

<p> ONTÜSTIK-QAZAQSTAN MEDISINA AKADEMIASY «Оңтүстік Қазақстан медицина академиясы» АҚ </p>		<p> SOUTH KAZAKHSTAN MEDICAL ACADEMY АО «Южно-Казахстанская медицинская академия» </p>
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MEASURING INSTRUMENTS

Program of questions for midterm control №1

Discipline code: SOFPCH 1203

Name of discipline: "Molecular Biology of Cell"

Volume of hours/credits: 24 hours/ 1.5 credits.

Course and semester of study: 1/1

Compiled by:  Azhibayeva-Kupenova D.T.

Head of the department, professor  Yessirkepov M.M.


Protocol № 17_ of «_26_» __05__ 2023 y.

Program of questions for midterm control №2

Compiled by:  Azhibayeva-Kupenova D.T.

Head of the department, professor  Yessirkepov M.M.

Protocol № 17_ of «_26_» __05__ 2023 y.

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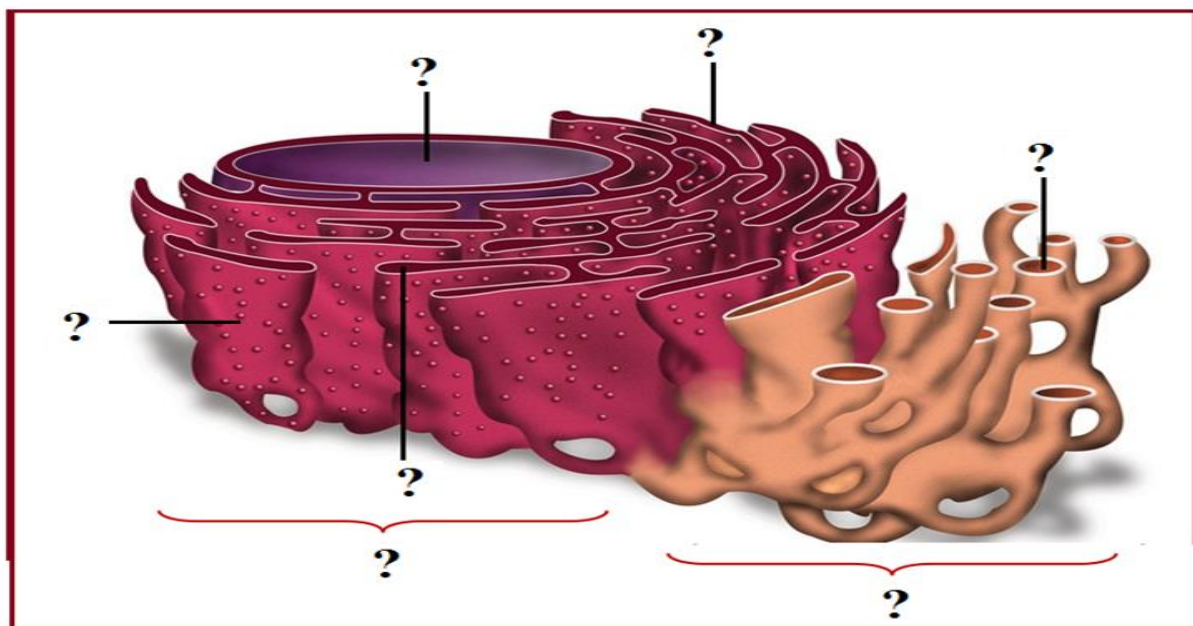
Topic 1: Structure and functions of the main components of the cell

Student _____ group _____

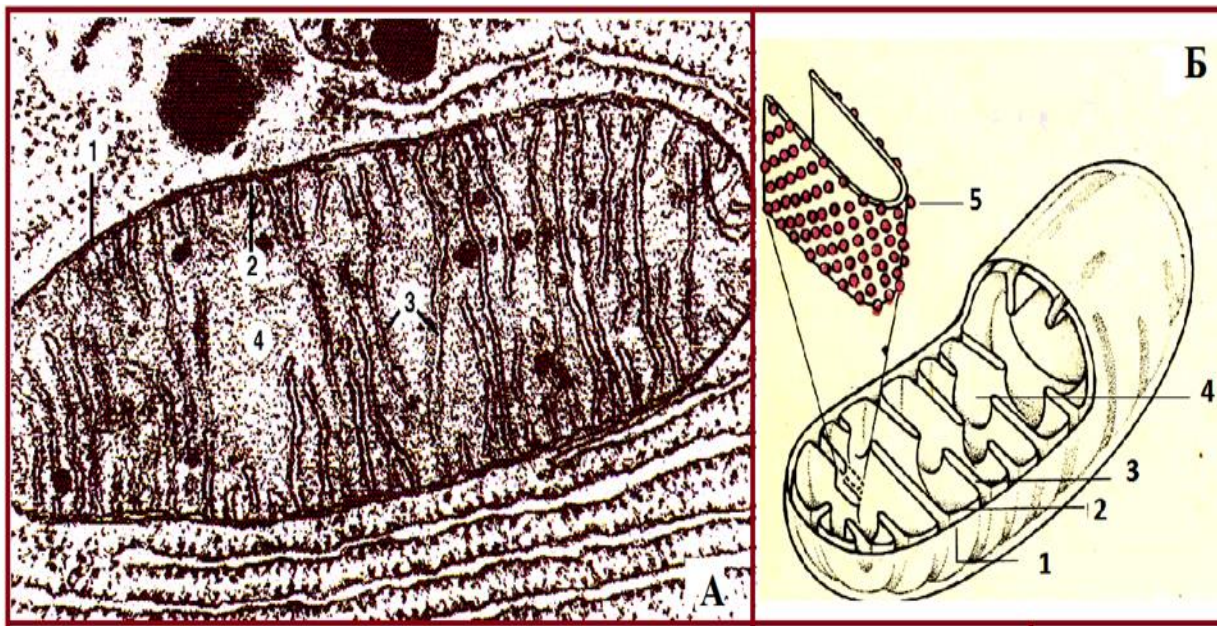
Answer the questions, complete the tasks, fill in the tables, solve the problems listed below:

Test tasks:

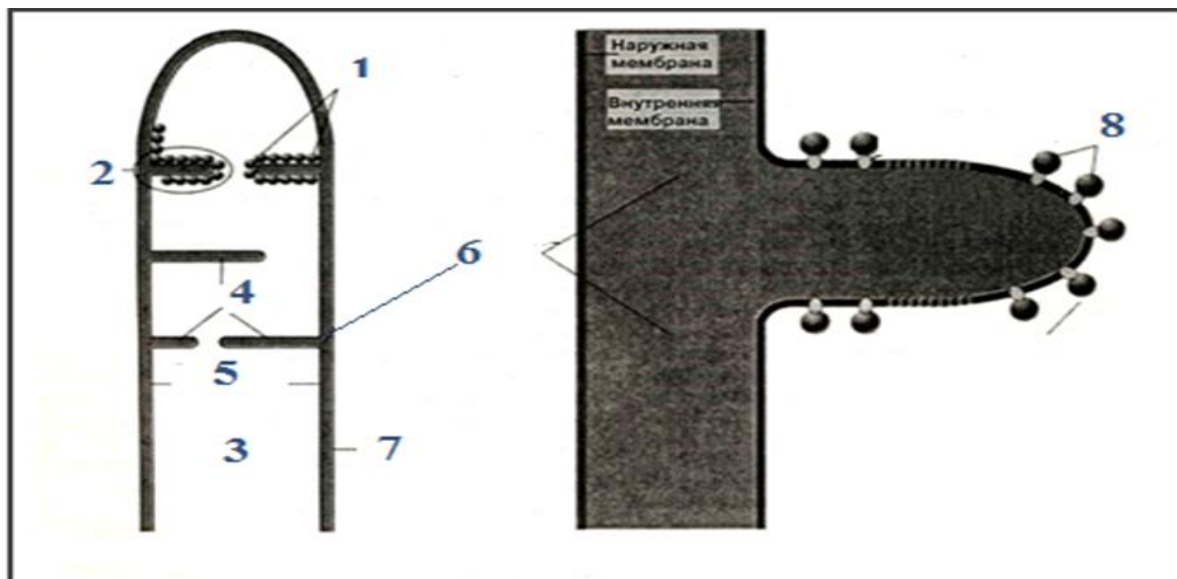
1. Name the components of the cell having membrane structure, give a characteristic of them
2. What are the components of the biomembrane?
3. What proteins are distinguished in the biomembrane?
4. Membrane lipids have what ends?
5. Functions of the plasma membrane
6. Selective permeability of the membrane
7. Protein and ATP synthesis occurs in which organelles?
8. Active and passive transport
9. Vesicular transport
10. Ion channels and pumps
11. Intercellular interactions. Contacts.
12. Adhesive proteins.
13. Basic principles of cellular theory
14. Structure and functions of the nucleus
15. Structure and functions of the EPT
16. Structure and functions of the Golgi complex
17. Structure and function of the lysosome
18. Structure and function of the peroxisome
19. Structure and function of the ribosome
20. Structure and function of the cytoskeleton
21. Structure and function of mitochondria
22. Structure and functions of the cytoskeleton
23. Genetic material of eukaryotic cell
24. Levels of organisation of the genetic material of the cell
25. Structure and functions of ribosome
26. Which cell structures contain chromatin?
27. Structural and functional state of chromosomes in a non-dividing cell
28. Structural and functional state of chromosomes in a dividing cell
29. Determine the chemical composition of a chromosome?
30. What is the genetic material in a eukaryotic cell?
31. What is the genetic material in prokaryotes?
32. Forms of structural organisation of chromosomes in the cell cycle
33. Cellular components involved in the transmission of external signal into the cell
34. Answer which structure is shown in the figure. Sign the structures marked with lines, indicate its location and function.



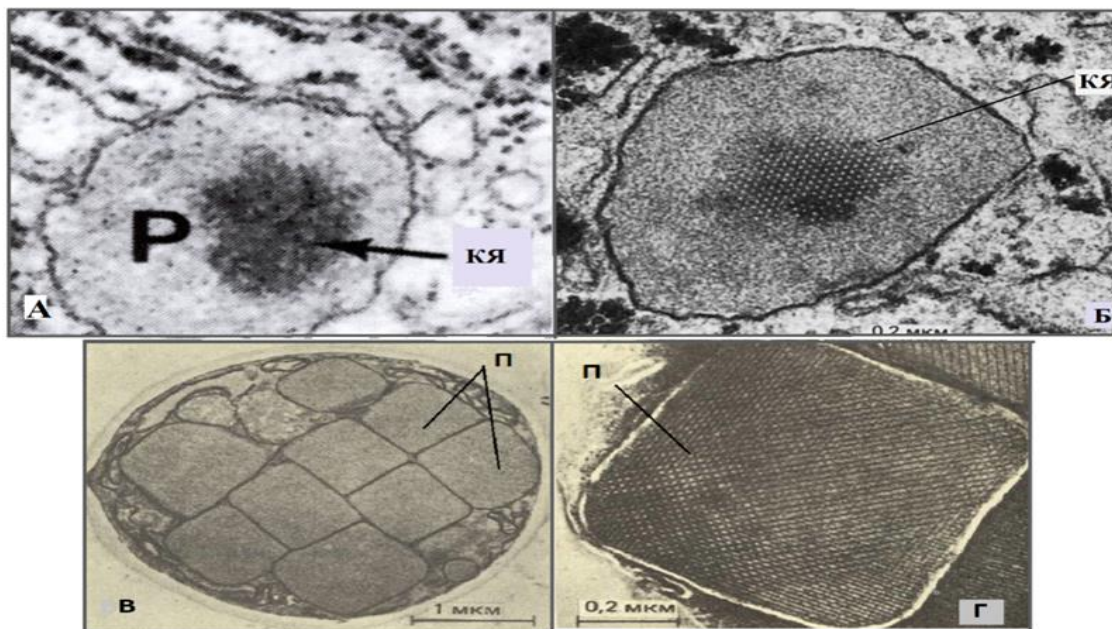
Answer which structure is shown in the figure. Sign the structures marked with lines, indicate its location and functions.



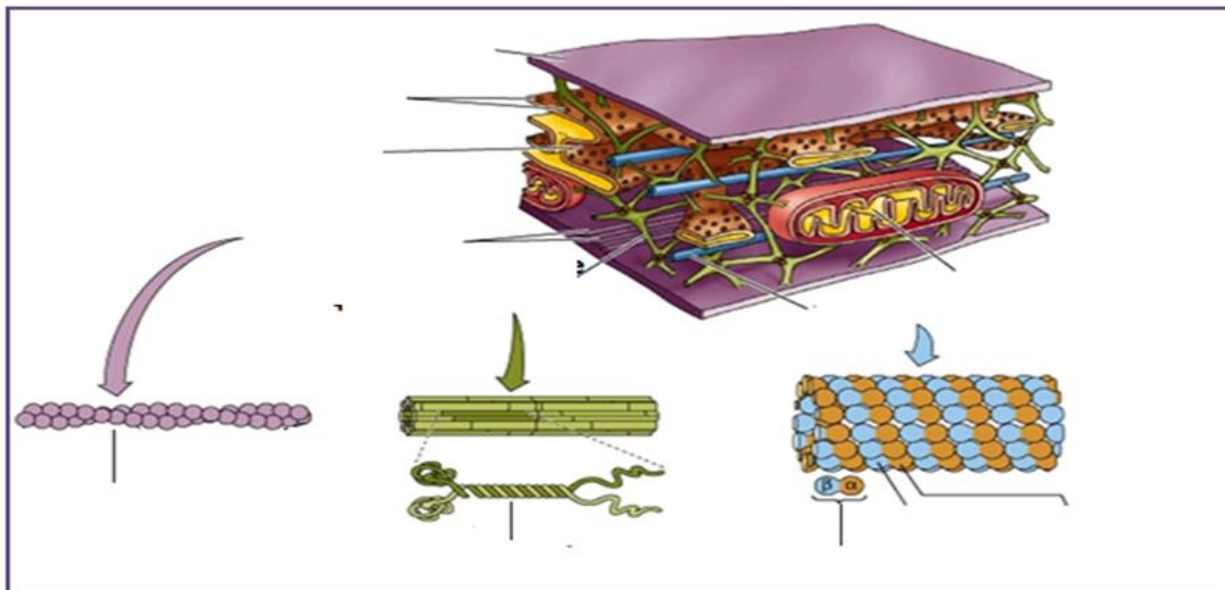
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Answer which structure is shown in the figure. Sign the structures marked with lines, indicate its location and functions.



II. Oral questions:

1. What is a cell?
2. Name the components of a cell?
3. What are the components of a bio membrane?
4. What are the organelles of a cell?

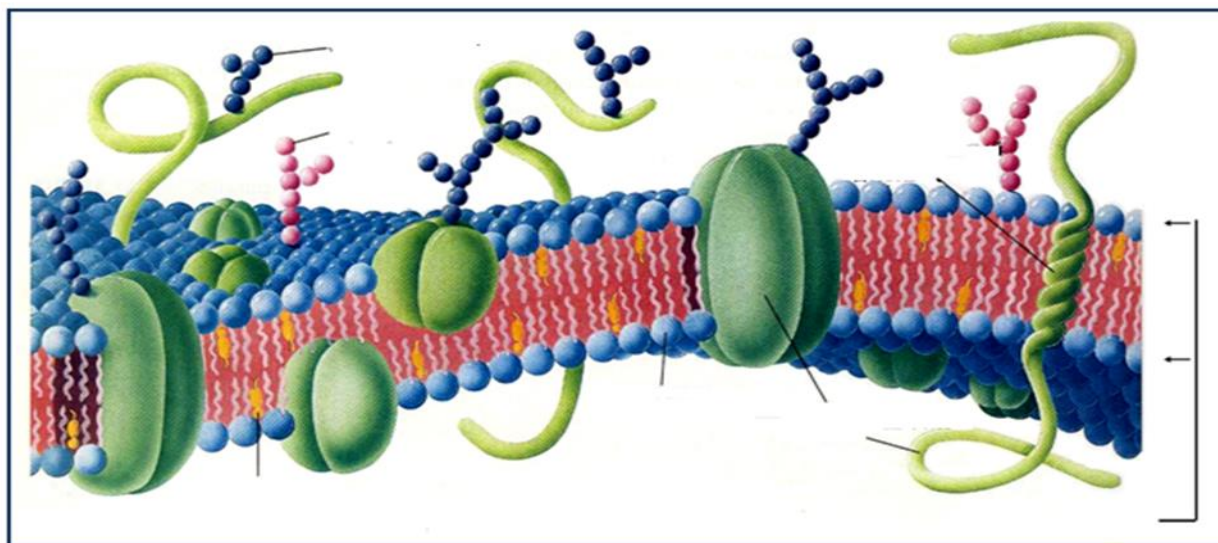
Topic 2: Eukaryotic cell. Cell surface apparatus of cells. Plasma membrane.

