles**

Pathogenicity: Adult worm causes **taeniasis:** mechanical injuring of the intestinal mucosa, absorption of nutrients and formation of pathologic intestinal reflexes. The disease manifests as abdominal discomfort, alternating diarrhea and constipation, anemia, weakness, loss of weight, fatigue.

Cysticercus larvae in humans cause cysticercosis.: epilepsy, behavioral disorders, hydrocephalus and pareses.

***Laboratory diagnosis*:** helminthoscopy

The **diagnosis of cysticercosis** is done by **biopsy of the lesion, X-rays or CT scanning and immunodiagnosis (serologic tests).**

Prophylaxis:

Personal prevention is not to eat raw or partly cooked pork.

Control of the disease includes prevention of contamination of water and soil with human feces; adequate inspection of pork at slaughterhouses and markets; revealing and treatment of infected persons; health education.

Unarmed tapeworm or beef tapeworm (Taeniarhynchus saginatus) is the agent of **taeniarhynchiasis.**

Geographical distribution. Worldwide.

Location. The adult worm lives in the human small intestine.

Morphology. The adult worm is about 5 –12 m. Scolex is 1.5-2 mm equipped with 4 suckers. . **Ovary is composed of 2 lobes**.

The **uterus of the gravid segment has 17-35 branches.** The gravid segments are expelled singly and can crawl out of the anus, so the eggs are laid in the perianal skin.

Life cycle. The definitive host is human being, intermediate host is a cattle (cow, zebu, buffalo).

Humans are infected while eating undercooked beef with cysticerci ("measly beef").

Diagnosis: ***demonstration of*** *proglottids in feces or eggs in perianal scraping.*

Echinococcus granulosus is the causative agent of

echinococcosis (hydatid disease). The disease in humans is caused by larval stage of the parasite.

Geographical distribution. Worldwide. It is more prevalent in sheep and cattle raising regions with temperate climates.

Location. Hydatid cyst develops in human liver and lungs, brain, kidneys, pancreas, heart

Adult worm inhabits small intestine of the dogs.

Morphology. **The adult worm is 2-7 mm long.**

Eggs are spherical, 30 –40 μm in dogs feces

Phynn of echinococcus type (hydatid cyst) is shaped like a bladder filled with colorless toxic fluid with scolices Phynn grows in man about 5 cm a year

Life cycle is in 2 hosts. The **definitive host is a dog**

Intermediate hosts are most of mammals including sheep, cattle, goat, pigs, and man.

the eggs are passed out in the feces of the dog.

Human beings, sheep, cattle get the infection on ingestion of the eggs from contaminated food or water. Man often acquires the disease through d**irty hands after stroking infected dog**. **Eggs can be spread on grass** and then be transmitted **onto the sheep wool,** so infection may occur after **cutting the wool or its processing**.

The definitive hosts (dog, wolf) become infected while consuming the organs of animals with echinococcus cysts.

Pathogenicity

Clinical symptoms depend on the size and location of the cyst.

Diagnosis is done by **X-ray, ultra sound, CT methods, immunologic method (serologic tests)**.

Prophylaxis. Personal prevention is to wash hands after having touched dogs or taking care after sheep; to wash vegetables and fruit, boil water. Periodical deworming of guard and pet dogs is useful.

Diphyllobothrium latum (broad tapeworm) **is an agent of** diphyllobothriosis.

Geographical distribution. The disease occurs in central and northern Europe, North America, Siberia, Japan and Central Africa.

Location. **Adult worm inhabits the small intestine of man**

Morphology. It measures 2 to 20m (usually 2-9 m) in length Scolex is elongated, spoon-shaped, 5 mm in sizewith 2 grooves (bothria)

Eggs are widely oval, operculated, bile-stained, 68-75 μm.

Phynn is of plerocercoid type 1-5 cm in length.

Life cycle. **The definitive hosts are man** , cat, dog, pig, fox, bear.

The **I intermediate host is fresh ware minor crustacean – cyclops**,

II intermediate host is fresh water fish (pike, soodak, perch, trout)

Eggs are passed in **human feces**

The **I larval stage coracidium** develops in water environment during 3-5 weeks

It **must be ingested by** a **cyclop** and turns into a **procercoid**.

If a cyclop is ingested by a **fish, plerocercoid** phynn d**evelops in its muscles, liver and ovary**.

Human being becomes infected through undercooked fish or fresh caviar. Plerocercoid larva is infective stage. Phynn turns into the mature worm in the small intestine **2 months later**. **Life span is about 10 years.**

Diphyllobothriosis is a nature-foci disease in areas with rivers and lakes.

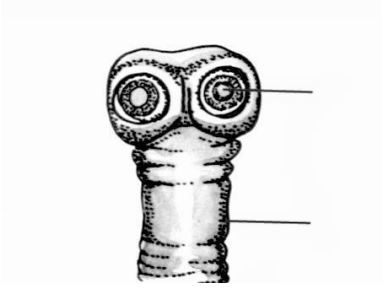
Pathogenicity. *the infection is **mostly asymptomatic.** The infected person may suffer from abdominal pain, diarrhea, fatigue, headaches and constant loss of weight.*

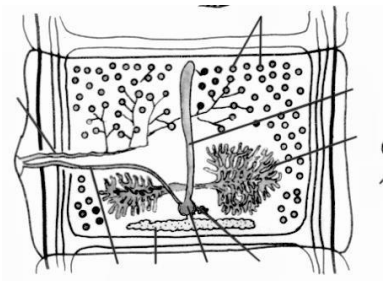
It causes the **diphyllobothric anemia**

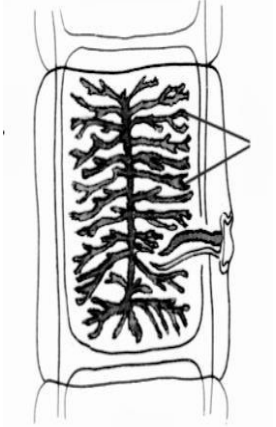
Diagnosis *is done by demonstration **of segments and eggs in stool**.*

Prophylaxis. **Personal prevention is to avoid eating raw or undercooked fish.**

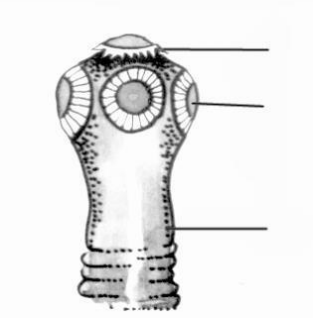
Task 3. Study under the microscope structure of scolex, mature and gravid proglottid of a beef tapeworm. Pay attention to suckers on the scolex, number of ovarian lobes in the mature segment, number of branches of the uterus in the gravid segment.

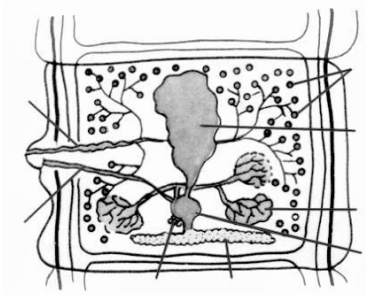


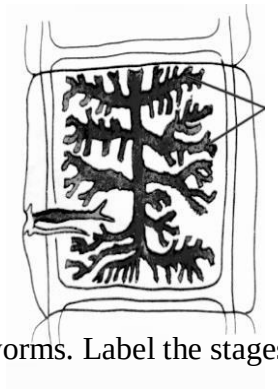




Task 4. Study under the microscope structure of scolex, mature and gravid proglottid of a pork tapeworm. Pay attention to suckers on the scolex, number of ovarian lobes in the mature segment, number of branches of the uterus in the gravid segment.