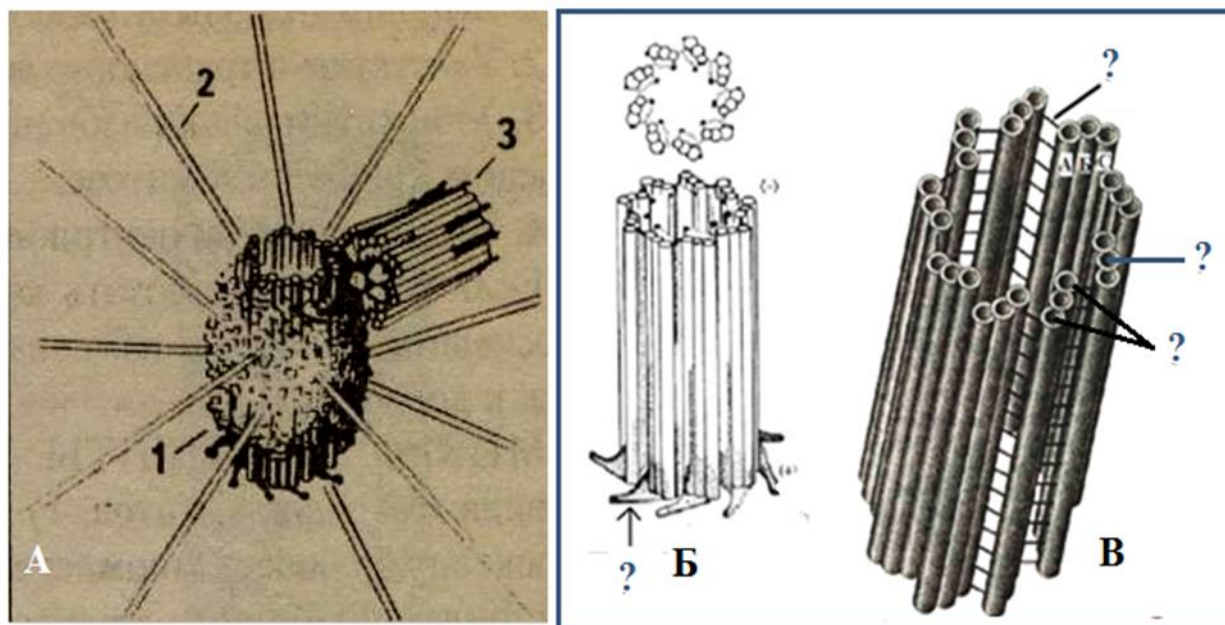
I. Tests:

1. Genetic material of prokaryotic cell
2. Genetic material of eukaryotic cell
3. Levels of organisation of the genetic material of the cell
4. Levels of compactisation of the genetic material of the cell
5. What are the components of chromatin?
6. Which of the cell structures contain chromatin?
7. Structural and functional state of chromosomes in a non-dividing cell
8. Structural and functional state of chromosomes in a dividing cell
9. Determine the chemical composition of a chromosome?
10. What is the genetic material in a eukaryotic cell?
11. What is the genetic material in prokaryotes?
12. Forms of structural organisation of chromosomes in the cell cycle
13. Cellular components involved in the transmission of external signal into the cell
14. Intercellular signalling substances
15. Stages of signal transduction into the cell
16. Enzymes involved in cell signalling processes
17. Signalling mechanisms not related to surface receptors
18. Name the components of the cell that have a membrane structure, give their characterisation

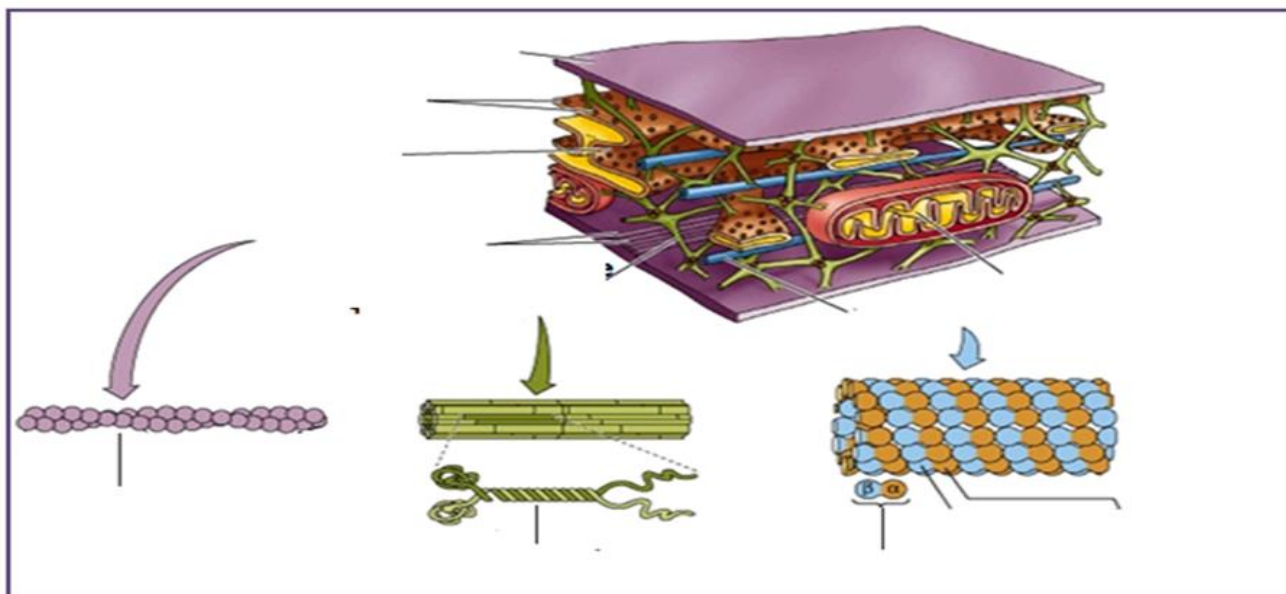
19. What are the components of the biomembrane?
20. What proteins are distinguished in the biomembrane?
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35. Structure and function of the peroxisome
36. Structure and function of the ribosome
37. Structure and function of the cytoskeleton
38. Structure and function of mitochondria

Answer which structure is shown in the figure. Sign the structures marked with lines, indicate its location and function.





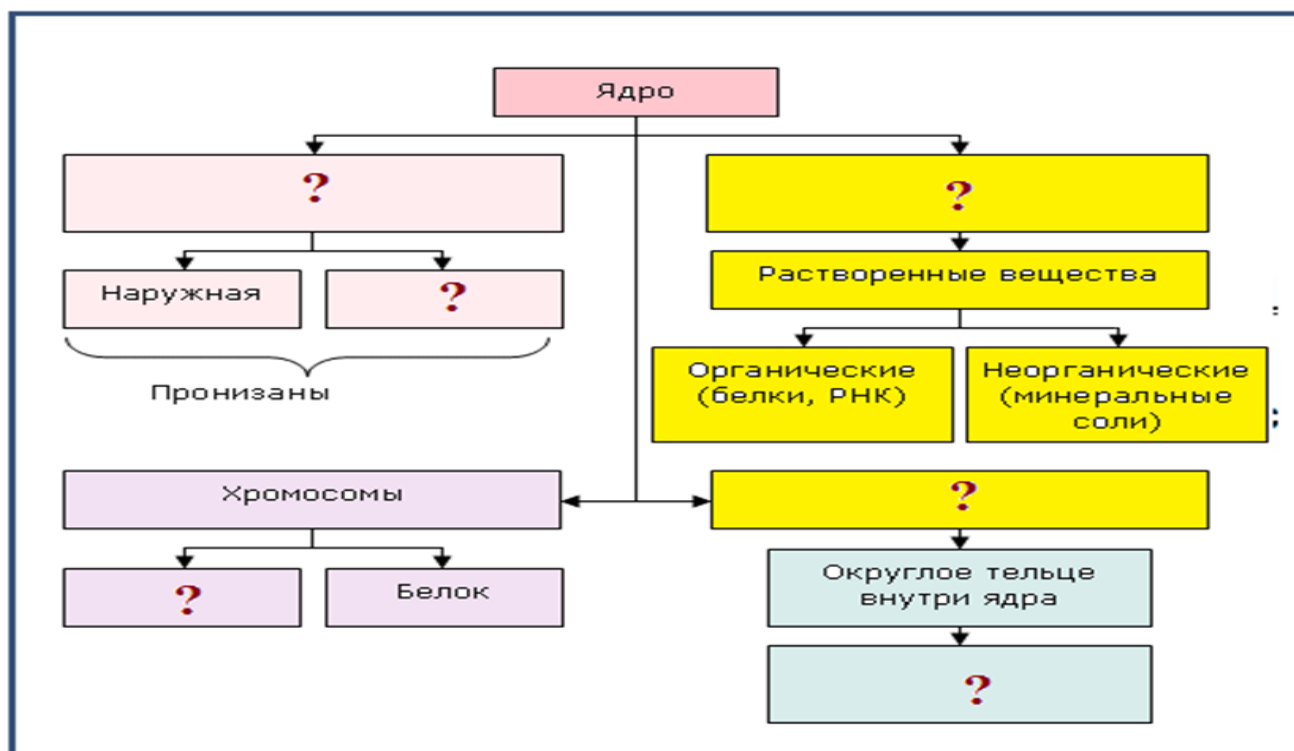
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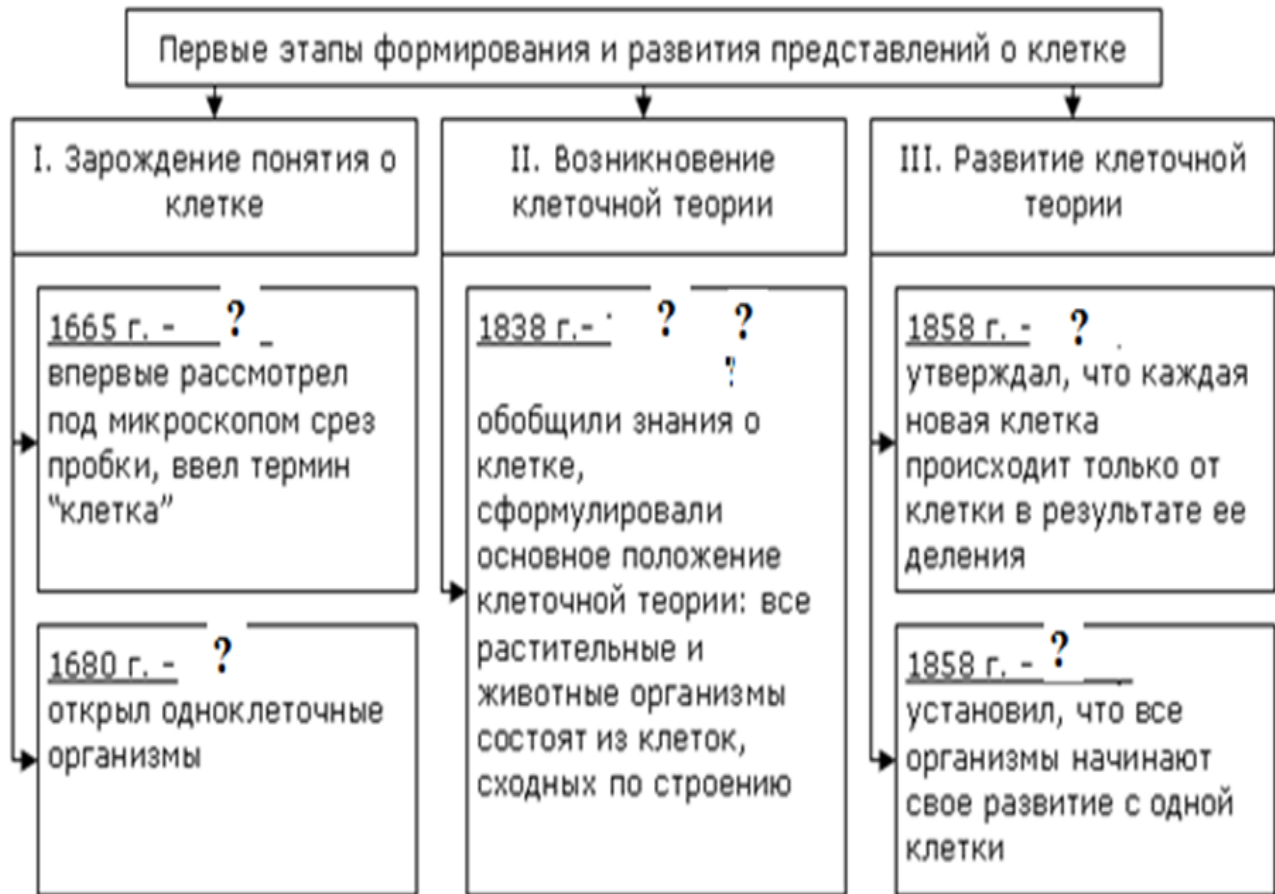


Fill in the places in the table marked with a question mark. Name their location and function.



Fill in the places in the table marked with a question mark. Name their location and function.





Fill in the places in the table marked with a question mark

III. Oral questions:

- Explain what is the surface apparatus of a cell?
- What types of eukaryotic cells do you know?
- What features of DNA structure cause its doubling?
- How does the structure of DNA and RNA molecules differ?
- How do the nucleotides of RNA and DNA differ?
- What species are there in the cell?

Topic №3: Plasma membrane. Transport of substances through membranes: passive and active, vesicular.


Answer the test questions:

1. The basis of biological membranes is formed by:

- A. Carbohydrates
- B. Proteins
- C. Glycoproteins
- D. Glycolipids

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- E. Phosphoproteins
2. Which component of the cell membrane represents a relatively impermeable barrier to most water-soluble molecules?
- Hycoproteins
 - Integral proteins
 - Peripheral proteins
 - Bilipid layer
 - Oligosaccharide chains
3. The structural function of lipids is that they are
- Protect internal organs from mechanical stress
 - Form biological membranes
 - Make the skin more plastic
 - Are suppliers of endogenous water
 - Are part of hormones
4. Which chemical component of the cell membrane has a receptor function?
- Glycolipids
 - Phospholipids
 - Lipoproteins
 - Glycoproteins
 - Cholesterol
5. Which structures of the plasma membrane contribute to the cell's recognition of signals?
- Microfilaments
 - Cilia
 - Folds
 - Receptors
 - Microvilli.
6. The most studied adhesive proteins are the membrane proteins of
- blood cells and endotheliocytes.
 - blood cells.
 - endotheliocytes.
 - skeletal muscle cells.
 - blood cells and neurons.
7. Adhesive membrane proteins are often referred to as ...
- channels.
 - pumps.
 - ligands.
 - matrix.
 - receptors.
8. Integrins are integral proteins of heterodimeric structure consisting of subunits of
- alpha G, betta.
 - alpha, betta-ji.
 - alpha ji, betta ji.
 - alpha, betta.
 - alpha, sigma
9. The intracellular domains of integrins are involved in

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- A. promoter recognition.
- B. fixation of the cytoskeleton.
- C. antigen fixation on the receptor.
- D. formation of the ligand-receptor complex.
- E. terminator recognition
- 10. Selectins are proteins that are
- A. dimers.
- B. trimers.
- C. tetramers.
- D. monomers.
- E. protein complexes
- 11. Immunoglobulins are
- A. antigen to antibody.
- B. a promoter.
- C. an antibody to an antigen.
- D. a ligand.
- E. a histone.
- 12. A key feature of cadherins is that their activity occurs only in the presence of ions
- A. Ca^{2+} .
- B. Fe^{3+} .
- C. Na^{+} .
- D. K^{+} .
- E. Zn^{2+} .
- 13. In an aqueous environment, amphiphilic molecules form a bilayer
- A. by active transport.
- B. by passive transport.
- C. as a result of ATP cleavage
- D. by translocase activity
- E. spontaneously.
- 14. Transmembrane proteins are embedded in the membrane
- A. superficially, acting as receptors.
- B. penetrating its lipid bilayer.
- C. superficially, acting as transport channels.
- D. deep, but do not penetrate the lipid bilayer.
- E. superficially, acting as intracellular receptors
- 15. Virtually every molecule of membrane lipid ...
- A. has a hydrophilic "head" and 2 hydrophobic "tails".
- B. has a hydrophilic "head" and a hydrophilic "tail".
- C. has a hydrophobic "head" and 2 hydrophilic "tails".
- D. has a hydrophobic "head" and a hydrophilic "tail".
- E. has no specific separation.
- 16. Sphingolipids include in their composition sphingosine instead of ...
- A. glycerol and a nitrogenous base.
- B. a nitrogenous base and a phosphoric acid residue.
- C. glycerol and a phosphoric acid residue.

D. glycerol and an amino acid

E. glycerol and a fatty acid.

17. Glycolipids ...

A. do not have a sphingosine molecule.

B. do not have a sphingosine molecule but are highly related to it.

C. have a sphingosine molecule.

D. have a cholesterol molecule.

E. have an amino acid molecule

18. In active transport ...

A. a substance diffuses across the membrane by translocase, against a concentration gradient

B. the substance diffuses across the membrane with the help of translocase

C. the substance diffuses across the membrane from a compartment with a higher concentration to a compartment with a lower concentration

D. the substance diffuses across the membrane from a compartment with equal concentration

E. in either direction

19. In the tubules of the kidney, glucose penetrates the epithelial cell by ...

A. facilitated diffusion.

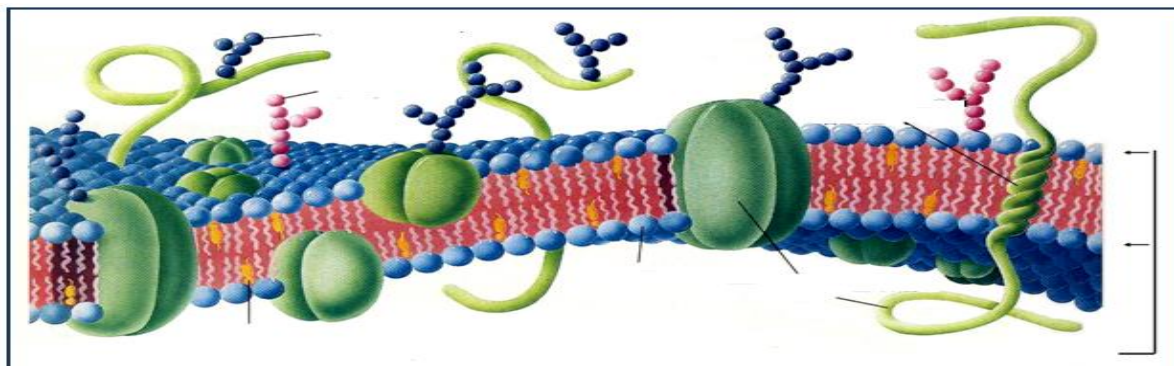
B. simple diffusion.

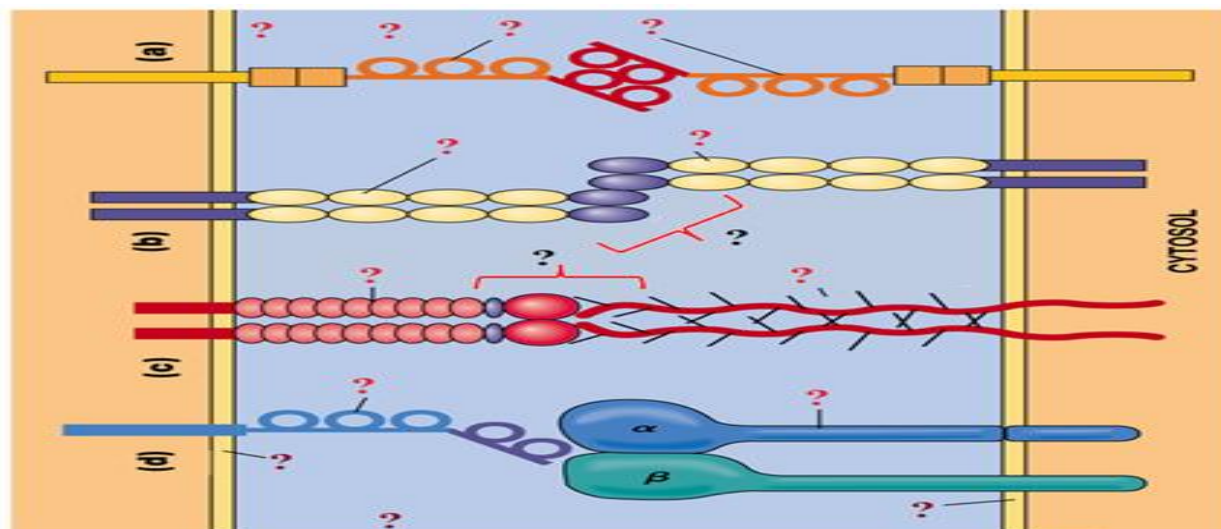
C. symport with K^+ ions

D. import with Ca ions

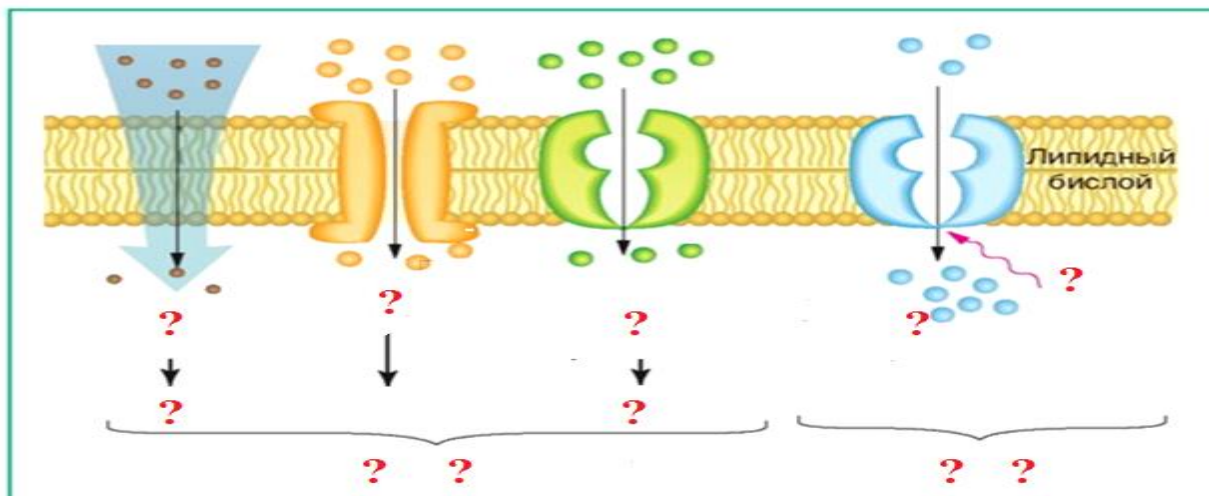
E. symport with Na^+ ions.

Answer which structure is shown in the figure. Sign the structures marked with lines, indicate its location and functions.

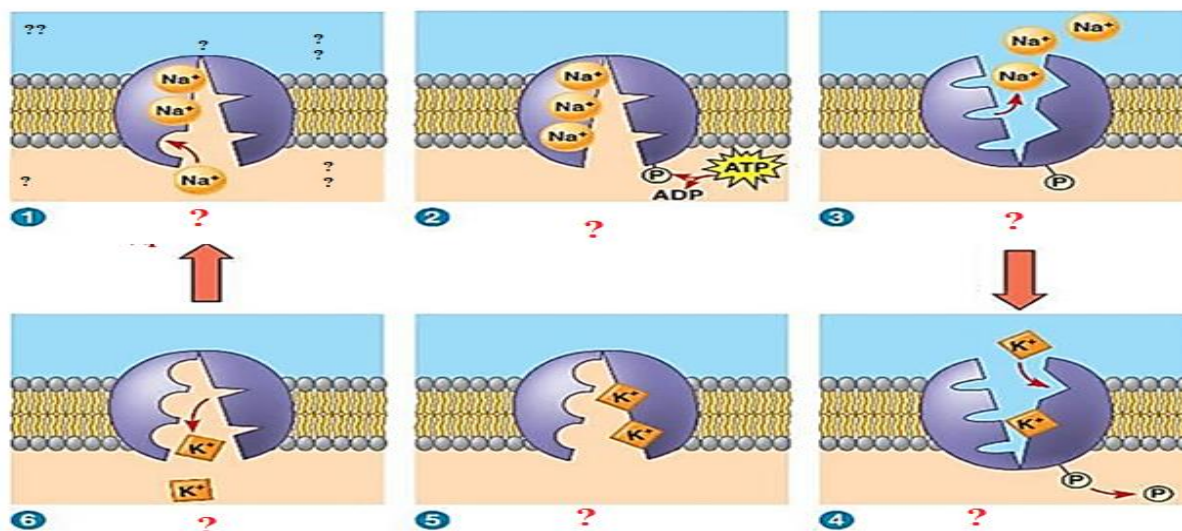




Объясните, какой процесс изображен на рисунке.
Подпишите, что указано под вопросами: ? - тип
молекулы, ? - тип взаимодействия,
? - структуры ткани.

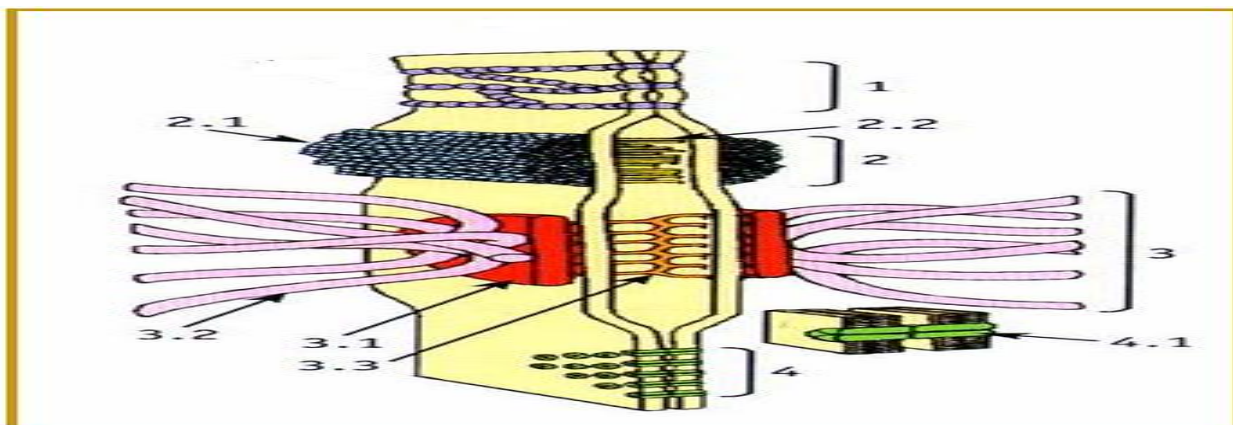


Какие процессы изображены на рисунке?
Дайте ему определение и укажите
условия его функционирования

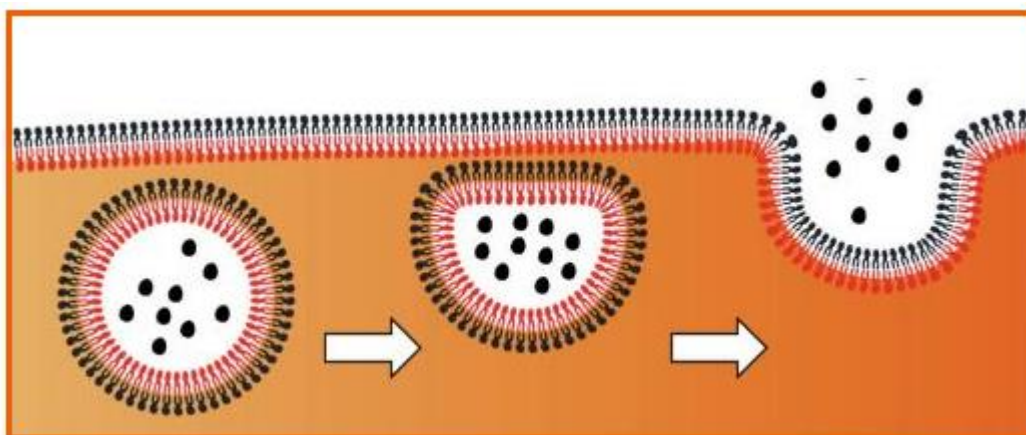


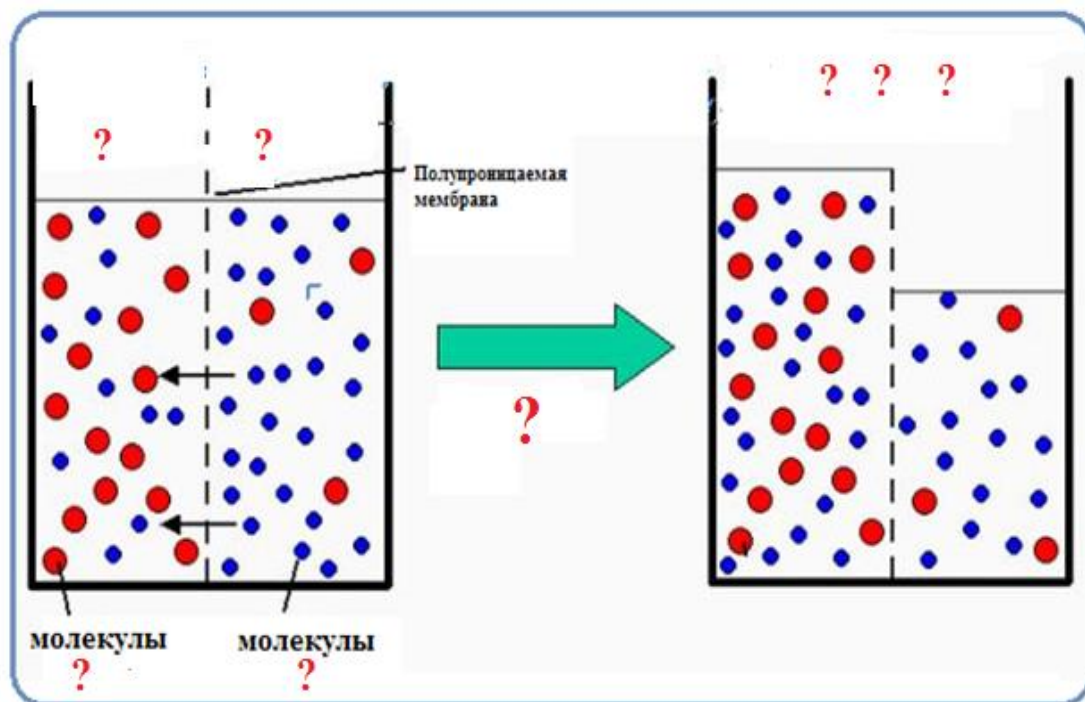
Назовите тип насоса и опишите цикл его работы

Answer which structure is shown in the figure. Sign the structures marked with lines.

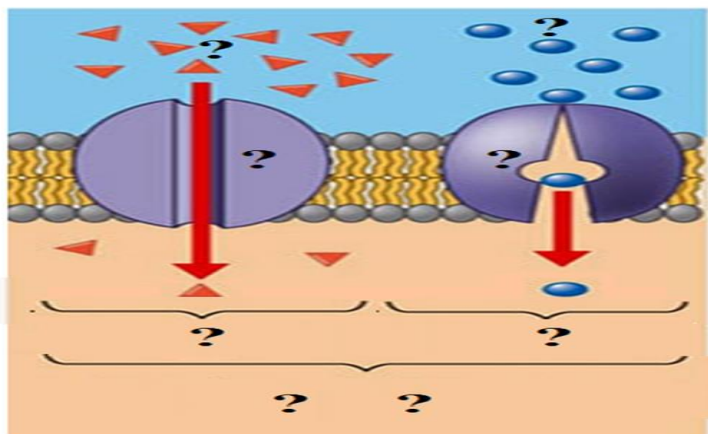


What is indicated in the figure? Name and describe the process. State its importance to cell function






**Какой процесс изображен на рисунке?
Дайте ему определение и укажите
условия его функционирования**



**Какие процессы изображены на рисунке?
Дайте им определение и укажите
условия их функционирования**


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I. Answer the questions:

1. What are monolayer, bilayer and vesicles (liposomes and vesicles)?
2. What are membrane proteins?
3. What are peripheral and integral.
4. What is endocytosis?
5. What is exocytosis

Topic №4: Structure and operation of ion channels and pumps.

I. Tests:

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- The transport of substances by ion pumps against a concentration gradient using ATP energy is called ... transport.
 - active
 - retrograde
 - passive
 - anterograde
 - diffuse
- The Na⁺, K⁺ pump consists of ... subunits.
 - one ρ- and two α subunits
 - two α- ω subunits
 - two ψ- and one α-
 - two α- and two β-
 - two β- and one ψ-
- the Na⁺, K⁺-pump is necessary for animal cells to
 - maintain osmotic balance.
 - synthesising ATP.
 - creating osmotic balance.
 - creating intracellular depots of Ca²⁺.
 - ensuring secretion of hydrochloric acid by gastric cells.
- ... found in the membranes of muscle cells and red blood cells and in the membrane of the endoplasmic reticulum.
 - Na⁺,K⁺-ATPase
 - Na⁺/K⁺-ATPase
 - Na⁺,K⁺ - pump
 - H⁺-ATPase
 - Ca⁺-ATPase
- Plasmolemmal Ca⁺-ATPase transports Ca²⁺ ions from the cell to the intercellular space, and cytoplasmic Ca⁺-ATPase transports Ca²⁺ ions from the hyaloplasm to the EPS cavity,
 - providing hydrochloric acid secretion by gastric cells.
 - synthesising ATP.
 - maintaining osmotic balance.
 - creating osmotic balance
 - creating intracellular depots of Ca²⁺.
- If channels open when the membrane potential changes, they are ... channels.
 - chemo-dependent
 - potential-dependent
 - co-operatively controlled
 - stimulus-controlled
 - indirectly controlled
- If channels are opened by the action of ligands on chemoreceptors of the cell membrane, they are ... channels.
 - indirectly controlled
 - potential-dependent
 - co-operatively controlled
 - stimulus-controlled

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E) chemo-dependent

8. If channels are opened with the participation of ligands and a certain electrical potential of the membrane, they are ... channels.

A) stimulus-controlled

B) chemo-dependent

C) potential-dependent

D) co-operatively controlled

E) indirectly controlled

9. If channels open under the influence of mechanical stimuli, they are ... channels.

A) co-operatively controlled

B) chemodependent

C) stimulus-controlled

D) potential-dependent

E) indirectly controlled

10. If channels open and close under the action of intracellular signals, they are ... channels.

A) co-operatively controlled

B) chemo-dependent

C) indirectly controlled

D) stimulus-controlled

E) potential-dependent

11. Distant interactions are realised by means of soluble substances secreted by cells into the environment and acting on other cells. These substances are called ...