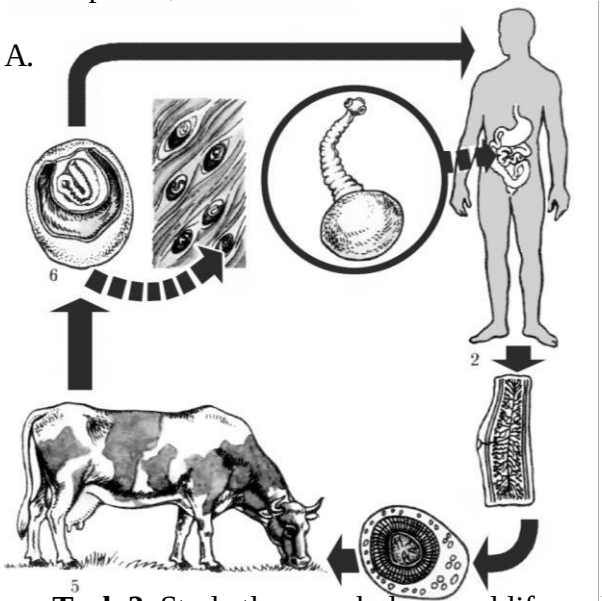




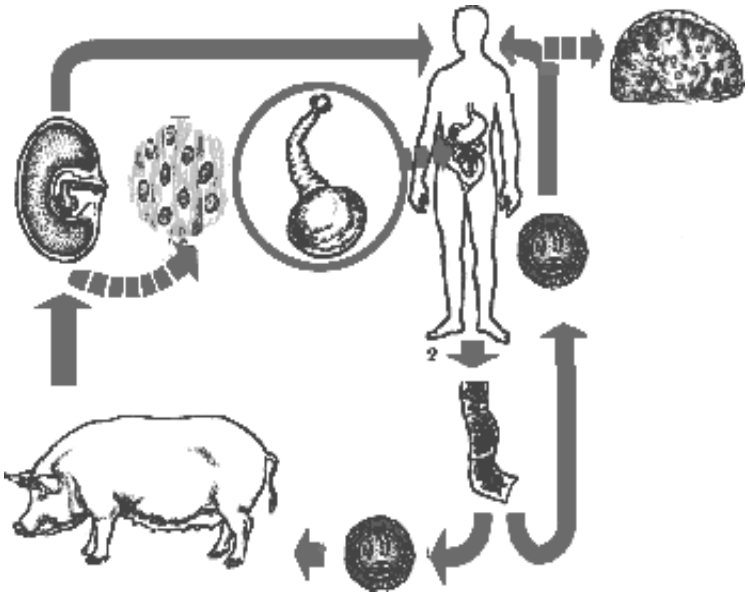


Task 5. Study a scheme of life cycles of beef (A) and pork (B) tapeworms. Label the stages of development, definitive and intermediate hosts.

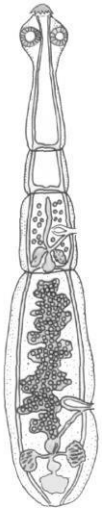
A.

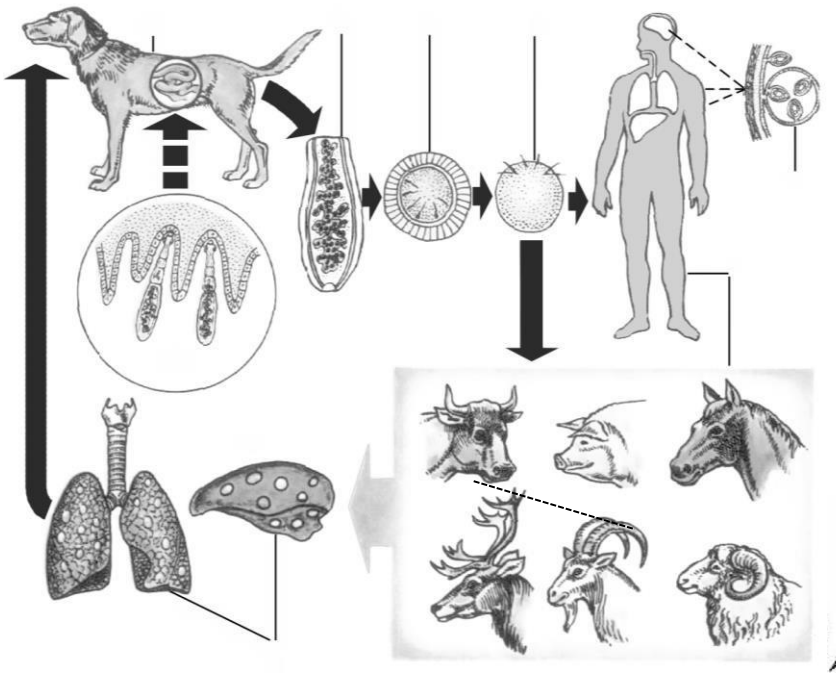


B.

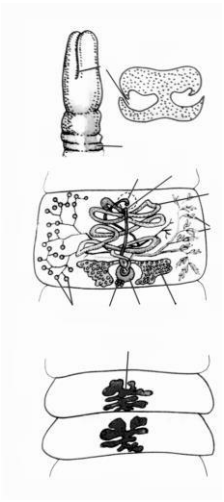


Task 3. Study the morphology and life cycle of dog tapeworm. Label the stages of development, structure of the echinococcus (hydatid) cyst, definitive and intermediate hosts.





Task 4. Study the morphology and life cycle of the broad tapeworm. Label the bothria on the scolex, uterus in the gravid proglottid, stages of development, definitive and intermediate hosts.



Student_____teacher_____date_____201_

ANSWER THE MULTIPLE CHOICE QUESTIONS

Tests for self-control with standard answer.

Choose the correct answer.

1. Unarmed tapeworm is an agent of:

a. Fasciolosis
b. Taeniasis
c. Paragonimosis

d. Taeniarhynchosis
e. Opistorchosis

2. Armed tapeworm is an agent of:
a. Opistorchosis
b. Fasciolosis
c. Taeniasis
d. Taeniarhynchosis
e. Paragonimosis

3. Armed tapeworm larvae are agents of:
a. Taeniasis
b. Taeniarhynchosis
c. Paragonimosis
d. Cysticercosis
e. Hymenolepidosis

4. Which of the following is an infective stage of a beef tapeworm?
a. Egg
b. Cysticercus
c. Cysticercoid
d. Echinococcus
e. Plerocercoid

5. Laboratory diagnosis of taeniasis is based on:
a. Demonstration of eggs in perianal mucus
b. Demonstration of proglottides in feces
c. Serum tests
d. Blood tests
e. Biopsy of muscular tissue

6. Which of the following may be regarded as taeniarhynchosis preventive measures?
a. Veterinary examination of pork
b. Boiling water
c. Keeping personal hygiene rules
d. Proper cooking fish
e. Proper cooking beef

7. White proglottides 20 x 7 mm in size, with a large number of uterus branches (20 to 34 branches) were discovered in feces. These may be proglottides of:
a. Fasciola hepatica
b. Opisthorchis felineus
c. Beef tapeworm
d. Pork tapeworm
e. Dwarf tapeworm

8. White proglottides 20 mm in length were discovered in feces. The number of uterus branches is 7 to 12. These may be proglottides of:
a. Armed tapeworm
b. Unarmed tapeworm
c. Dwarf tapeworm
d. Echinococcus
e. Alveococcus