A) mediators.

B) receptors.

C) receptors.

D) modulators.

D) modifiers.

12. Interactions that provide a strong connection between cells are

A) distant.

B) controlling.

C) contact.

D) anterograde.

D) retrograde.

13. The process of recognition and interaction between specific glycoproteins of two contiguous plasma cell membranes or cell membranes and extracellular matrix, is called

A) morphogenesis.

B) apoptosis.

C) histogenesis.

D) adhesion.

D) cell migration.


14. Proteins that provide direct cell-cell interaction are called proteins of

A) apoptosis.

B) adhesion.

C) carcinogenesis.

D) embryogenesis.

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D) recreation.

15. Proteins that provide intercellular adhesive contacts are:

A) Cadherins.

B) Globulins.

C) Glutelins.

D) Histones.

D) Protamines.

16. Proteins that provide intercellular adhesive contacts are:

A) Integrins.

B) Albumin.

C) Globulins.

D) Insulins.

D) Proteases.

17. Proteins that provide intercellular adhesive contacts are:

A) Albumin.

B) Selectins.

C) Phosphotases.

D) Proteases.

E) Nucleases.

18. Proteins that provide intercellular adhesive contacts are:

A) Actin.

B) Albumin.

C) Tubulin.

D) ICAM proteins.

E) Transferrin

19. A family of transmembrane proteins with a mass of 120-140kJ, Ca⁺⁺-dependent, consisting of 5 ectodomains and containing 4 cysteine residues each are

A) cadherins.

B) selectins.

C) integrins.

D) laminins.

D) fibronectins.

20. When extracellular Ca²⁺ is removed, tissue disintegration into individual cells occurs. This is due to the fact that adhesion is a ... process.

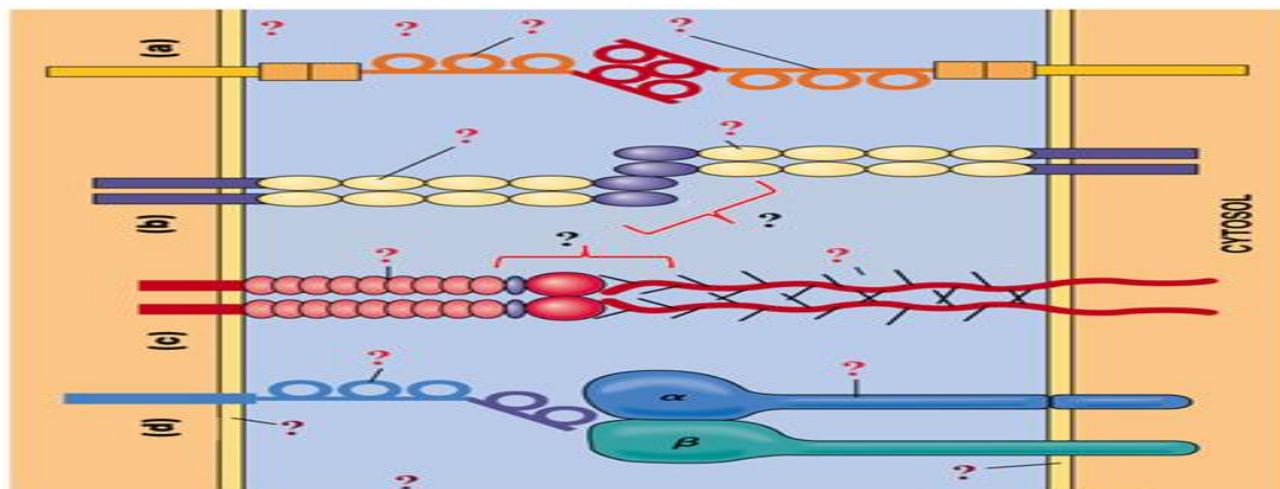
A) calcium-dependent

B) potassium-dependent

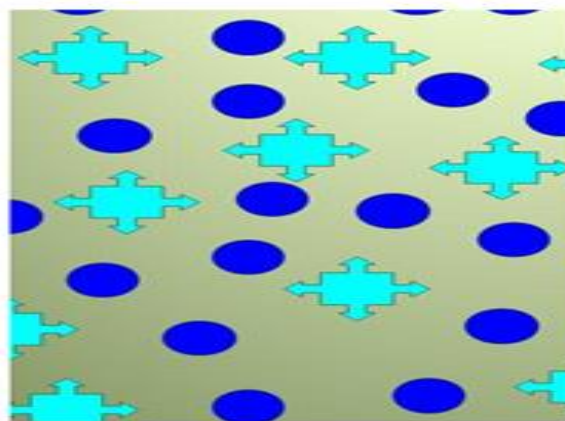
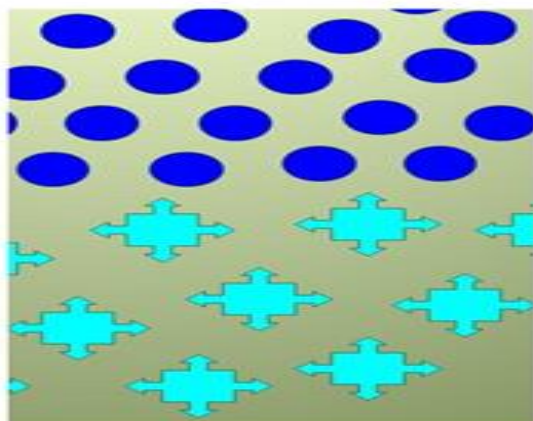
C) magnesium-dependent

D) sodium-dependent

E) phosphorus-dependent




Объясните, какой процесс изображен на рисунке. Подпишите, что указано под вопросами: ? - тип молекулы, ? - тип взаимодействия, ? - структуры ткани.



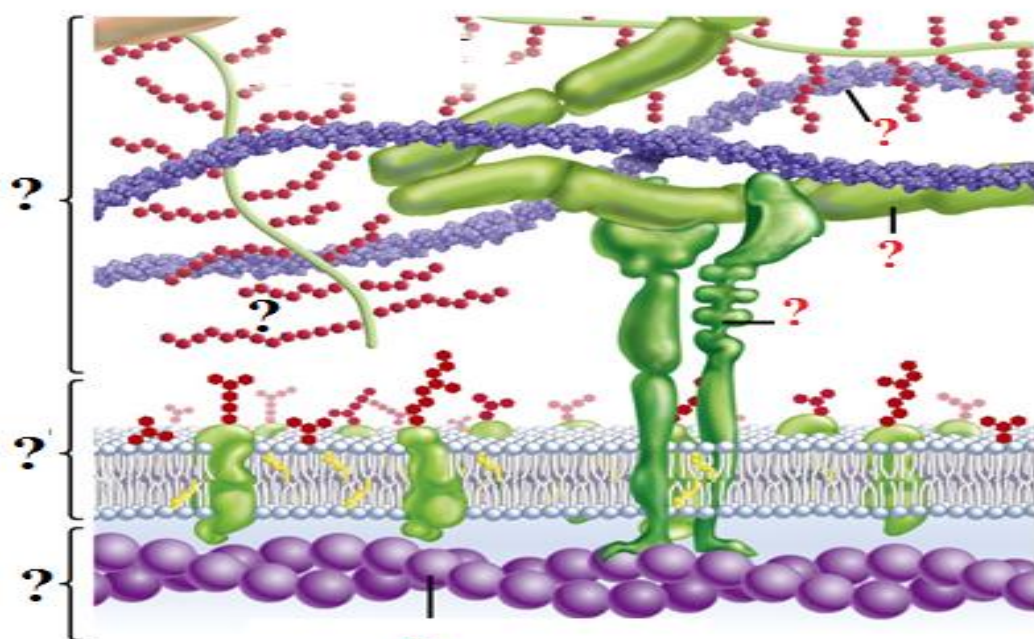
Какой процесс изображен на рисунке? Дайте ему определение и укажите условия его функционирования

Topic №5: Structure and function of cellular non-membrane organelles and the cytoskeleton of the cell.
I. Answer the questions:

1. Genetic material of prokaryotic cell
2. Genetic material of eukaryotic cell
3. Levels of organisation of the genetic material of the cell
4. Levels of compactisation of the genetic material of the cell
5. What are the components of chromatin?
6. Which of the cell structures contain chromatin?
7. Structural and functional state of chromosomes in a non-dividing cell
8. Structural and functional state of chromosomes in a dividing cell

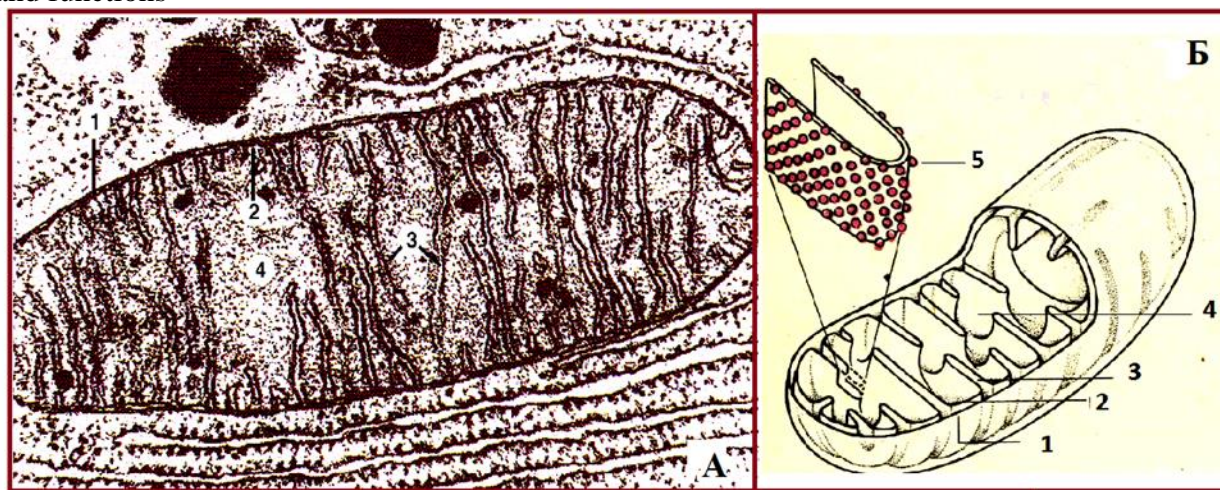
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9. Determine the chemical composition of a chromosome?
10. What is the genetic material in a eukaryotic cell?
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12. Forms of structural organisation of chromosomes in the cell cycle
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36. Structure and function of the ribosome
37. Structure and function of the cytoskeleton
38. Structure and functions of mitochondria

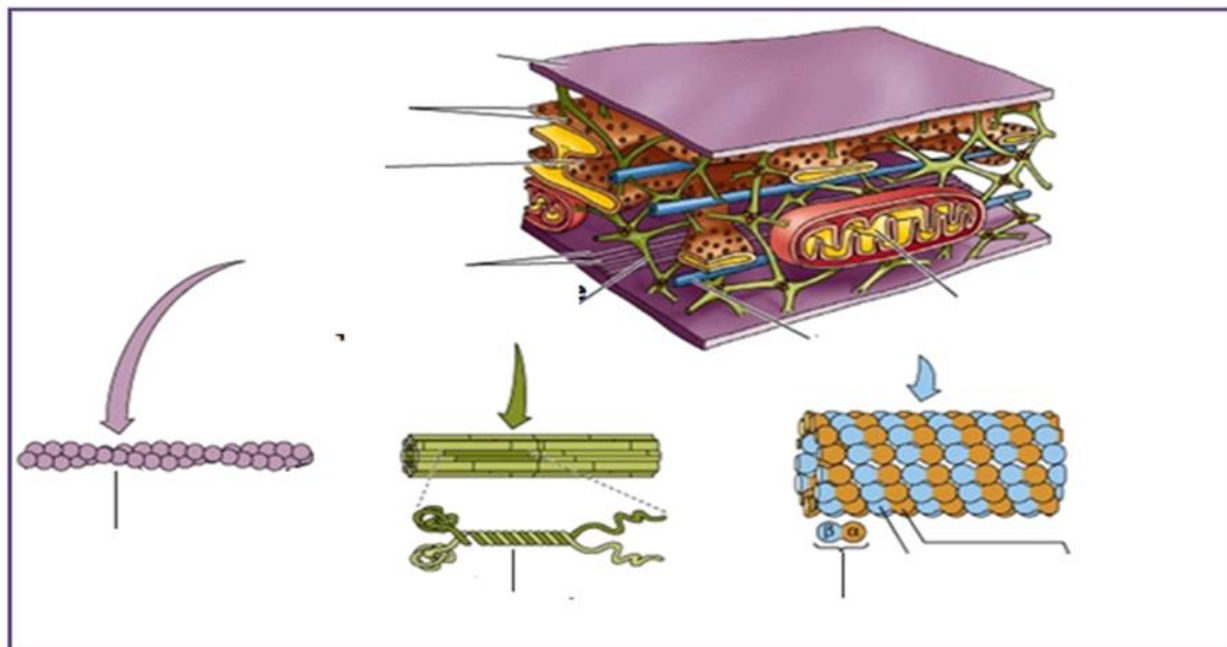


Какая часть ткани показана на рисунке? Назвать структуры, отмеченные вопросами. Ответьте, какую функцию выполняют структуры, отмеченные вопросами.

Answer which structure is shown in the figure. Sign the structures marked with lines, indicate its location and functions




Answer which structure is shown in the figure. Sign the structures marked with lines, indicate its location and functions



Topic №6: Molecular structure and functions of cell membrane organelles and nucleus.

I. Answer the questions:

1. Genetic material of prokaryotic cell
2. Genetic material of eukaryotic cell
3. Levels of organisation of the genetic material of the cell
4. Levels of compactisation of the genetic material of the cell
5. What are the components of chromatin?
6. Which of the cell structures contain chromatin?
7. Structural and functional state of chromosomes in a non-dividing cell
8. Structural and functional state of chromosomes in a dividing cell
9. Determine the chemical composition of a chromosome?
10. What is the genetic material in a eukaryotic cell?
11. What is the genetic material in prokaryotes?
12. Forms of structural organisation of chromosomes in the cell cycle
13. Cellular components involved in the transmission of external signal into the cell
14. Intercellular signalling substances
15. Stages of signal transduction into the cell
16. Enzymes involved in cell signalling processes
17. Signalling mechanisms not related to surface receptors
18. Name the components of the cell that have a membrane structure and characterise them

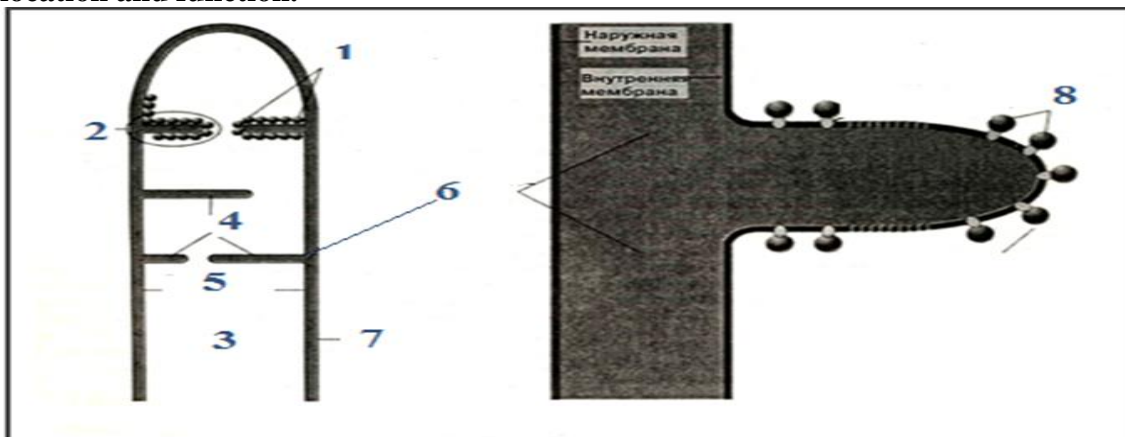
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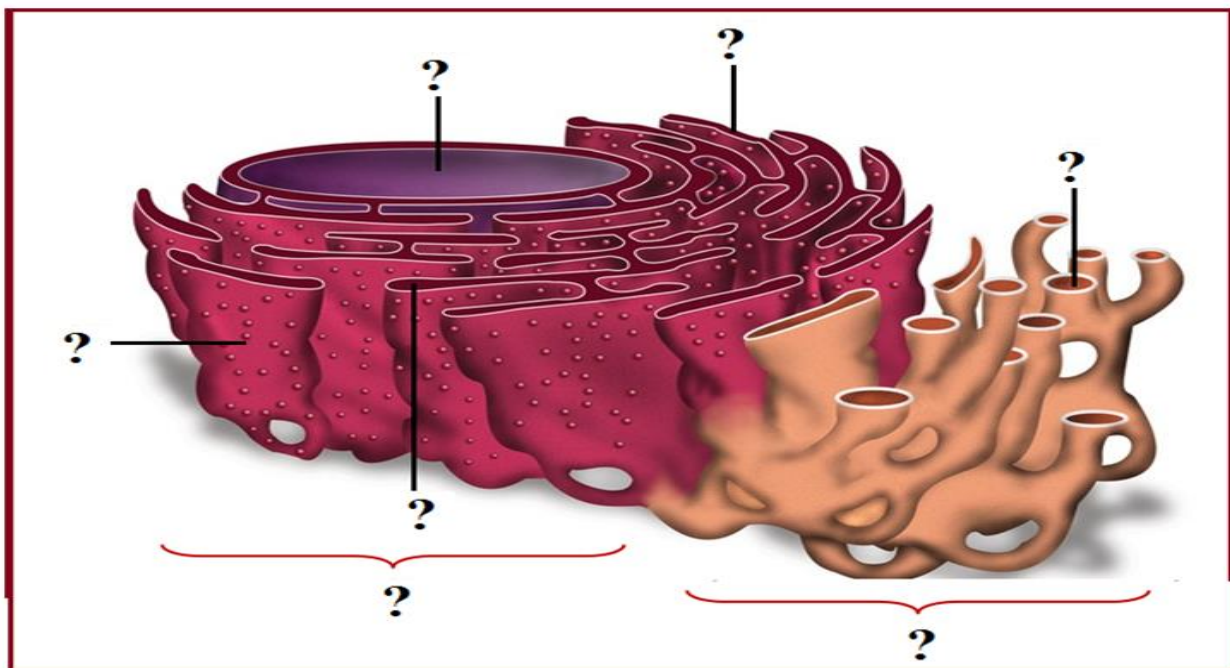
19. What are the components of a biomembrane?
20. The biomembrane differentiates between which proteins?
21. Membrane lipids have what ends?
22. Functions of the plasma membrane
23. Selective permeability of the membrane
24. Protein and ATP synthesis occurs in which organoids?
25. Active and passive transport
26. Vesicular transport
27. ion channels and pumps
28. intercellular interactions. Contacts.
29. Adhesive proteins.
30. Basic principles of cellular theory
31. Structure and functions of the nucleus
32. Structure and functions of the EPT
33. Structure and function of the Golgi complex
34. Structure and function of the lysosome
35. Structure and function of the peroxisome
36. Structure and function of the ribosome
37. Structure and function of the cytoskeleton
38. Structure and functions of mitochondria