9. The yellowish worm 2 meters in length was expelled with feces after treatment of the patient. Length of proglottides exceeds width. Scolex has four suckers and hooks. This worm may be identified as:
a. Beef tapeworm
b. Liver fluke
c. Pork tapeworm
d. Echinococcus
e. Dwarf tapeworm

10. Cysticercosis in human may result from:
a. Echinococcosis
b. Hymenolepidosis
c. Taeniasis
d. Taeniarhynchosis
e. Fasciolosis

11. By eating of pork which has not passed veterinary control is possible to get:
a. Taeniarhynchus saginatus
b. Echinococcus
c. Taeina solium
d. Fasciola hepatica
e. Opisthorchis felineus

12. Human may be infected with Taeniarhynchus saginatus by:
a. Contacts with cats
b. Consuming crabs and crawfish
c. Contacts with dogs
d. Eating contaminated beef
e. Eating contaminated pork

13. Which is a beef tapeworm infective stage for humans?
a. Egg
b. Cysticercus
c. Cysticercoid
d. Echinococcus
e. Plerocercoid

14. Laboratory diagnosis of a Beef tapeworm infection is based on:
a. Discovery of eggs in urine
b. Muscles biopsy
c. Discovery of proglottides in feces
d. Immunological tests
e. Blood tests

15. Which of the following may be regarded as taeniasis preventive measures:
a. Boiling water
b. Eating properly cooked fish
c. Veterinary examination of pork
d. Veterinary examination of beef
e. Keeping personal hygiene rules

16. Which of the following may be regarded as cysticercosis preventive measures:
a. Veterinary examination of beef
b. Keeping personal hygiene rules
c. Veterinary examination of pork
d. Eating properly cooked fish
e. Isolation of seek persons

17. Which of the following larvae may inhabit brain?
a. Beef tapeworm
b. Pork tapeworm
c. Dwarf tapeworm
d. Liver fluke
e. Cats fluke

18. Beef tapeworm infection may manifest by:
a. Disorders in digestion ;
b. Destruction of bile ducts c. Facial and eyelids edema
d. Anemia
e. Inflammation of appendix

1. Long fragments of segmented helminthes were discharged with feces after treatment of the patient. Width of proglottides exceeds their length. Rosette-like uterus is in the center of proglottide. These are fragments of:
a. Beef tapeworm
b. Pork tapeworm
c. Echinococcus granulosis
d. Dwarf tape worm
e. Broad tapeworm

2. It is possible to get infected with diphyllobotriosis by eating:
a. Crabs and crawfish
b. Unwashed vegetables
c. Improperly cooked meat
d. Improperly cooked fish
e. Contaminated water

3. What is the pathogenic action of dwarf tapeworm?
a. Liver, lungs and brain affection
b. Malignant anemia
c. Intestine villi destruction, intoxication
d. Anemia, neurological disorders, vermiform appendix inflammation
e. Eyelids and face edema, fever and muscle pain

4. Laboratory diagnosis of echinococcosis includes:
a. Immunological tests
b. Feces examination
c. Muscle biopsy
d. Urine ovoscopy

5. Which of the following is the Echinococcus infective stage for humans:
a. Egg
b. Plerocercoid
c. Metacercaria
d. Cysticercoid
e. Cysticercus

6. Laboratory diagnosis of diphyllobotriosis includes:
a. Feces examination
b. Urine ovoscopy

c. Immunological reactions
d. Muscle biopsy
e. Sputum microscopy

7. Which of the following refers to hymenolepidosis preventive measures:
a. Keeping personal hygiene rules
b. Consuming properly cooked fish
c. Consuming well-done meat
d. Veterinary control in markets and stores
e. Consuming properly cooked crabs and crawfish

8. Which of the following refers to echinococcosis preventive measures:
a. Veterinary control in markets and stores
b. Consuming properly cooked fish
c. Washing hands after touching and playing with dogs
d. Consuming well-done meat
e. Consuming properly cooked crabs and crawfish

9. Anemia due to the lack B12 vitamin is a symptom of:
a. Taeniasis
b. Taeriiarhynchosis
c. Hymenolepidosis
d. Echaiococcosis
e. Diphyllobotriosis

10. Malignant anemia may be caused by:
a. Beef tapeworm
b. Pork tapeworm
c. Broad tapeworm
d. Dwarf tapeworm
e. Echinococcus

11. Vermiform white colored larvae up to 6 mm in length with two grooves on the frontal part of the body were discovered in muscles of fish. Eating this fish may be dangerous because of risk of
a. Fasciolosis
b. Opistorchosis
c. Paragonimosis
d. Taeniasis
e. Diphyllobotriosis

12. What is the typical location of Echinococcus larva in human organism?
a. Large intestine
b. Small intestine
c. Liver
d. Blood
e. Skin

13. Which of the following refers to diphyllobotriosis preventive measures?
a. Avoid consuming raw or improperly cooked fish
b. Keeping personal hygiene rules
c. Beef veterinary control
d. Pork veterinary control
e. Consuming properly cooked crabs and crawfish

14. Which of the following helminthes is a diphyllobotriasis agent?
a. Dwarf tapeworm
b. Beef tapeworm
c. Broad tapeworm
d. Pork tapeworm
e. Liver fluke

15. It is possible to get infected with echinococcosis by:
a. Consuming contaminated meat
b. Contacting to sick persons
c. Contacting to dogs
d. Eating unwashed vegetables
e. Through mosquito bites

Practical class 18. Round worms. Ascaris, pin worm, whip worm, trichina

The Purpose of the Lesson. To study class Nematoda. Agents of the nematodoses: human ascaris (Ascaris lumbricoides), Trichocephalus trichiurus, Enterobius vermicularis. Ways of infection, pathogenicity, laboratory diagnosis and prophylaxis.

TOPIC CONTENT

1. General characteristics of Phylum Nemathelminthes. Progressive features of Nematodes.
2. Ascaris. Morphology, life cycle, ways of infection, pathogenic action, methods of laboratory analysis, prevention.
3. Pinworm. Morphology, life cycle, ways of infection, pathogenic action, methods of laboratory analysis, prevention.
4. Whipworm. Morphology, life cycle, ways of infection, pathogenic action, methods of laboratory analysis, prevention.
5. Trichinaworm. Morphology, life cycle, ways of infection, pathogenic action, methods of laboratory analysis, prevention.
6.

TEST QUESTIONS FOR INDIVIDUAL WORK

1. Complete the table "Diagnostic criteria of the nematodes"

#	Latin name of the helminthes	Size of the body	Shape of the body	Characteristics of the eggs		
				Size	Shape	Color
1	Ascaris					
2	Pinworm					
3	Whipworm					

2. Complete the table"Life cycles and epidemiology of the helminthes"

Name of the helminthes	Name of the disease	Location	Life span	Infective stage	Source of the infection	Laboratory diagnosis	Personal prevention
Ascaris							
Pinworm							
Whipworm							

Diseases caused by Roundworms are **nematodoses.**

Ascaris lumbricoides is the agent of **ascariasis.**

Geographical distribution Worldwide

Morphology. A **female** is **20-40 cm** . **Male** is **15-25 cm.**

A female produce **fertilized and unfertilized eggs** of oval shape **50-70/40-50 µm,** golden brown .

The unfertilized egg is 50-106 mcm

Location. The mature worm passes its life in human small intestine.