II. Oral questions:

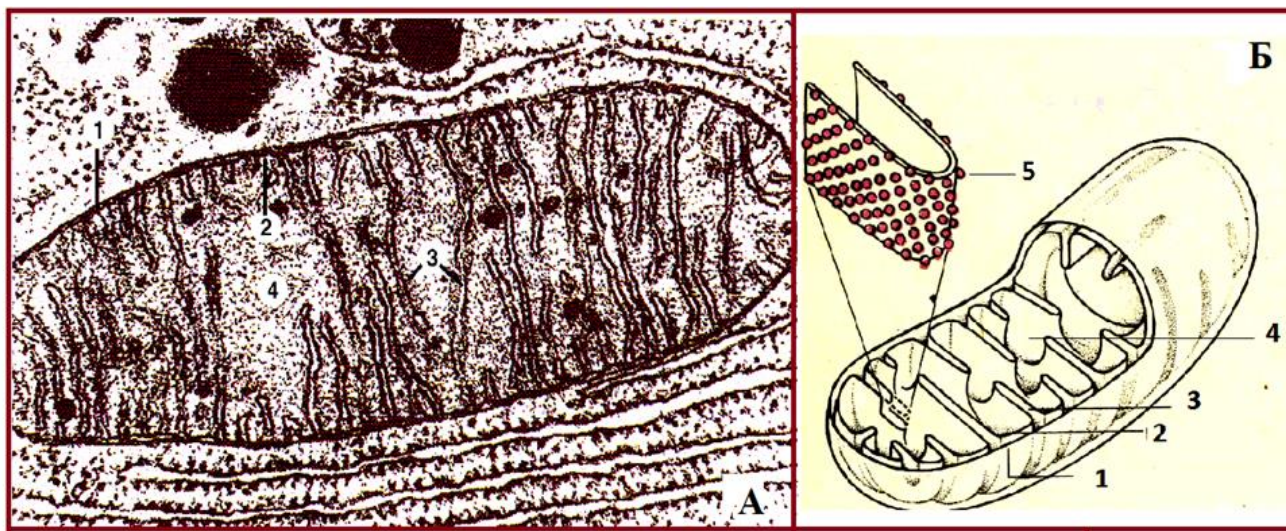
1. Membrane organelles of the cell.
2. Structure and functions of mitochondrion, Golgi complex.
3. Three-dimensional model of Golgi complex, ER
4. Nuclear apparatus of the cell, structural organization of chromatin, karyoplasm.


Answer which structure is shown in the figure. Sign the structures marked with lines, indicate its location and function.





Answer which structure is shown in the figure. Sign the structures marked with lines and, indicate its location and functions.



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Topic №7: Intercellular interactions. Contacts.

I. Tests

- Distance interactions are carried out by soluble substances secreted by cells into the environment and acting on other cells. These substances are called ...
 - secretions
 - receptors.
 - mediators.
 - modulators.
 - modifiers.
- Interactions that provide a strong connection between cells are
 - anterograde.
 - controlling.
 - distant.
 - contact.
 - retrograde.
- The process of recognition and interaction between specific glycoproteins of two contiguous plasma membranes of cells or cell membranes and extracellular matrix, are called
 - histogenesis.
 - apoptosis.
 - adhesion.
 - morphogenesis.
 - cell migration.
- Proteins that provide direct cell-cell interaction are called proteins of
 - recreation.
 - apoptosis.
 - carcinogenesis.
 - embryogenesis.
 - adhesion.
- Proteins that provide intercellular adhesive contacts are:
 - Cadherins.
 - Globulins.
 - Glutelins.
 - Histones.
 - Protamines.
- Proteins that provide intercellular adhesive contacts are:
 - Integrins.
 - Albumin.
 - Globulins.
 - Insulins.
 - Proteases.
- Proteins that provide intercellular adhesive contacts are:
 - Phosphotases.
 - Albumin.
 - Selectins.
 - Proteases.

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D) Nucleases.

8. Proteins that provide intercellular adhesive contacts are:

- A) ICAM proteins.
- B) Albumin.
- C) Tubulin.
- D) Actin.
- D) Transferrin

9. A family of transmembrane proteins with a mass of 120-140kD, Ca⁺⁺-dependent, consisting of 5 ectodomains and containing 4 cysteine residues each are

- A) laminins.
- B) selectins.
- C) integrins.
- D) cadherins.
- D) fibronectins.

10. When extracellular Ca²⁺ is removed, tissue disintegration into individual cells occurs. This is due to the fact that adhesion is a ... process.

- A) potassium-dependent
- B) calcium-dependent
- C) magnesium-dependent
- D) sodium-dependent
- E) phosphorus-dependent

11. When the membrane cadherins of two neighbouring cells bind, adhesion is ensured by ... binding.

- A) heterophilic
- B) amphiphilic
- C) hydrophilic
- D) homophilic
- D) dietheric

12. Cadherins also appear in the organism at the ... embryonic stage of ontogenesis.


- A) progenesis
- B) organogenesis
- C) fragmentation
- D) blastulation
- E) segregation

13. When cell membrane integrins bind to the extracellular matrix, adhesion is provided by binding.

- A) heterophilic
- B) homophilic
- C) hydrophilic
- D) amphiphilic
- E) dietheric

14. Integral proteins - receptors for protein molecules of fibronectin extracellular matrix are

- A) elastins.
- B) cadherins.
- C) selectins.
- D) laminins.

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D) integrins.

15. Integrins are heterodimer proteins consisting of ... and subunits.

- A) α - and β -
- B) α - and ψ -
- C) δ - and β -
- D) ω - and β -
- E) γ - and σ -

16. Protein subunits ... consist of three domains: extracellular, membrane and intracellular.

- A) selectins
- B) cadherins
- C) integrins
- D) laminins
- D) elastins

17. Recognition of specific ligands and adhesion with them are responsible for

- A) extracellular domains, integrins.
- B) intracellular domains of integrin proteins.
- C) extracellular domains, selectin.
- D) intracellular domains of lectin proteins.
- E) extracellular domains of cadherin.

18. Responsible for binding to cytoskeleton proteins are

- A) intracellular domains of integrin proteins.
- B) extracellular domains, integrin.
- C) extracellular domains, selectin.
- D) intracellular domains of lectin proteins.
- E) extracellular domains of cadherin.

19. ... Cytoskeleton provide the link between the adhesive protein and the cytoskeleton.

- A) Extracellular matrix proteins
- B) Oxidoreductases
- C) Globular proteins
- D) Anchor proteins
- E) Hormone proteins

20. Functioning of integrins is a ... dependent process.


- A) magnesium
- B) potassium and magnesium
- C) calcium and magnesium
- D) sodium and calcium
- E) phosphorus and potassium

II. Situational tasks

1. **Fill in the blanks in the following statements.**

A. The network of interlocking coils of protein and polysaccharide molecules adjacent to the outer surface of most cells in multicellular organisms is called _____ .

b. Skin and bone are composed primarily of _____ , a name often used to refer to the extracellular matrix along with the cells enclosed within it.

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- B. _____ are long unbranched polysaccharide chains composed of repeating disaccharide units that necessarily contain an amino sugar.
- c. _____ is a polysaccharide found in large quantities in the extracellular matrix of animal embryos; it is distinguished from other glycoaminoglycans by its large size, lack of sulfate groups, and simple structure - it is made of repeating disaccharide units.
- d. _____ are synthesised in much the same way as glycoproteins, but their polysaccharide chains are attached to serine residues, and the molecular mass of the carbohydrate may exceed that of the core protein by 10-20 times.
- E. _____ are the most abundant proteins in mammals; their distinguishing features are their three-chain helical structure and high glycine and proline content.
- f. The major component of elastic fibres is _____; it is a very hydrophobic non-glycosylated protein containing little hydroxyproline and hydroxylysine.
- g. Of all the extracellular adhesion glycoproteins, the best studied is _____, which promotes cell-to-substrate adhesion by binding to cell surface receptors and to various components of the extracellular matrix.
- k. The continuous thin layer of specialised extracellular matrix underlying all epithelial layers and tubules and surrounding individual muscle and fat cells is called _____.
- l. _____, a glycoprotein composed of three cross-linked polypeptides, binds to type IV collagen, heparin sulfate, and cell surfaces.

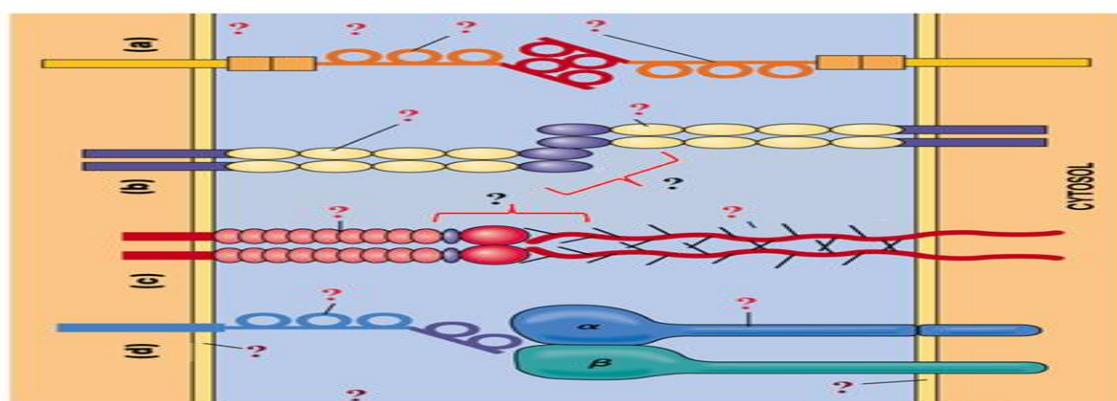
2. State which of the following statements are true and which are false. If the statement is incorrect, explain why.

- A. The extracellular matrix is a relatively inert filler that stabilises tissue structure.
- B. The main chemical difference between glycoproteins and proteoglycans relates to the structure of their carbohydrate side chains: in glycoproteins they are short, highly branched oligosaccharides, while in proteoglycans they are much longer unbranched polysaccharide chains.
- C. Proteoglycans of the basal membrane of the renal tubules play a crucial role in regulating the flow of macromolecules from the blood into the urine.
- D. Collagen degradation and resynthesis are very important for the maintenance of the extracellular matrix: otherwise the lack of vitamin C would not lead to scurvy, in which there is a progressive weakening of connective tissue due to insufficient collagen hydroxylation.
- E. During maturation of fibrillar collagens, three peptide bonds in each polypeptide monomer are broken.
- E. When cytochalasin disrupts the actin microfilaments of fibroblasts; the cells lose contact with fibronectin fibres in the substrate, indicating a direct link between fibronectin and actin.
- G. Most types of collagens form fibrils, but type IV collagen molecules instead form a layer-like network that forms the basis of the basal membrane.
- H. The elastic properties of elastin are due to its high content of alpha-helices, which act as molecular springs.
- I. Cells never bind to extracellular matrix molecules directly, but always indirectly through extracellular glycoproteins.

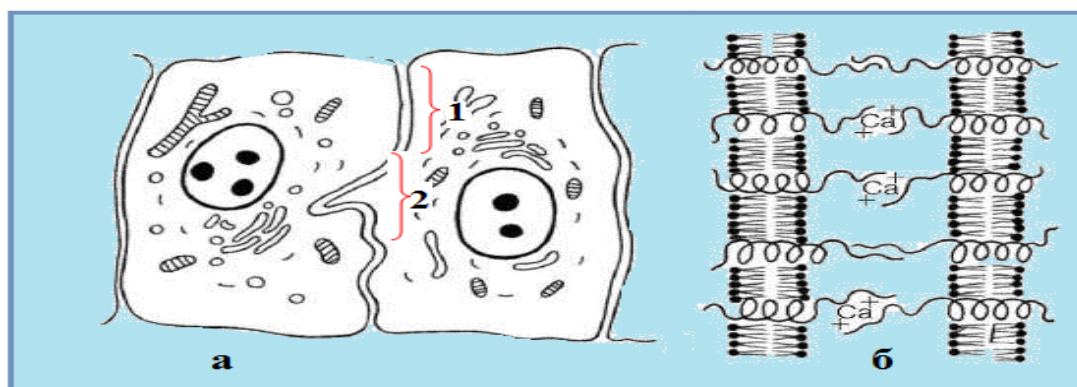
III. Oral response questions:

- Definition of the concept of adhesion
 - Families of adhesive membrane proteins
- integrins;

- selectins
- adhesive immunoglobulins
- cadherins
- 3 Mechanism of T-lymphocyte homing.
- 4. Mechanism of T-cell migration
- 5. Inflammatory response and adhesion
- 6. Immune responses
- 7. Intercellular contacts
- 8. Types of contacts:
 - simple intercellular junctions
 - interdigitation
 - adhesive belt
 - tight junction
 - nexus or slit-like connection



Объясните, какой процесс изображен на рисунке. Подпишите, что указано под вопросами: ? - тип молекулы, ? - тип взаимодействия, ? - структуры ткани.




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Name the type of contact. Describe its structure. Name the adhesive proteins. For which cells it is characteristic. Name its function.


Topic №8: Adhesive function of membranes. External signal transduction in the cell.

I. Answer the test questions:

- The most studied adhesive proteins are the membrane proteins of
 - of blood cells and endotheliocytes.
 - blood cells.
 - endotheliocytes.
 - skeletal muscle cells.
 - blood cells and neurons.
- Adhesive membrane proteins are often referred to ...
 - channels.
 - pumps.
 - ligands.
 - matrix.
 - receptors.
- Integrins are integral proteins of heterodimeric structure consisting of subunits of
 - alpha G, betta.
 - alpha, betta-ji.
 - alpha ji, betta ji.
 - alpha, betta.
 - alpha, sigma
- The intracellular domains of integrins are involved in
 - promoter recognition.
 - fixation of the cytoskeleton.
 - fixation of antigen on the receptor.
 - formation of the ligand-receptor complex.
 - terminator recognition
- Selectins are proteins that are
 - dimers.
 - trimers.
 - tetramers.
 - monomers.
 - complexes of proteins
- Immunoglobulins are
 - antigen to antibody.
 - a promoter.
 - an antibody to an antigen.
 - a ligand.
 - a histone.
- A key feature of cadherins is that their activity occurs only in the presence of ions
 - Ca²⁺.
 - Fe³⁺.

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- C. Na^+ .
D. K^+ .
E. Zn^{2+} .
8. Mediators of inflammation do not include
A. histamine.
B. thrombin.
C. interleukin-1.
D. prion.
E. somatostatin
9. Caspases are found in the cytoplasm of
A. cells that have entered into division.
B. cells that have entered apoptosis.
C. cells that have entered necrosis.
D. germ cells in the form of caspases.
E. all cells as procaspases.
10. The activity of caspases depends on
A. the presence of the caspase gene.
B. the absence of inhibitors in the cell.
C. the presence of intensifiers in the cell.
D. the receptor .
E. the presence of stimulators in the cell.
11. The content of the p53 protein is regulated mainly .
A. at the level of synthesis.
B. regulated spontaneously.
C. by specific mediators.
D. at the level of decay.
E. at the level of termination
12. Under normal conditions, the activity and content of the p53 protein is ...
A. high.
B. medium.
C. low.
D. is not expressed.
E. is regulated by ions
13. The restraining agent for factor p53 is not ...
A. SRP protein.
B. Mdm2 protein.
C. ARF.
D. 14-3-3b.
E. ATS protein
14. In an aqueous environment, amphiphilic molecules form a bilayer
A. by active transport.
B. by passive transport.
C. as a result of ATP cleavage
D. by translocase activity
E. spontaneously.