Life cycle. **Ascaris is a geohelminth (eggs passed in feces undergo maturation in soil). Female produces about 240 000 eggs per day.** Development at the temperature +24-+37 C lasts for 12 to 24 days (**3 weeks**)

Man gets the infection by the ingestion of infective eggs with dirt, food, vegetables, water.

Larva hatches from the egg in the small intestine, penetrates into blood vessels are carried by circulation i**nto the liver** and via **right heart** into **lungs**. **In the lungs the larvae penetrate into alveoli** Then larvae crawl up to **bronchi, trachea, larynx and then are swallowed** again. The **migration lasts for 14-15 days.**

Larvae become mature in the small intestine in 2-3 months.

Life span of the mature worm is about a year.

Ascariasis is an anthroponosis.

Pathogenicity. Ascaris causes toxic and mechanical injury and allergy. During the first **pulmonary stage** (**migration of larvae)** clinical symptoms are **pain in the chest, cough, urticarial rush.**

During the **intestinal stage clinical symptoms include vomiting, stomachache, diarrhea, headache, insomnia. Possible complications of the disease are:**

X. perforation of the intestine;
Y. intestinal obstruction;
Z. mechanical jaundice because of blockage of the bile ducts;
AA. abscess of the liver;
BB. appendicitis;
CC. asphyxia because of migration of adult worms to the respiratory tract.

Diagnosis. At the **pulmonary stage** is (**larvoscopy of phlegm**). at the **intestinal stage** of ascariasis the **ovoscopy of feces** is done. When only males or females are present in the organism of the host, eggs in the feces are absent.

Prophylaxis:

DD. personal prevention is to wash hands, vegetables, fruit, to boil water. Control of the disease:
EE. treatment of affected individuals;
FF. proper disposal of human feces;
GG. struggle with flies and cockroaches;
HH. health education.

Enterobius vermicularis (pinworm) is the agent of **enterobiasis**.

Geographical distribution Worldwide.

Morphology. Pinworm is a small worm of white color.

Female is **9-12 mm** , **male is 2-5 mm**

Eggs are transparent, asymmetric Size of eggs is **50/60**µm.

Location. Lower part of the small intestine.

Life cycle. Pinworm is a **geohelminth**, parasites **in humans only**. . Females migrate to the rectum, creep out of anus at night and l**ay the eggs on the skin of the perineal region**.

4-6 hours after having been laid eggs reach the infective stage.

Females laying eggs cause severe itching. Patients scratch the itching regions while

sleeping. Thus the eggs get on fingers of the patient, under the nails, on bed linen and then on food, toys, dishes. If the patient neglects the hygienic rules he gets infection again. So, enterobiasis is characterized by repeated self infection – autoreinfection.

Life span is about 1 month but the disease can last for years due to **autoinfection.**

Enterobiasis is an **anthroponosis.**

The main symptoms of enterobiasis are itching and skin inflammation in the perineal region.

***Diagnosis*. Demonstration of pinworms in stool and eggs in a perineal scrapings, Graham's method (adhesive skin test)**.

Prophylaxis. Personal prevention is proper personal hygiene (frequent hand washing before meals and after defecation). Fingers should not be put in the mouth as a habit.

To prevent autoinfection patient has to take a bath every morning and wash his hands carefully. Linen should be ironed every morning. Children must keep their fingernails short.

Control of the disease.

33. Treatment of the infected case and all members of the family.
34. Observe the personal hygiene of kindergartens and food handling occupations.

Thrichocephalus trichiurus or Trichiurus trichiura (the whipworm) is the agent of **thrichocephaliasis** (trichuriasis).

Geographical distribution Worldwide.

***Morphology.* Mature female is 3-5 cm** in length, **male is 3-4,5 cm** in length. Thrichocephalus is a **hemathophage**, it **consumes blood and tissue liquid.**

Eggs are **yellowish-brown** , shaped as a lemon Size of an egg is **50/60**

***Location.* Large intestine of man, especially the caecum and appendix.**

Life cycle. Thrichocephalus is a **geohelminth.**

Eggs are excreted with feces. It takes about 25-30 days for the egg to develop in the moist soil in optimal conditions (tє 25-40 єC, oxygen, moist). Life span is abou**t 3-5 years.**

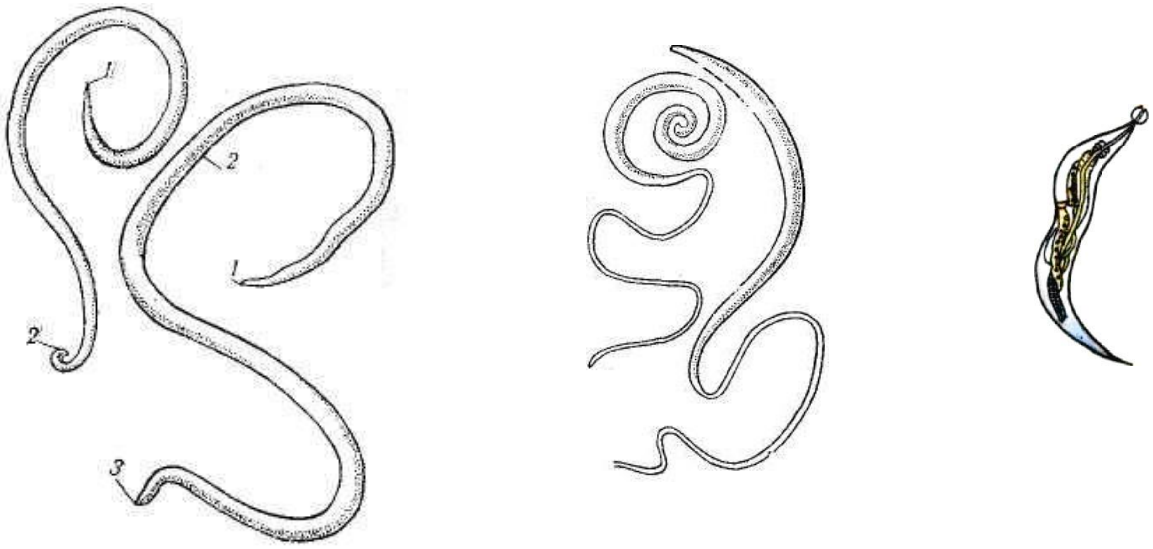
Epidemiology. Thrichocephaliasis is an **anthroponosis(**through the dirty hands, fruit, vegetables, berries, or water contaminated with eggs) Eggs can survive in soil for 3 years. Flies are mechanical carriers

Pathogenicity. Thrichocephalus causes mechanical injuring of the intestinal mucosa and toxic-allergic reactions,appendicitis, anemia.

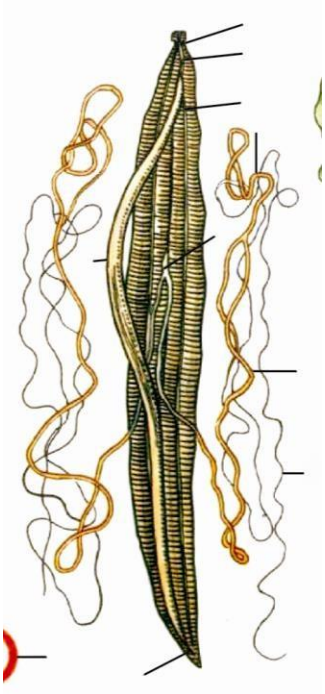
Diagnosis. ovoscopy of feces

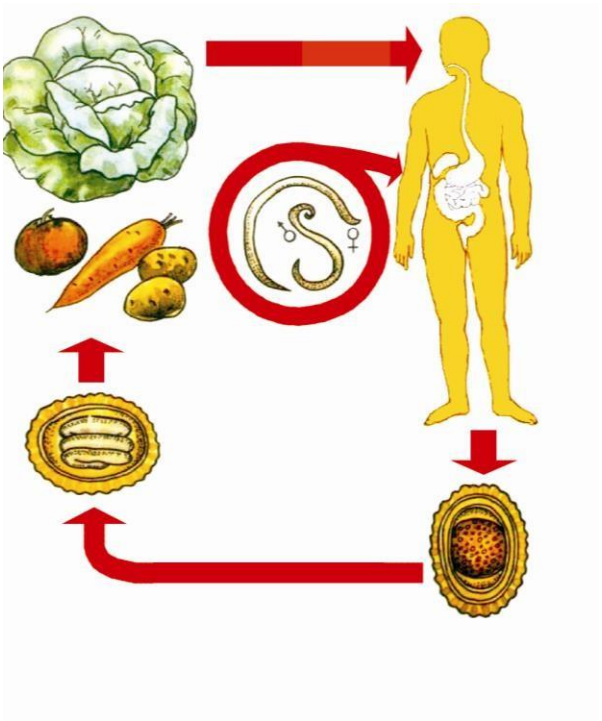
Prophylaxis. The same as in case of ascariasis.

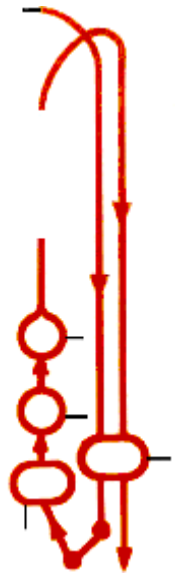
Task 1. Identify the species of round worms and its sex. Detect its actual size.



Task 2. Study morphology of female Ascaris and scheme of its life cycle. Label structure, stages of development, and way of migration in human organism.

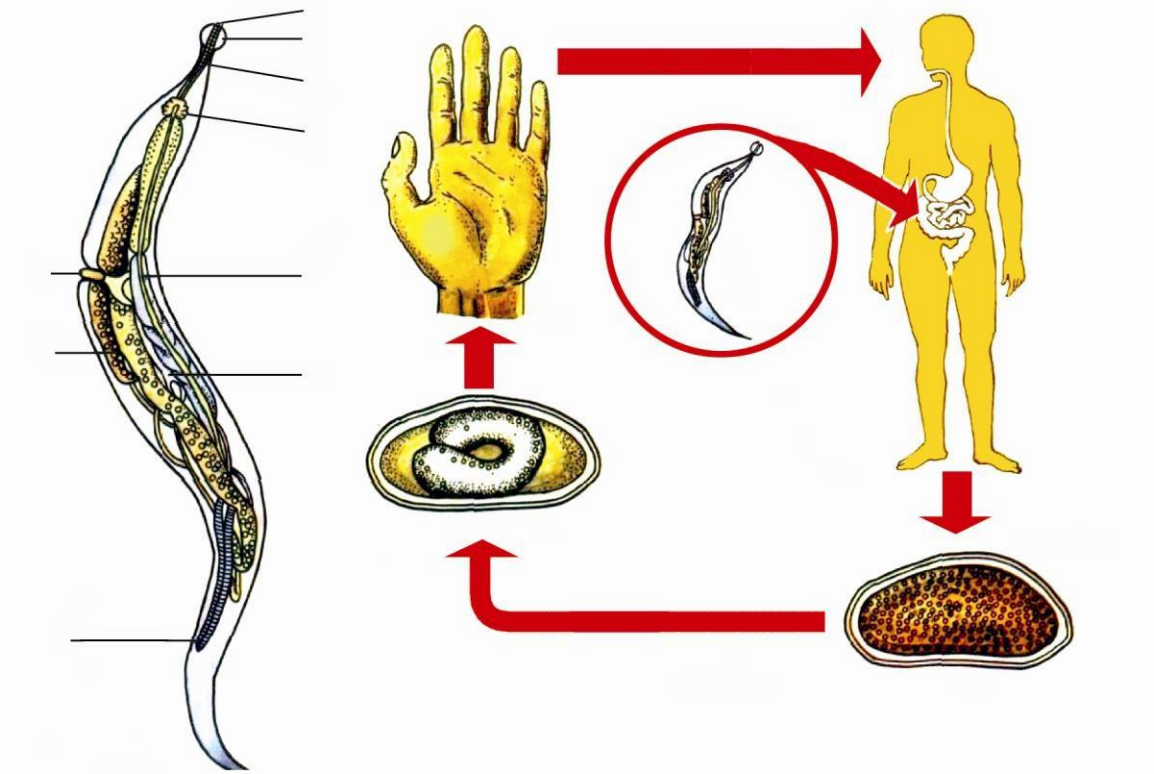






Task 3. Study a scheme of life cycle of whipworm. Point out stages of the life cycle.

Task 4. Study a scheme of life cycle of whipworm. Point out stages of the life cycle.



Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. Migration via lungs and respiratory system is typical for:
   a. Enterobius vermicularis
   b. Triehocephaius trichiurus
   c. Ascaris lumbricoides
   d. Echinoeoccus gramilosis
   e. Taenia solium

2. White helminthes 5 to 10 mm in length were discovered in human feces .Esophagus

of parasite is expanded in the frontal part. Microscopic examination of material scraped off perianal area demonstrated presence of transparent asymmetrical eggs 50 to 60 µm in length. Determine the species of parasite:

a. Ascaris
b. Trichocephalus trichiurus
c. Piflworrn
d. Echinococcus
e. Dwarf tapeworm

3. The nematode is characterized by a direct development without migration. Eggs need 25 to 30 days for maturation in soil. Consuming vegetables, berries or drinking water contaminated by matured eggs may infect human being. Determine species of helminthes:

a. Ascaris
b. Pinworm
c. Whip worm
d. Echinococcus
e. Broad tapeworm

4. Intestinal obstruction is a possible complication of:

a. Hymenolepidosis
b. Fasciolosis
c. Opisthorchosis
d. Ascaridosis
e. Enterobiosis

5. Inflammation of appendix is a possible complication of:

a. Opisthorchosis
b. Fasciolosis
c. Taeniasis
d. Hymenolepidosis
Tricliocеplialosis

6. Contaminated vegetables is a possible source of

a. Taemasis
b. Taeniarhynchosis
c. Qpisthorchosis
d. Trichocephalosis
e. Diphyllobotriosis

7. The enterobiosis agent is:

a. Ascaris
b. Pinworm
c. Whipworm
d. Echinococcus
e. Dwarf tape worm

8. Infective stage of pinworm for human being is:

b. Sporocyst
a. Cysticercus
b. Metacercaria
c. Filariaform larva
d. Egg

9. Which of the following refers to enterobiasis laboratory diagnosing?

b. Immunological tests
a. Feces ovoscopy
b. Microscopy of perianal area scrapes
c. Blood examination
d. Muscles biopsy

10. Ascaris eggs get matured in

a. 21 days
b. 4 to 6 hours
c. One week
d. One day
e. 25 to 30 days

11. Whipworm eggs get matured in:

a. 21 days
b. 4 to 6 hours
c. One week
d. One day
e. 25 to 30 days

12. Which of the following is the whipworm infective stage for human?

a. Egg
b.Cysticercus
c.Cysticercoid
d. Plerocercoid
e.Echinococcus

13. Which of the following refers to ascariasis laboratory diagnosis?

a. Muscle biopsy
b. Urine sediment microscopy
c. Feces microscopy
d. Serological tests
II. Microscopy of perianal scrapes