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15. Transmembrane proteins are embedded in the membrane
 - A. superficially, acting as receptors.
 - B. through its lipid bilayer.
 - C. superficially, acting as transport channels.
 - D. deep, but do not penetrate the lipid bilayer.
 - E. superficially, acting as intracellular receptors
16. Virtually every molecule of membrane lipid ...
 - A. has a hydrophilic "head" and 2 hydrophobic "tails".
 - B. has a hydrophilic "head" and a hydrophilic "tail".
 - C. has a hydrophobic "head" and 2 hydrophilic "tails".
 - D. has a hydrophobic "head" and a hydrophilic "tail".
 - E. has no specific separation.
17. Sphingolipids include sphingosine in their composition instead of ...
 - A. glycerol and a nitrogenous base.
 - B. a nitrogenous base and a phosphoric acid residue.
 - C. glycerol and a phosphoric acid residue.
 - D. glycerol and an amino acid
 - E. glycerol and a fatty acid.
18. Glycolipids ...
 - A. do not have a sphingosine molecule.
 - B. do not have a sphingosine molecule but are highly related to it.
 - C. have a sphingosine molecule.
 - D. have a cholesterol molecule.
 - E. have an amino acid molecule
19. In active transport ...
 - A. the substance diffuses across the membrane by translocase, against a concentration gradient
 - B. the substance diffuses across the membrane with the help of translocase
 - C. the substance diffuses across the membrane from a compartment with a higher concentration to a compartment with a lower concentration
 - D. the substance diffuses across the membrane from a compartment with equal concentration
 - E. in either direction
20. In the renal tubules, glucose penetrates into the epithelial cell by
 - A. facilitated diffusion.
 - B. simple diffusion.
 - C. symport with K⁺ ions
 - D. import with Ca ions
 - E. symport with Na⁺ ions.

II. Situational tasks

1. Fill in the blanks in the following statements.
 - A. The network of interlocking coils of protein and polysaccharide molecules adjacent to the outer surface of most cells in multicellular organisms is called _____ .
 - B. Skin and bone are composed primarily of _____ , a name often used to refer to the extracellular matrix along with the cells enclosed within it.

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B. _____ are long unbranched polysaccharide chains composed of repeating disaccharide units that necessarily contain an amino sugar.

Г. _____ is a polysaccharide found in large quantities in the extracellular matrix of animal embryos; it is distinguished from other glycoaminoglycans by its large size, lack of sulfate groups, and simple structure - it is made of repeating disaccharide units.

Д. _____ are synthesized in much the same way as glycoproteins, but their polysaccharide chains are attached to serine residues, and the molecular mass of the carbohydrate may exceed that of the core protein by 10-20 times.

E. _____ is the most abundant proteins in mammals; their distinguishing features are their three-chain helical structure and high glycine and proline content.

Ж. The major component of elastic fibres is _____; it is a very hydrophobic non-glycosylated protein containing little hydroxyproline and hydroxylysine.

3. Of all the extracellular adhesion glycoproteins, the best studied is _____, which promotes cell-to-substrate adhesion by binding to cell surface receptors and to various components of the extracellular matrix.

И. The continuous thin layer of specialised extracellular matrix underlying all epithelial layers and tubules and surrounding individual muscle and fat cells is called _____.

K. _____, a glycoprotein composed of three cross-linked polypeptides, binds to type IV collagen, heparan sulfate, and cell surfaces.

2. State which of the following statements are correct and which are incorrect. If the statement is incorrect, explain why.

A. The extracellular matrix is a relatively inert filler that stabilises tissue structure.

B. The main chemical difference between glycoproteins and proteoglycans relates to the structure of their carbohydrate side chains: in glycoproteins they are short, highly branched oligosaccharides, while in proteoglycans they are much longer unbranched polysaccharide chains.

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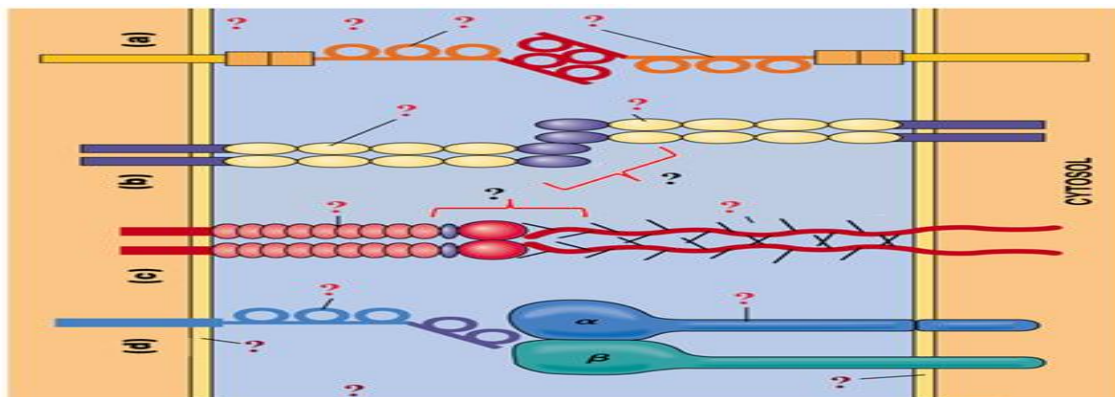
III. Oral response questions:

1. Definition of the concept of adhesion

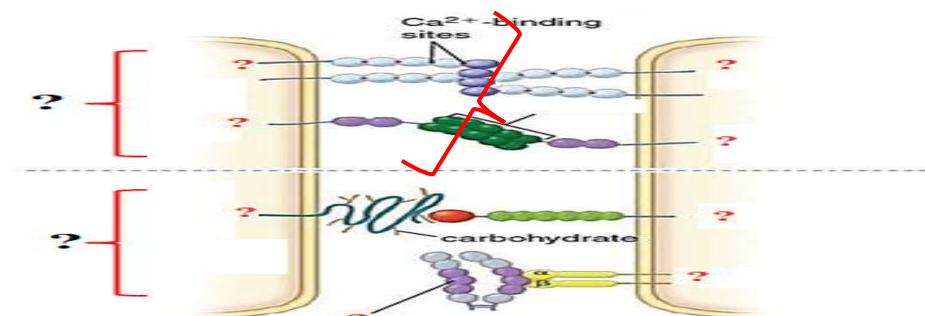
2. Families of adhesive membrane proteins

- integrins;

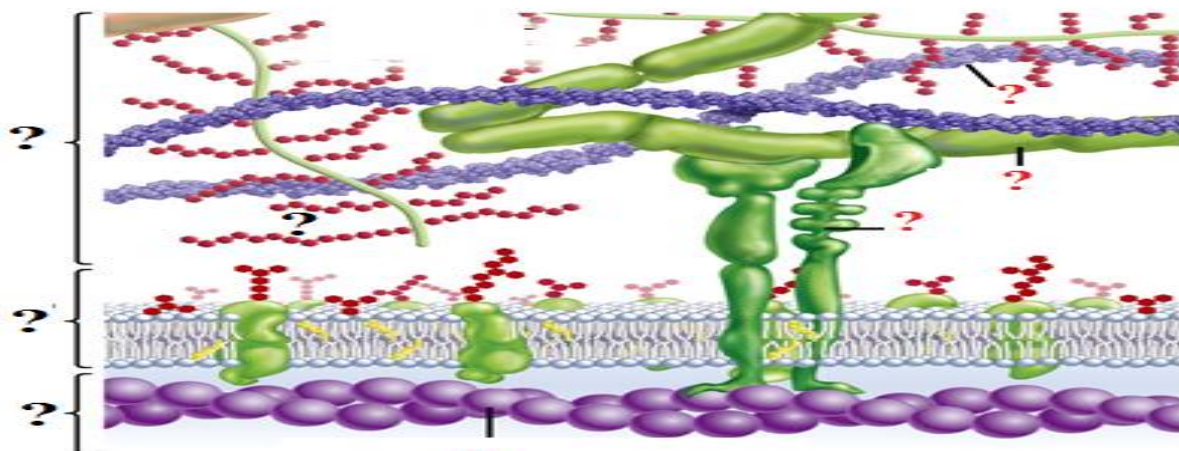
- selectins
 - adhesive immunoglobulins
 - cadherins
- 3 Mechanism of T-lymphocyte homing.
 4. Mechanism of T-cell migration
 5. Inflammatory response and adhesion
 6. Immune responses
 7. Intercellular contacts
 8. Types of contacts:
 - simple intercellular junctions
 - interdigitation
 - adhesive belt
 - tight junction
 - nexus or slit-like connection
 9. Extracellular matrix



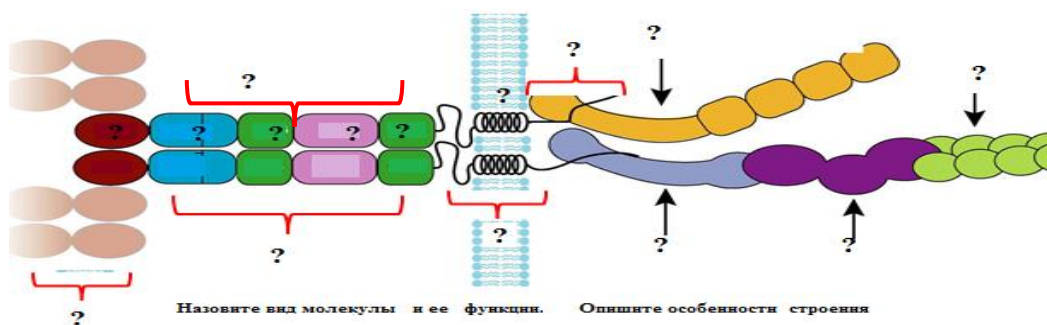
Объясните, какой процесс изображен на рисунке. Подпишите, что указано под вопросами: ? - тип молекулы, ? - тип взаимодействия, ? - структуры ткани.



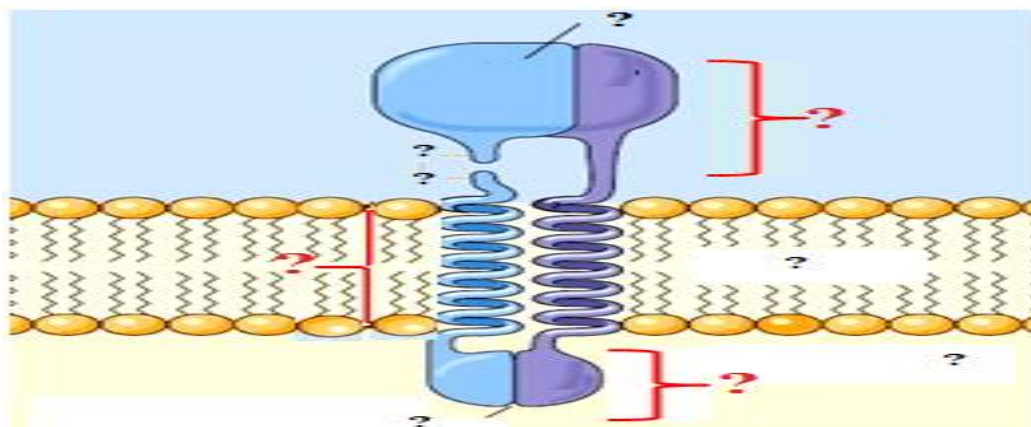
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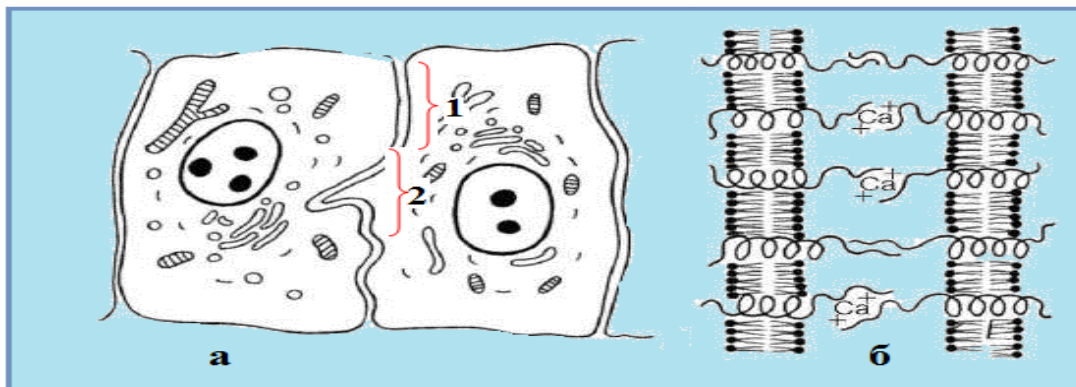
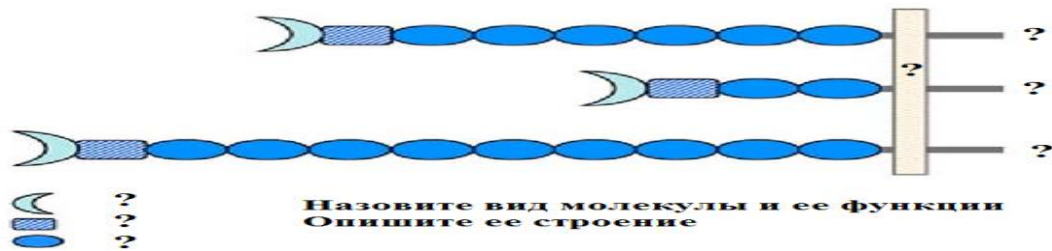
Какая часть ткани показана на рисунке? Назвать структуры, отмеченные вопросами. Ответьте, какую функцию выполняют структуры, отмеченные вопросами.



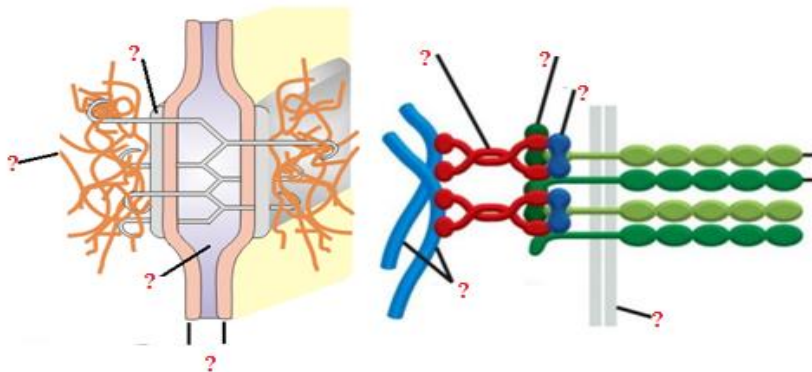
Назовите вид молекулы и ее функции. Опишите особенности строения



Назовите вид молекулы и ее функции. Опишите особенности строения



Name the type of contact. Describe its structure. Name the adhesive proteins. For which cells it is characteristic. Name its function.




Name the type of contact. Describe its structure. Name the adhesive and anchoring proteins of this contact. For which cells it is characteristic. Name its function.

Topic №9: Cell cycle. Mitosis. Meiosis.


I. Answer the test questions:

1. In the cell cycle, DNA replication occurs in


- A) interphase.
- B) prophase.
- C) metaphase.
- D) anaphase.

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- D) telophase.
2. In anaphase I of meiosis to the poles of the dividing cell diverge
- sister chromatids
 - whole chromosomes from homologous pairs.
 - fragments of chromosomes from homologous pairs.
 - fragments of nonhomologous chromosomes.
 - fragments of different chromosomes.
3. In anaphase II of meiosis to the poles of the dividing cell diverge
- sister chromatids.
 - whole chromosomes from homologous pairs
 - fragments of chromosomes from homologous pairs.
 - fragments of non-homologous chromosomes.
 - fragments of different chromosomes.
4. In prophase I of meiosis conjugate
- bivalents of non-homologous chromosomes.
 - sister chromatids.
 - fragments of chromosomes from homologous pairs.
 - fragments of nonhomologous chromosomes.
 - bivalent chromosomes.
5. In prophase I of meiosis crosses
- chromosomes from homologous pairs.
 - sister chromatids.
 - fragments of chromosomes from homologous pairs.
 - fragments of non-homologous chromosomes.
 - fragments of different chromosomes.
6. A set of chromosomes in which each chromosome has a paired homologous chromosome is called
- haploid
 - diploid.
 - triploid.
 - tetraploid.
 - pentaploid.
7. In mitosis, chromosomes line up at the cellular equator during
- telophase.
 - prophase.
 - metaphase.
 - anaphase.
 - interphase.
8. Unlike mitosis, meiosis is
- is characteristic of bacterial cells.
 - is not accompanied by chromosome spiralisation.
 - consists of two divisions.
 - is observed in viruses.
 - takes place in somatic cells.
9. The frequency of crossingover between two genes located on the same chromosome depends on
- the distance between these genes.