14. Which of the following refers to enterobiasis preventive measures?

a. Keeping personal hygiene rules
b. Veterinary examination of pork
c. Consuming properly cooked fish
d. Veterinary examination of beef
e. Consuming properly cooked meat

15. Lemon-shaped eggs 50 x 30 □m in size with corks on the both poles were discovered in human feces . Clinical manifestations include appendix inflammation. The possible agent is:

a. Cat fluke
b. Ascaris
c. Pinworm
d. Whipworm
e. Echinococcus

16. Approximate time necessary for pinworm eggs maturation is:
    a.21 days
    b.4 to 6 hours
    c.One day
    d.25 to 30 days
    e.One week
17. Which of the following refers to Triehocephalosis preventive measures?
    a. Do not walk barefoot
    b. Keep personal hygiene rules
    c. Veterinary control in markets
    d. Consuming well-done beef and pork
    e. Sick persons isolation
18. Autoinvasion is possible in:
    a. Trichocephalosis
    b. Diphyllobotriasis
    c. Enterobiasis
    d. Paragonimosis
    e.Ascariasis

Practical class 19. Arthropoda. Arachnoideans as agents and vectors of diseases. Insects as human ectoparasites.

The Purpose of the Lesson. To study characters of structure and classification of **Arthropoda.** Medical importance of Arachnida and Insects.

TOPIC CONTENT

1. Characters of structure and classification of Arachnida.
2. Medical importance of spiders.
3. Peculiarities of morphology and development of ticks and mites.
5. Medical importance of Ixodida? Argasida and Gamasida ticks as vectors of human disorders.
6. Medical importance of the itch mite and follicle mite.
7. What are the changes in louse's morphology because of their parasitic mode of life?
9. Morphology and biological peculiarities, life cycles of lice.
10. Medical importance of lice as agents and vectors of human diseases.
11. Pediculose and phtiriose.

Medical importance of E.N.Pavlovsky's works about natural focal transmissive diseases,

TEST QUESTIONS FOR INDIVIDUAL WORK

	Questions	Answers
1	What are the characters of Arthropoda? I) body cavity- 1; 2) body parts -1,2,3; 3) organs of respiratory system-1; 4) peculiarities of circulatory system -1; 5) organs of nervous system-1,2; 6) peculiarities of excretory system- 1; 7) development -1, 2.	
2	What are the peculiarities of Arachnida? 1) body parts-l ,2; 2) mouth apparatus -1,2; 3) number of walking extremitie - 1; 4) respiratory organs -1; 5) development: of spiders-l ; of ticks -1; of mites -1.	

3	What are the orders of Arachnida? 1,2,3,4.	
4	Examples of venomous Arachnida? 1,2,3	
5	What is the medical importance of Crimean scorpion-1; Caracurt ("black widow")-1 ; Southern Russian tarantula (wolf Spider)-1.	
6	What are the peculiarities of ticks and mites during their different stages of development? 1) larva -1,2,3; 2) chrysalis -1,2;	
7	3) Imago -1,2,3,4. Which ticks and mites are 1) transmitters of human invasions - 1,2,3,4; 2) agents of human diseases -1, 2.	
8	Transovarial transmission of viruses is …	
9	Transphase transmission of viruses is …	
10	Natural focus is ...	
11	What are the components of natural focus? 1 ,2,3,4	

Fill the table 1"Epidemiological importance of parasitic ticks"

Ticks and mites families	Latin name	Geography of inhabitance	morphology	Life cycle	Medical importance
Ixodida	Taiga tick Canine tick Pasture ticks				
Argasida					
Gamasida					

Fill the table 1"Epidemiological importance of parasitic ticks and mites"

Characters, species, Latin name	Itch mite	Follicle mite
Agent of disease		
localization		
morphology		
Life cycle		
Way of human invasion		
Pathogen effect		
Laboratory diagnostic		

Contents of the topic (scheme)

1. Home fly. Morphology.
2. Autumn fly. Life cycle, transmission of agents of diseases.

3. Wolfartia magnifica fly. Life cycle, medical importance.
4. Malarial and not malarial gnats, their morphological characters.
5. Metamorphose and characteristic of gnats stages of development (egg, larva, chrysalis, and imago).
6. Organization of effective struggle against gnats.
7. Scientists role in the struggle against transmissive diseases.
8. What are the changes in louse's morphology because of their parasitic mode of life?
9. Morphology and biological peculiarities, life cycles of lice.
10. The meaning and importance of N.G.Minh and O.O.Mochutkovsky works in examination of transmissive ways of agents of typhuses.
11. Pediculose and phtiriose.
12. Epidemic importance of fleas. Characteristic of "fleas block".
13. Epidemic importance of bed-bug and kissing bug.

	Questions	Answers
	What are the characters of insect's morphology? 1) parts of their body -1,2,3; 2) number of walking legs -1; 3) Respiratory organs -1. What are the stages of insects development? 1) with complete metamorphosis -1,2,3,4; 2) With incomplete metamorphosis - 1,2,3. Which type of mouth apparatus appears in the process of evolution at first? What is it: 1) type of fly's mouth apparatus; 2) the way of agents transmission; 3) what does it transmits-l ,2,3,4,5,6; 4) The type of gnat's mouth apparatus. What is the medical importance of 1) autumn fly; 2) tsetse fly; 3) Wolfartia magnifica; 4) Malarial gnats; 5) Not malarial gnats -1, 2, 3,4,5,6. What are the agents.of miases; 1) tissular-l,2;' 2) intestinal -1,2,3; 3) Urinal-I, 2. What are the main ways of struggle against gnats? -1,2 What are lice-human parasites? 1,2,3. What is 1) type of lice's mouth apparatus; 2) type of lice development. What are the morphological differences of head louse and body louse? 1,2, 3 What is a medical importance of lice? 1) head louse-1,2; 2) body louse -1,2;	

	3) pubic or crab louse -1. What is a mechanism of human invasion with 1)relapsing fever -1; 2) epidemic typhus-1. What are the symptoms of 1)pediculose -1,2,3; 2) phtiriose -1, 2. What are the species of fleas? 1,2,3. What is a medical importance of fleas? 1,2,3. What are the ways of transmission of plague to human by fleas? 1,2. What is a medical importance of bugs: 1) bed – bug; 2) kissing bug -1, 2.	

Class Arachnoidea.

The Arachnoidea have :

A body has 2 regions: cephalothorax and abdomen.

Cephalothorax bears two pairs of the mouth parts called chelicerae and pedipalpi for feeding and 4 pairs of walking legs

Respiration occurs by trachea or book-lungs

Development is direct.

The venomous glands

The major orders of Arachnoidea are Aranei, Solpugae, Scorpions, Acarina.

Order Aranei.

The venomous species in South Ukraine are Karacurt (*Lacrodectus tredecimguttatus)* (one of the black-widow spider species) and tarantula or wolf spider – (*Lycosa singorensis*).

Tarantula is the large spider, about 35 mm in length, covered by thick black or sometimes red color hair. It lives in the holes in soil.

Medical importance. Bite of tarantula spider is very painful and may cause allergic reaction – hyperemia, edema, tachycardia, sleeplessness.

Karacurt (Lactrodectus tredecimguttatus)male is 1 cm and female is 1,5-2 cm Characteristic feature is dazzling white spots and red dots in the center. Karacurt lives the holes of rodents, sheds, garages, toilets, among the stones in the beaches.

Medical importance. The poison of Karacurt may be deadly for humans and animals as it is neurotoxic and blocks of transmission of neuromuscular impulse. The symptoms of poisoning are nervous pain, disturbance, tachycardia, bronchial spasm, depression, delirium.The first aid is injection of antikaracurt serum,

Order Solpugae. Solpugae (phalanges) inhabit countries with hot climate.

Medical importance. Solpugae are not poisonous, but its bite causes the inflammation as they inoculate bacteria and toxic substances from chelicerae into the biting wound.

Order Scorpions Scorpion is 1-17 cm with poison sting

Medical importance. The sting of the scorpion is very painful. The poison causes edema, sleepiness, fever. The poison of large tropical species can lead to the death, especially in children

Order Acarina

Parasitiform ticks are Ixodidae, Argasidae, Gamasidae.

Ixodidae ticks are bloodsucking arachnids. The sizes are from 2-5mm up the 3 cm.

They are biological vectors of spring-summer encephalitis, taiga encephalitis, Rocky mountain spotted fever, tularemia.

Ixodidae female can transmit virus of encephalitis through the eggs (transovarial transmission) to the following developmental phases (transphase transmission).

Ixodes ricinus (Canine tick)

a temporary parasite of wild and domestic animals, can attack human. It lives in forests of Europe.

a male is 2.5 mm,a hungry female is 4 mm(after bloodsucking is about 11 mm)

Females lay the 10000-12000 eggs once a life-time into the soil.

Canine tick is the carrier of the agents of the spring-summer encephalitis, supports the circulation of tularemia among the rodents and transmits it to humans.

Ixodes persulcatus (Taiga tick) inhabits the forests, taiga It parasites on the mammals, birds, rodents, and hedgehogs. It is the main vector of taiga encephalitis. Transovarial and transphase transmission of the virus is present.

the system of destruction of the ticks in biogeocenosis with the help of acaricides (chemicals killing the ticks).

Dermacentor pictus lives of steppe zone and is the carrier of tularemia, endemic typhus, brucellosis.

Argasidae ticks

The size of female is about 8.2 mm, the size of male is about 5.8mm.

Argasidae ticks are ticks of shelter places. They inhabit caves, holes, houses. Argasidae ticks can fasting for about 10 years.

Example of Argasidae is *Ornithodorus papillipes ("Persian bug")*. It is the vector of tick-born relapsing fever (agents are spirochetes).

Gamasidae ticks. It is numerous of very small ticks (0,3-0,4 mm), which are ectoparasites of various mammals and birds. A chicken and rat ticks attack the human. It causes the irritation of skin, dermatitis.

Acariform ticks (mites) are constant parasites. Acarus siro or Sarcoptes scabiei (itch mite) causes scabies.

Morphology. The female is 0.4-0.45 mm and male is 0.2 mm .

Location Itch mite is a constant human intracutaneous parasite.It lives mainly between the fingers, in armpits, lower part of the abdomen, buttocks, popliteal fossae.

Life cycle Females make tunnels in epidermis. During the life period (50 days) it lays 20-30 eggs. The development occurs with the metamorphosis (egg, larva, nymph I, nymph II) and takes 9-14 days. Wandering of the mites in skin causes severe itch. Scratching the mites' tunnels host disseminates the parasites all over the body.

Man-to-man transmission occurs during the contact with the patient (handshake) or through the clothes.

Laboratory diagnosis is based on *microscope examination of skin scrubs*, (demonstration of the parasites).

Prophylaxis is based on personal and social hygiene, isolation and treatment of patients.

Demodex folliculorum (follicle mite) is the agent of demodecosis.

It is the vermiform mite 0,3 mm. It parasites in sebaceous glands of the face in regions of the nose, eyelids, forehead, and internal acoustic duct, in hair follicles of the eyebrows and eyelashes.

The disease manifests by loss of hair, purulent pimples, eczema.

The invasion is by contacts with sick person, through the towels, pillows.

The diagnosis is based on microscoping of the purulent contents of the pimples or

removed hair follicle.

Class Insecta. The body consists of : the head, thorax and abdomen.

Reproduction is sexual. The development occurs with complete or incomplete metamorphosis.

Medical importance of Insects. Insects are

the agents of human diseases (lice),

mechanical vectors of intestinal diseases (flies),

biological vectors of transmissive diseases (lice, fleas, bed-bugs, mosquitoes, tsetse flies)

Order Anoplura (lice)

Parasites of human being are head louse (*Pediculus humanus capitis*), body louse (*Pediculus humanus humanus*) and pubic louse (*Phtirus pubis*).

Pediculus humanus capitis (Head louse)

Morphology : The body is light-gray Females are 3-4mm The body is head, thorax, abdomen. The head is with 2short antennas (an olfactorial organ), 2simple eyes and mouth apparatus of piercing-and-sucking type.

Louse has 3 pairs of appendages.

Location: hairy head areas. One can get infection through combs, brushes, hats of the affected person. Negligence to personal hygienic rules helps the transmission of the parasites.

Life cycle. Eggs (nits) are being posted to the hair (3-4 eggs are being laid per day and up to 150 eggs are produced by a female during its life). Development goes with incomplete metamorphoses (egg, larvae I ,II and III, imago). Larva and imago feed on blood. The development from an egg to imago lasts about 16 days. Life span of head lice is about 27-38 days.

Medical importance: head lice is an ectoparasite, an agent of pediculosis. Affected people suffer with severe head itching.

Head lice is a carrier of obligate-transmissive diseases - relapsing fever and epidemic typhus.

Pediculus humanus humanus or *Pediculus humanus corporis* (Body louse).

Morphology : Females measure up to 4.-7.5 mm, males are up to 3.75 mm.

Life cycle: development is with incomplete metamorphosis.

Eggs (nits) are laid onto clothes folds and are stuck to the cloth.

A female lays up to 14 eggs per day and 300 per life.

Development from an egg to imago lasts for 16 days at the temperature of 25 C. The larva and imago feed on blood. Life span is 32-46 days.

Location: they live in folds of underwear.

Medical importance. Body louse is a constant human ectoparasite, an agent of pediculosis.

Basic symptoms are skin itching, pigmented spots on bites points.

Scratches from itching cover the body.

A person gets infected through contacts with an affected person or with his clothes.

Body louse is a carrier of epidemic typhus and lice-born relapsing fever.

Phtirus pubis (Pubic lice)

Morphology.A female is 1.5 mm, male is 1 mm in length.

Location: on pubic hair, eyelashes, eyebrows, in axillary cavity, moustache and beard. In case of severe infection parasites are present all over the body hair.

Life cycle: Development is with incomplete metamorphosis.

Development from an egg to imago takes 22-27 days. Life span is 17 - 22 days.

Medical importance. Pubic lice is an agent phtiriosis.

Main symptom is itching. Phtiriosis can be transmitted during sexual contacts and through underwear of an invaded person.

They do not transmit agents of any disease.

Destroying of lice:

JJ. Mechanical way- brushing out the insects with a special brush, hair cutting or shaving.

KK. Chemical way- washing hair and body with special shampoos and soaps that contain insecticides, processing of clothes with insecticides

LL. Physical way - clothes of a carrier are to be processed in a special disinfecting camera with steam or hot ironing

Preventive means include

- Hygienic rules (regular bathing, taking shower, washing of bed linen)
- Regular inspection of children in kindergarten, school, etc. Treating of affected individuals
- Health education

Order Aphaniptera (Fleas) Fleas are blood sucking insects

Morphology. The body is light-yellow or dark-brown. The body length is 0.5-5 mm. The mouth apparatus is of piercing-and-sucking type.