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- B) the dominance and recessiveness of these genes.
C) the conditions of crossbreeding.
D) the number of genes in that chromosome.
E) the number of genes in a pair of homologous chromosomes.
10. The stretch of a chromosome connecting two chromatids is called a
A) centromere.
B) acrosome.
C) centrosome.
D) centriole.
D) endosome.
11. Human somatic cells contain ...
A) 46 pairs of chromosomes.
B) 92 pairs of chromosomes.
C) 23 pairs of chromosomes.
D) 32 pairs of chromosomes.
D) 69 pairs of chromosomes.
12. The prophase I of meiosis differs from the prophase of mitosis by
A) destruction of chromosomes.
B) spiralisation of chromosomes.
C) the formation of the division spindle.
D) the presence of conjugation and crossingover.
E) destruction of fragments of non-homologous chromosomes.
13. In the prophase of meiosis I, as well as in the prophase of mitosis
A) chromosome conjugation occurs.
B) despiralisation of chromosomes takes place.
C) the division spindle is formed.
D) protein synthesis occurs.
E) protein denaturation occurs.
14. Anaphase I differs from the anaphase of mitosis
A) the disintegration of sister chromosomes.
B) the absence of conjugation and crossingover.
C) the divergence of chromatids to the poles of the cell.
D) the presence of conjugation and crossingover.
E) divergence of homologous chromosomes to the poles of the cell.
15. The longest period of time in the life cycle of a cell is
A) prophase.
B) telophase.
C) interphase.
D) anaphase.
D) metaphase.
16. During the post-synthetic period of interphase, the cell
A) doubles centrioles, accumulates ATP, synthesises proteins.
B) spirals chromosomes, dissolves the nuclear membrane.
C) synthesises DNA.
D) increases in size, forms RNA and proteins.

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E) divides the cell.

17. During the synthetic period of interphase, the cell

- A) replicates DNA.
- B) spirals chromosomes, dissolves the nuclear membrane.
- C) increases in size, forms RNA and proteins
- D) doubles centrioles, accumulates ATP, synthesises proteins.
- E) divides the cell.

18. During the presynthetic period of interphase, the cell

- A) doubles centrioles, accumulates ATP, synthesises proteins.
- B) spirals chromosomes, dissolves the nuclear membrane.
- C) synthesises DNA.
- D) increases in size, forms RNA and proteins, fulfils its function.
- E) divides the cell.

19. Meiosis results in the formation of ... from the mother cell.

- A) two diploid daughter cells
- B) four haploid daughter cells.
- C) four diploid daughter cells.
- D) two sexually haploid cells.
- E) two haploid daughter cells.

20. Crossingover is the process of

- A) convergence of homologous chromosomes in meiosis
- B) chromosomal mutation.
- C) exchange of sites between homologous chromosomes in meiosis.
- D) divergence of chromatids to the poles of the cell in mitosis.
- E) exchange of sites between non-homologous chromosomes.

21. "Apoptosis from within" in cellular malnutrition is observed in


- A. haemolytic anaemia.
- B. mechanical jaundice.
- C. ischaemic heart disease.
- D. hepatitis B.
- E. Parkinson's disease.

22. The immediate "tools" of apoptosis are


- A. caspases.
- B. amylases.
- C. lipases.
- D. phosphatases.
- E. nucleases.

23. Caspases have an amino acid residue in their active centre -

- A. valine.
- B. alanine.
- C. aginine.
- D. serine.
- E. leucine.

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24. Caspases are found in the cytoplasm of
- cells that have entered into division.
 - cells that have entered apoptosis.
 - all cells, in the form of procaspases.
 - cells that have entered necrosis.
 - germ cells in the form of caspases.
25. The activity of caspases depends on
- the presence of the caspase gene.
 - the presence of intensifiers in the cell.
 - the receptor .
 - the presence of stimulators in the cell.
 - the absence of inhibitors in the cell.
26. The content of the p53 protein is regulated mainly .
- at the level of synthesis.
 - at the level of breakdown.
 - regulated spontaneously.
 - by specific mediators.
 - at the level of termination
27. Under normal conditions, the activity and protein content of p53 is
- high.
 - medium.
 - is not expressed.
 - is regulated by ions
 - low
28. The restraining agent for factor p53 is not ...
- the Mdm2 protein.
 - ARF.
 - SRP protein.
 - 14-3-3b.
 - SRP protein
29. Tumour cells have
- "irregular" membrane structure.
 - "irregular" structure of organelles.
 - The "wrong" structure of the nucleus.
 - The "wrong" genome
 - "wrong" structure of mitochondria
30. The number of genes relevant to oncogenesis is
- 10-15.
 - more than 1500.
 - about 2000.
 - about 1000.
 - 120-150.
11. The p53 protein functions mainly as a .
- a transcription factor.
 - a replication factor.

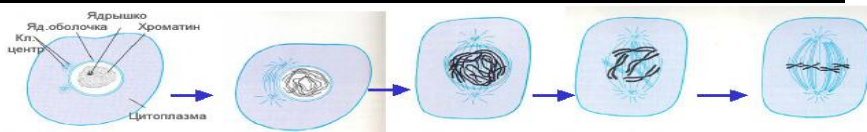
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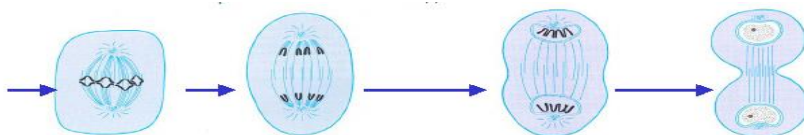
- C. a translational factor.
D. a folding factor
E. mutation factor
12. The p53 protein activates genes responsible for
A. meiosis.
B. mitosis.
C. apoptosis
D. apoptosis and mitosis.
E. amitosis.
13. The p53 protein activates genes responsible for
A. osteogenesis.
B. myogenesis.
C. chondrogenesis.
D. angiogenesis.
E. ontogenesis.
14. p53 is one of the most important tumour ...
A. suppressors.
B. activators.
C. promoters.
D. operators.
E. enhancers.
15. In the first half of the presynthetic period of the cell cycle, a complex.
A. CA+cdk-1
B. CB+CDK1
C. CB+cdk 2
D. CE+cdk 3
E. CD+CDK 4
16. In the second half of the presynthetic period of the cell cycle, the action of the ... complexes.
A. CA+cdk-1
B. CB+ cdk 1
C. CE+ cdk - 2
D. CB+ cdk 2
E. CD+cdk 1
17. In the synthetic period of the cell cycle, the action of ... complexes.
A. CE+CDK 2
B. CB+CDC-1
C. CB+CDC-2
D. CA+CDC-2
E. CD-CZK-4
18. In mitosis, cell division acts in a complex.
A. CE+CDK2
B. CB+CDK1
C. CD+CDC4
D. CD+CDC-6
E. CA+CDC-2

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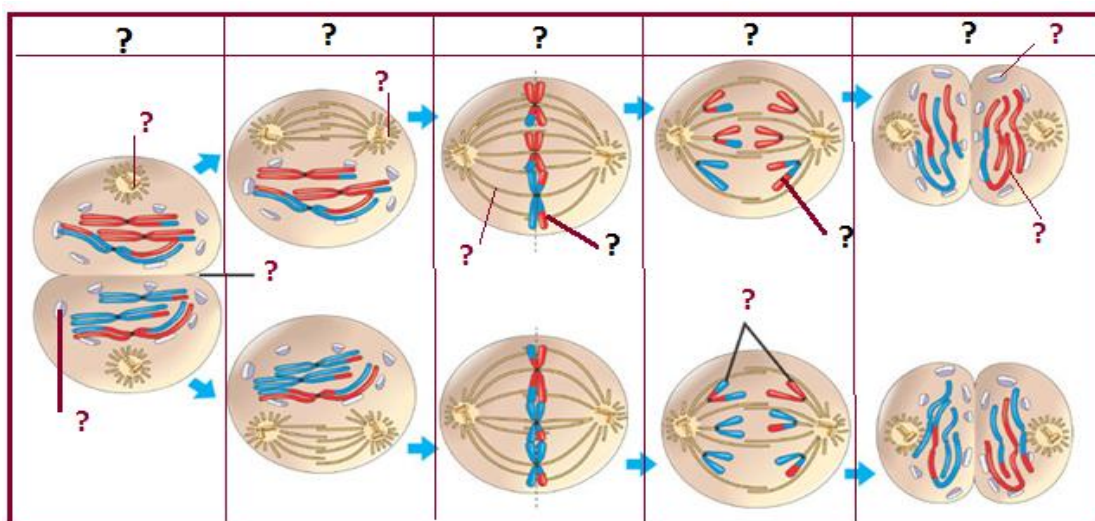
19. A mitosis-stimulating factor is considered to be a complex of
- CB+CDK-1
 - CE+CDC2
 - CD+CDC-4
 - C3+CDK-6
 - CA+CDC-2
20. Cyclin-cyclin-dependent complexes of the presynthetic cycle specific proteins.
- hydrolyse
 - neuralise
 - inhibit
 - phosphorylate
 - dephosphorylate
21. Cyclin-cyclin-dependent synthetic period complexes provide synthesis of any site of DNA.
- repeated
 - repeated
 - single and precise
 - partial
 - terminal
22. Anaphase securing factor is specific ... For mitosis-stimulating factor
- protein kinase
 - caspase
 - hydrolase
 - phosphatase
 - ubiquitin ligase
23. In anaphase of the cell cycle, proteins phosphorylated in prophase are
- are phosphorylated
 - dephosphorylated
 - are hydrolysed
 - synthesised
 - carboxylated
24. Mitosis-stimulating factor (CB+CDK1) phosphorylates ..., which ensures chromosome condensation.
- H1
 - H2A
 - H2B
 - H3
 - H4

II Describe the phases of mitosis that are represented in the figure.






Indicate the type of division and label all its phases in the figure.



Сравнение митоза и мейоза

	Митоз	Мейоз
Фазы деления		
Что происходит с ДНК в интерфазе до начала деления?		
Конъюгация гомологичных хромосом		
Сколько делений подряд происходит?		
Хромосомы или хроматиды расходятся при делении?		
Изменяется ли число хромосом в дочерних клетках?		
Сколько дочерних клеток образуется?		
В каких клетках происходит процесс?		

III. Situational tasks

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1. Fill in the blanks in the following statements.

2. III. Situational tasks

1. Fill in the blanks in the following statements.

- A. During _____, the contents of the nucleus condense to form chromosomes visible in the microscope.
- B. During _____, the cell divides into two daughter cells
- C. The readily observable events of mitosis and cytokinesis together occupy only a short period of the cell cycle, called _____.
- D. The interval between successive mitoses is called _____.
- D. The period of the cell cycle designated for DNA synthesis is called _____.
- E. The cytoplasm of cells in M phase contains a factor called _____; it can bring the nucleus into a state of mitosis at any phase of the cell cycle.

2. State which of the following statements are correct and which are not. If the statement is incorrect, explain why.

- A. The doubling of most cellular components during cell division does not require strict control.
- B. The duration of the cell cycle varies with cell type, with the greatest variation in the G1 phase.
- C. It is not possible to measure cell cycle duration in animal tissues.
- D. Synchronous cell populations can be obtained by centrifugation.
- E. In phase G1, cells undergo a transient state called the start point; it is associated with internal changes leading to the initiation of DNA synthesis.
- J. The rates of synthesis of most proteins vary depending on the stage of the cell cycle.
- K. If a cell in S phase fuses with a cell in early G1 phase, DNA synthesis begins immediately in the nucleus that is in G1 phase.
- L. When cells in G2 phase fuse with cells in S phase, DNA synthesis is blocked in the nuclei of S phase cells. This phenomenon is known as blockade of DNA repeat replication.
- M. When mitotic cells fuse with cells in any other phase of the cell cycle, all nuclei in the shared cytoplasm enter mitosis.
- N. In normal cells, each stage of the cell cycle depends on the proper completion of the preceding stage.
- O. Neither RNA synthesis nor protein synthesis is necessary for cells to enter mitosis.

IV. Oral Answer Questions:


- 1. Cell cycle of a cell and its periods - G1-, G2- and S-periods;
- 2. Mitosis. Phases of mitosis.
- 3. Cell cycle regulation: cyclins and cyclin-dependent kinases, their role in mitotic cycle regulation.
- 4. Mitosis-stimulating factor, its role in the mitotic cycle.
- 5. Mechanism of action of cyclin-Cdk complexes:
 - in G1 - period;
 - in S and G2 periods;
- 6. Cell cycle arrest and transition to apoptosis;

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Topic №10: Molecular mechanisms of apoptosis and oncogenesis. Carcinogenesis

I. Answer the test questions:


1. caspase activity depends on
the presence of the caspase gene.
the presence of intensifiers in the cell.
receptor .
the presence of stimulators in the cell.
the absence of inhibitors in the cell.
2. The immediate "tools" of apoptosis are .
A. caspases.
B. amylases.
C. lipases.
D. phosphatases.
E. nucleases.
3. Caspases have an amino acid residue in their active centre -
A. valine.
B. alanine.
C. aginine.
D. serine.
E. leucine.
4. Caspases are found in the cytoplasm of
A. cells that have entered into division.
B. cells that have entered apoptosis.
C. all cells, in the form of procaspases.
D. cells that have entered necrosis.
E. germ cells in the form of caspases.
5. "Apoptosis from within" in cellular malnutrition is observed in
F. haemolytic anaemia.
G. mechanical jaundice.
H. ischaemic heart disease.
I. hepatitis B.
J. Parkinson's disease.
6. The activity of caspases depends on
A. the presence of the caspases gene.
B. the presence of intensin in the cell.
C. the receptor .
D. the presence of stimulators in the cell.
E. the absence of inhibitors in the cell.
6. The content of the p53 protein is regulated mainly .
A. at the level of synthesis.
B. at the level of breakdown.
C. regulated spontaneously.
D. by specific mediators.
E. at the level of termination

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7. Under normal conditions, the activity and protein content of p53
 - A. high.
 - B. medium.
 - C. is not expressed.
 - D. is regulated by ions
 - E. low
8. The restraining agent for the p53 factor is not the .
 - A. the Mdm2 protein.
 - B. ARF.
 - C. SRP protein.
 - D. 14-3-3b.
 - E. SRP protein
9. Tumour cells have
 - A. "irregular" membrane structure.
 - B. "irregular" structure of organelles.
 - C. The "wrong" structure of the nucleus.
 - D. The "wrong" genome
 - E. "wrong" structure of mitochondria
10. The number of genes relevant to oncogenesis is
 - A. 10-15.
 - B. more than 1500.
 - C. about 2000.
 - D. about 1000.
 - E. 120-150.
11. The p53 protein functions mainly as a .
 - A. a transcription factor.
 - B. a replication factor.
 - C. a translational factor.
 - D. a folding factor
 - E. mutation factor
12. The p53 protein activates genes responsible for
 - A. meiosis.
 - B. mitosis.
 - C. apoptosis
 - D. apoptosis and mitosis.
 - E. amitosis.
13. The p53 protein activates genes responsible for
 - A. osteogenesis.
 - B. myogenesis.
 - C. chondrogenesis.
 - D. angiogenesis.
 - E. ontogenesis.
14. p53 is one of the most important tumour ...
 - A. suppressors.

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- B. activators.
C. promoters.
D. operators.
E. enhancers.
15. In the first half of the presynthetic period of the cell cycle, a complex.
- A. CA+cdk-1
B. CB+CDK1
C. CB+cdk 2
D. CE+cdk 3
E. CD+CDK 4
16. In the second half of the presynthetic period of the cell cycle, the action of the ... complexes.
- A. CA+cdk-1
B. CB+ cdk 1
C. CE+ cdk - 2
D. CB+ cdk 2
E. CD+cdk 1
17. In the synthetic period of the cell cycle, the action of ... complexes.
- A. CE+CDK 2
B. CB+CDC-1
C. CB+CDC-2
D. CA+CDC-2
E. CD-CDK-4
18. In mitosis, cell division acts in a comlex.
- A. CE+CDK2
B. CB+CDK1
C. CD+CDC4
D. CD+CDC-6
E. CA+CDC-2
19. A mitosis-stimulating factor is considered to be a complex of
- A. CB+CDC-1
B. CE+CDC2
C. CD+CDC-4
D. C3+CDK-6
E. CA+CDC-2
20. Cyclin-cyclin-dependent complexes of the presynthetic cycle specific proteins.
- A. hydrolyse
B. neuralise
C. inhibit
D. phosphorylate
E. dephosphorylate
21. Cyclin-cyclin-dependent synthetic period complexes provide synthesis of any site of DNA.
- A. repeated
B. repeated
C. single and precise
D. partial

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E. terminal

22. Anaphase securing factor is specific ... for mitosis-stimulating factor

- A. protein kinase
- B. caspase
- C. hydrolase
- D. phosphatase
- E. ubiquitin ligase

23. In anaphase of the cell cycle, proteins phosphorylated in prophase are

- A. are phosphorylated
- B. dephosphorylated
- C. are hydrolysed
- D. synthesised
- E. carboxylated

24. Mitosis-stimulating factor (CB+CDK1) phosphorylates ..., which ensures chromosome condensation.

- A. H1
- B. H2A
- C. H2B
- D. H3
- E. H4

III. Situational tasks

1. Fill in the blanks in the following statements.

- A. During _____, the contents of the nucleus condense to form chromosomes visible in the microscope.
- B. During _____, the cell divides into two daughter cells
- C. The easily observable events of mitosis and cytokinesis together occupy only a short period of the cell cycle, called _____.
- D. The interval between successive mitoses is called _____.
- E. The period of the cell cycle designated for DNA synthesis is called _____.
- F. The cytoplasm of cells in M phase contains a factor called _____; it can bring the nucleus into a state of mitosis at any phase of the cell cycle.