Life cycle. Development is with complete metamorphosis (egg, larva, chrysalis, imago). Eggs are laid in cracks , in dry garbage, rodents' caves Life cycle lasts from 19 to 270 days depending on temperature and humidity. Mature flea lives for 1.5 years

Medical importance. Some fleas can feed on different hosts. That feature explains the medical importance of fleas as carriers of nature-foci transmissive diseases - plague, tularemia, rat epidemic typhus and others.

Plague is an extremely dangerous nature-foci disease. Its agent is plague bacilli (Pasteurella pestis). Natural reservoirs of plague are various rodents. Fleas are mechanical carriers of plague. Xenopsylla cheopis (rat flea) is the most important vector of plague.

Order Heteroptera (bugs)

Cimex lectularius (Bed-bug)

Morphology. The body is oval shaped and dark-brown . A female is 4.8-8.4 mm, male - 4.9-6.4 mm

Life cycle . Bed-bugs inhabit old houses, beds, furniture, live under wall-paper, etc. Females lay eggs in the places they inhabit. Development is with incomplete metamorphosis. A larva feeds on blood and moults several times to become imago. Development lasts 28-56 days. Imago can survive without food for a year

Medical importance. Bed-bug (Cimex lectularis) is a temporary human ectoparasite. Bites are painful and may cause allergic reactions. They don't transmit any infectious diseases.

Triatoma megista (Kissing bug) is carrier of Trypanosoma cruzi, an agent of Chaga's disease.

Materials for self-control of the training quality

Tests for self-control with standard answer.

Choose the correct answer.

1. What is the medical importance of arthropods?
A. Vectors of the human diseases
B. Causative agents of the human diseases
C. Poisonous animals
D. Biological hosts of the parasites
E. All of the above

2. Causative agents of the diseases are
A. Canine tick
B. Taiga tick
C. Itch mite
D. Dermacentor tick

3. Biological vectors of vector-born disorders are
A. Itch mite
B. Follicle mite
C. Dermacentor
D. House fly
E. Black cockroach

4. Medical importance of follicle mite
A. Causative agent of scabies
B. Vector of taiga encephalitis
C. Causative agent of demodecosis
D. Vector of tick-born relapsing fever
E. Vector of tularemia

5. Canine tick is the vector of
A. Tick-born relapsing fever
B. Tularemia
C. Demodecosis
D. Scabies
E. Endemic typhus

6. O. pappilipes ("Persian bug") is the vector of
A. Taiga encephalitis
B. Tularemia
C. Tick-born relapsing fever
D. Plague
E. Brucellosis

7. Ticks are
A. Vectors of scabies
B. Vectors of demodecosis
C. Causative agents of plague
D. Causative agents of typhus
E. Vectors of encephalitis

8. Specific vectors of taiga encephalitis is
A. Flea
B. Itch mite
C. Follicle mite
D. Ixodida tick
E. Mosquito

9. Vector of viral encephalitis is
A. Pubic lice
B. Canine tick
C. Demodex
D. Dermacentor
E. Bed bug

10. Vector of endemic typhus is
A. Taiga tick
B. Canine tick
C. Demodex mite
D. O. pappilipes
E. Bed bug

11. It is possible to get scabies by all these ways except for
A. Hand shaking
B. Through the direct contacts
C. Trough the sexual contacts
D. Trough the personal things of the patient
E. By biological vectors

12. Prevention of scabies is all except
A. Treatment of the patients
B. Eradication of biological vectors
C. Disinfection of personal things of the patient
D. Keeping the rules of personal hygiene
E. Health education work

13. Ixodidae ticks are the vectors of
A. Leishmaniasis
B. Plague
C. Malaria
D. Tularemia
E. Demodecosis

14. Ticks are characterized by all except

A. Temporal parasites
B. Causative agents of tularemia
C. Feed on blood, skin epidermis
D. Intra cutaneous parasites
E. Development with metamorphosis

15. Medical importance of itch mite
A. Vector of tularemia
B. Causative agent of demodecosis
C. Causative agent of scabies
D. Causative agents of myiasis
E. Vector of encephalitis

16. Demodex feeds on
A. Blood
B. Secretion of sebaceous glands
C. Epidermis
D. Duodenal contents

17. Causative agent of demodecosis is
A. Canine tick
B. Taiga tick
C. Itch mite
D. Follicle mite
E. Dermacentor

1. Which organism is a mechanical vector of cysts of Protozoa and infections agents of gastrointestinal disorders?
   A. Fleas;
   B. Cockroaches;
   B. Bed bugs
   C. Sand-flies;
   D. Wohlfartia fly

2. Sand-flies are specific vectors of:
   A. Japanese encephalitis;
   B. Taiga encephalitis;
   A. Anthrax;
   B. Spotted fever;
   C. Leishmaniasis

3. Wohlfartia fly is a:
   A. Specific vector;
   B. Mechanical vector;
   C. Vector of plague agents;
   D. Agent of myiasis;
   E. Vector of trypanosomosis.

4. House flies are vectors of:
   A. Vector-born infections;
   B. Intestinal infections;
   C. Leishmaniasis;
   D. Relapsing fever;
   E. Plague.

5. Which of the following insects is a vector of Malaria?
   A. Anopheles mosquito;
   B. Culex mosquito;
   C. Aedes mosquito;
   D. All mosquito species;
   E. Sand-flies.

7. Medical importance of fleas
   A. Agents of phthiriasis
   B. Vectors of plague
   C. Vectors o intestinal disorders
   D. Vectors of typhus
   E. Agents of pediculosis

8. Head louse feeds on
   A. Epidermis
   B. Contents of the sebaceous glands
   C. Animal blood
   D. Human blood
   E. Lymph

9. Medical importance of head louse is
   A. Endoparasite
   B. Causative agent of phthiriasis
   C. Vector of relapsing fever
   D. Vector of encephalitis
   E. Causative agent of myiasis

10. Head and body lice are causative agents of
   A. Relapsing fever
   B. Typhus
   C. Myiasis
   D. Phthiriasis
   E. Pediculosis

11. Pubic louse is the causative agent of
   A. Scabies
   B. Phthiriasis
   C. Pediculosis
   D. Typhus
   E. Relapsing fever

12. Infection by relapsing fever occurs
A. Trough the bite of head louse
B. Through the bite of body louse
C. Trough the bite of pubic louse
D. Bu crashing lice an inoculation of hemolymph
E. Trough the bite of wohlfartia fly

13. Bad bug is
A. Ectoparasite
B. Vector of tularemia
C. Causative agent of pediculosis
D. Vector of plague
E. Mechanical vector of intestinal infections

14. Causative agent of pediculosis is
A. Head louse
B. Body louse
C. Pubic louse
D. Head and body lice
E. Itch mite

15. Medical importance of fleas
A. Agents of phthiriasis
B. Vectors of plague
C. Vectors o intestinal disorders
D. Vectors of typhus
E. Agents of pediculosis

16. Symptoms of pediculosis are all except for
A. Lice on the eyelashes and eyebrows
B. Skin scratches
C. Skin rash
D. Nits attached to hair

17. Head louse is the vector of
A. Scabies
B. Demodecosis
C. Phthiriasis
D. Pediculosis
E. Relapsing fever

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