2. State which of the following statements are correct and which are not. If the statement is incorrect, explain why.

- A. The doubling of most cellular components during cell division does not require strict control.
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- E. In phase G1, cells undergo a transient state called the start point; it is associated with internal changes leading to the initiation of DNA synthesis.
- F. The rates of synthesis of most proteins vary depending on the stage of the cell cycle.
- J. If a cell in S phase fuses with a cell in early G1 phase, DNA synthesis begins immediately in the nucleus that is in G1 phase.
- K. When cells in G2 phase fuse with cells in S phase, DNA synthesis is blocked in the nuclei of S phase cells. This phenomenon is known as blockade of DNA repeat replication.

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L. When mitotic cells fuse with cells in any other phase of the cell cycle, all nuclei in the shared cytoplasm enter mitosis.

M. In normal cells, each stage of the cell cycle depends on the proper completion of the preceding stage.

N. Neither RNA synthesis nor protein synthesis is necessary for cells to enter mitosis.


IV. Oral Answer Questions:

1. Cell cycle of a cell and its periods - G1-, G2- and S-periods;
2. Mitosis. Phases of mitosis.
3. Cell cycle regulation: cyclins and cyclin-dependent kinases, their role in mitotic cycle regulation.
4. Mitosis-stimulating factor, its role in the mitotic cycle.
5. Mechanism of action of cyclin-Cdk complexes:
 - in G1 - period;
 - in S and G2 periods;
6. Cell cycle arrest and transition to apoptosis;


Topic №11: Cell cycle and molecular mechanisms of its regulation.

I. Answer the test questions:

1. In the synthetic period of the interphase of mitosis
 - A) conjugation occurs.
 - B) chromosomes diverge to opposite sides.
 - C) the DNA content doubles.
 - D) bivalents are formed.
 - E) a cell centre is formed.
2. The amount of genetic material of the nucleus in the presynthetic period of interphase is equal to
 - A) 2p 4s.
 - B) 1p 4s.
 - C) 1p 2s.
 - D) 2p 2s.
 - D) 3p.
3. The amount of genetic material of the nucleus in the post-synthetic period of interphase is equal to
 - A) 2p 4s.
 - B) 1p 2s.
 - C) 2p 2s.
 - D) 1p 4s.
 - D) 3p.
4. In the first half of the presynthetic period of the cell cycle, a . complex.
 - A) CE+cdk 3
 - B) CA+cdk1
 - C) CB+cdk1
 - D) CB+cdk 2
 - E) CD+cdk4
5. In the second half of the presynthetic period of the cell cycle, the ... complex.
 - A) CA+cdk1

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- B) CE+ cdk 2
C) CB+ cdk 1
D) CB+cdk 2
E) CD+cdk 1
6. In the synthetic period of the cell cycle, the complex.
- A) CA+cdk2
B) CE+ cdk2
C) CB+ cdk 1
D) CB+ cdk2
E) CD- cdk 4
7. In the mitosis of cell division acts complex.
- A) CB+ cdk 1
B) CE+ cdk 2
C) CD+ cdk 4
D) CD+ cdk 6
E) CA+ cdk 2
8. The mitosis-stimulating factor is considered to be a complex of
- A) CD+ cdk4
B) CE+ cdk 2.
C) CB+ cdk-1.
D) C3+ cdk6.
E) CA+ cdk2.
9. Cyclin-cyclin-dependent complexes of the presynthetic cycle certain proteins.
- A) inhibit
B) hydrolyse
C) neuralise
D) phosphorylate
E) dephosphorylate
10. Cyclin-cyclin-dependent synthetic period complexes provide synthesis of any stretch of DNA.
- A) single and precise
B) multiple
C) repeated
D) partial
E) terminal
11. In anaphase of the cell cycle, proteins phosphorylated in prophase
- A) are hydrolysed.
B) are phosphorylated.
C) dephosphorylated.
D) are synthesised.
E) are carboxylated.
12. Activation of cyclin-dependent kinases requires
- A) cyclic AMP.
B) cyclin.
C) cyclic MSF.
D) cyclosporine.

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D) cholestylin.

13. The checkpoint in G1 is a restriction point

A) where the decision to enter the cell cycle is checked.

B) where the correctness of DNA replication is checked.

C) where the completeness of DNA replication is detected.

D) checks whether all kinetochores are attached to microtubules.

E) the onset of S becomes irreversible, i.e. processes leading to the next cell division are triggered.

14. The S point is a restriction point

A) where the correctness of DNA replication is checked.

B) where the decision to enter the cellular is checked.

C) where the completeness of DNA replication is detected.

D) checks whether all kinetochores are attached to microtubules.

E) the onset of S becomes irreversible, i.e. processes leading to the next cell division are triggered.

15. Low molecular weight substances enter the cell, and are excreted outward by

A) biotransport.

B) cellular transport.

C) transmembrane transport.

D) transcytosis.

D) recreation.

16. Transport of substances that does not require the expenditure of additional energy and occurs along a concentration gradient by diffusion is called

A) passive.

B) active.

C) uniportal.

D) symport.

D) osmotic.

17. The transport of substances carried out against a concentration gradient of substances and requiring the expenditure of ATP energy is called

A) uniportal.

B) passive.

C) active.

D) symport.

D) osmotic.

18. Vesicles that originate from the membrane of one organelle and travel to the membranes of another organelle provide

A) vesicular transport of proteins and lipids synthesised in the plasmalemma.

B) transport of substances that does not require the expenditure of additional energy.

C) transport of substances against a concentration gradient.


D) vesicular transport of proteins and lipids synthesised in EPS.

E) transport of substances through the collagen cell.


19. The process in which the substance absorbed from the cell surface is pre-bound to specific receptors of the plasmalemma and then transported into the cell as part of a fringed vesicle is called receptor-mediated

A) endocytosis.

B) exocytosis.

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- C) transcytosis.
D) phagocytosis.
D) pinocytosis.
20. The molecular structures of membranes that allow ions to move across the membrane in both directions: inward and outward, are called
A) ion channels.
B) transporters.
C) ion pumps.
D) ion conductors.
D) translocases.
21. The immediate "tools" of apoptosis are
A. caspases.
B. amylases.
C. lipases.
D. phosphatases.
E. nucleases.
22. "Apoptosis from within" in cellular malnutrition is observed in
K. haemolytic anaemia.
L. mechanical jaundice.
M. ischaemic heart disease.
N. hepatitis B.
O. Parkinson's disease.
23. Caspases have an amino acid residue in the active centre -
A. valine.
B. alanine.
C. aginine.
D. serine.
E. leucine.
24. Caspases are found in the cytoplasm of
A. cells that have entered into division.
B. cells that have entered apoptosis.
C. all cells, in the form of procaspases.
D. cells that have entered necrosis.
E. germ cells in the form of caspases.
25. The activity of caspases depends on
A. the presence of the caspase gene.
B. the presence of intensifiers in the cell.
C. the receptor .
D. the presence of stimulators in the cell.
E. the absence of inhibitors in the cell.
26. The content of the p53 protein is regulated mainly .
A. at the level of synthesis.
B. at the level of breakdown.
C. regulated spontaneously.
D. by specific mediators.

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E. at the level of termination

27. Under normal conditions, the activity and protein content of p53 is ...

- A. high.
- B. medium.
- C. is not expressed.
- D. is regulated by ions
- E. low

28. The restraining agent for factor p53 is not

- A. the Mdm2 protein.
- B. ARF.
- C. SRP protein.
- D. 14-3-3b.
- E. SRP protein

29. Tumour cells have

- A. "irregular" membrane structure.
- B. "irregular" structure of organelles.
- C. The "wrong" structure of the nucleus.
- D. The "wrong" genome
- E. "wrong" structure of mitochondria

30. The number of genes relevant to oncogenesis is

- A. 10-15.
- B. more than 1500.
- C. about 2000.
- D. about 1000.
- E. 120-150.

31. The p53 protein functions primarily as a .

- A. a transcription factor.
- B. a replication factor.
- C. a translational factor.
- D. a folding factor
- E. mutation factor

32. The p53 protein activates genes responsible for


- A. meiosis.
- B. mitosis.
- C. apoptosis
- D. apoptosis and mitosis.
- E. amitosis.

33. The p53 protein activates genes responsible for

- A. osteogenesis.
- B. myogenesis.
- C. chondrogenesis.
- D. angiogenesis.
- E. ontogenesis.

34. p53 is one of the most important tumour ...

- A. suppressors.

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- B. activators.
- C. promoters.
- D. operators.
- E. enhancers.

35. In the first half of the presynthetic period of the cell cycle, a complex.

- A. CA+cdk-1
- B. CB+CDK1
- C. CB+cdk 2
- D. CE+cdk 3
- E. CD+CDK 4

36. In the second half of the presynthetic period of the cell cycle, the action of the ... complexes.

- A. CA+cdk-1
- B. CB+ cdk 1
- C. CE+ cdk - 2
- D. CB+ cdk 2
- E. CD+cdk 1

37. In the synthetic period of the cell cycle, the action of ... complexes.

- A. CE+CDK 2
- B. CB+CDC-1
- C. CB+CDC-2
- D. CA+CDC-2
- E. CD-CDC-4

38. In mitosis, cell division acts in a comlex.

- A. CE+CDC2
- B. CB+CDC1
- C. CD+CDC4
- D. CD+CDC-6
- E. CA+CDC-2

39. A mitosis-stimulating factor is considered to be a complex of

- A. CB+CDC-1
- B. CE+CDC2
- C. CD+CDC-4
- D. C3+CDK-6
- E. CA+CDC-2

40. Cyclin-cyclin-dependent complexes of the presynthetic cycle specific proteins.

- A. hydrolyse
- B. neuralise
- C. inhibit
- D. phosphorylate
- E. dephosphorylate

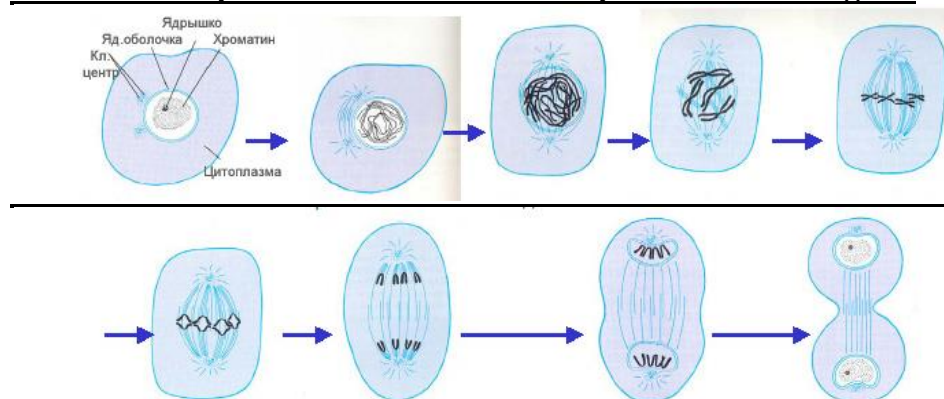
21. Cyclin-cyclin-dependent synthetic period complexes provide synthesis of any site of DNA.

- A. repeated
- B. repeated
- C. single and precise

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- D. partial
E. terminal
22. Anaphase securing factor is specific ... For mitosis-stimulating factor
- A. protein kinase
B. caspase
C. hydrolase
D. phosphatase
E. ubiquitinligase
43. In anaphase of the cell cycle, proteins phosphorylated in prophase are
- A. are phosphorylated
B. dephosphorylated
C. are hydrolysed
D. synthesised
E. carboxylated
44. Mitosis-stimulating factor (CB+CDK1) phosphorylates ..., which ensures chromosome condensation.
- A. H1
B. H2A
C. H2B
D. H3
E. H4

II Describe the phases of mitosis that are represented in the figure.



III. Situational tasks

1. Fill in the blanks in the following statements.

- A. During _____, the contents of the nucleus condense to form chromosomes visible in the microscope.
- B. During _____, the cell divides into two daughter cells
- B. The easily observable events of mitosis and cytokinesis together occupy only a short period of the cell cycle, called _____.
- Г. The interval between successive mitoses is called _____.
- Д. The period of the cell cycle designated for DNA synthesis is called _____.
- E. The cytoplasm of cells in M phase contains a factor called _____; it can bring the nucleus into a state of mitosis at any phase of the cell cycle.

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2. State which of the following statements are correct and which are not. If the statement is incorrect, explain why.

- A. The doubling of most cellular components during cell division does not require strict control.
- B. The duration of the cell cycle varies by cell type, with the greatest variation being in the G1 phase.
- C. It is not possible to measure cell cycle duration in animal tissues.
- D. Synchronous cell populations can be obtained by centrifugation.
- E. In phase G1, cells undergo a transient state called the start point; it is associated with internal changes leading to the initiation of DNA synthesis.
- F. The rates of synthesis of most proteins vary depending on the stage of the cell cycle.
- J. If a cell in S phase fuses with a cell in early G1 phase, DNA synthesis begins immediately in the nucleus that is in G1 phase.
- K. When cells in G2 phase fuse with cells in S phase, DNA synthesis is blocked in the nuclei of S phase cells. This phenomenon is known as blockade of DNA repeat replication.
- L. When mitotic cells fuse with cells in any other phase of the cell cycle, all nuclei in the shared cytoplasm enter mitosis.
- M. In normal cells, each stage of the cell cycle depends on the proper completion of the preceding stage.
- N. Neither RNA synthesis nor protein synthesis is necessary for cells to enter mitosis.


IV. Oral Answer Questions:

- 1. Cell cycle of a cell and its periods - G1-, G2- and S-periods;
- 2. Mitosis. Phases of mitosis.
- 3. Cell cycle regulation: cyclins and cyclin-dependent kinases, their role in mitotic cycle regulation.
- 4. Mitosis-stimulating factor, its role in the mitotic cycle.
- 5. Mechanism of action of cyclin-Cdk complexes:
 - in G1 - period;
 - in S and G2 periods;
- 6. Cell cycle arrest and transition to apoptosis;


Topic №12: Cell cycle and molecular mechanisms of its regulation.

I. Answer the test questions:

- 1. "Apoptosis from within" in cellular malnutrition is observed in
 - A. haemolytic anaemia.
 - B. mechanical jaundice.
 - C. ischaemic heart disease.
 - D. hepatitis B.
 - E. Parkinson's disease.
- 2. The immediate "tools" of apoptosis are
 - A. caspases.
 - B. amylases.
 - C. lipases.
 - D. phosphatases.
 - E. nucleases.
- 3. Caspases have an amino acid residue in their active centre -

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- A. valine.
 - B. alanine.
 - C. aginine.
 - D. serine.
 - E. leucine.
4. Caspases are found in the cytoplasm of
- A. cells that have entered into division.
 - B. cells that have entered apoptosis.
 - C. all cells, in the form of procaspases.
 - D. cells that have entered necrosis.
 - E. germ cells in the form of caspases.
5. The activity of caspases depends on
- A. the presence of the caspase gene.
 - B. the presence of intensifiers in the cell.
 - C. the receptor .
 - D. the presence of stimulators in the cell.
 - E. the absence of inhibitors in the cell.
6. The content of the p53 protein is regulated mainly .
- A. at the level of synthesis.
 - B. at the level of breakdown.
 - C. regulated spontaneously.
 - D. by specific mediators.
 - E. at the level of termination
7. Under normal conditions, the activity and protein content of p53 is ...
- A. high.
 - B. medium.
 - C. is not expressed.
 - D. is regulated by ions
 - E. low
8. The restraining agent for factor p53 is not
- A. the Mdm2 protein.
 - B. ARF.
 - C. SRP protein.
 - D. 14-3-3b.
 - E. SRP protein
9. Tumour cells have
- A. "irregular" membrane structure.
 - B. "irregular" structure of organelles.
 - C. The "wrong" structure of the nucleus.
 - D. The "wrong" genome
 - E. "wrong" structure of mitochondria
10. The number of genes relevant to oncogenesis is
- A. 10-15.
 - B. more than 1500.
 - C. about 2000.

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- D. about 1000.
E. 120-150.
11. The p53 protein functions mainly as a .
A. a transcription factor.
B. a replication factor.
C. a translational factor.
D. a folding factor
E. mutation factor
12. The p53 protein activates genes responsible for
A. meiosis.
B. mitosis.
C. apoptosis
D. apoptosis and mitosis.
E. amitosis.
13. The p53 protein activates genes responsible for
A. osteogenesis.
B. myogenesis.
C. chondrogenesis.
D. angiogenesis.
E. ontogenesis.
14. p53 is one of the most important tumour ...
A. suppressors.
B. activators.
C. promoters.
D. operators.
E. enhancers.
15. In the first half of the presynthetic period of the cell cycle, a complex.
A. CA+cdk-1
B. CB+CDK1
C. CB+cdk 2
D. CE+cdk 3
E. CD+CDK 4
16. In the second half of the presynthetic period of the cell cycle, the action of the ... complexes.
A. CA+cdk-1
B. CB+ cdk 1
C. CE+ cdk - 2
D. CB+ cdk 2
E. CD+cdk 1
17. In the synthetic period of the cell cycle, the action of ... complexes.
A. CE+CDK 2
B. CE+CDK-1
C. CB+CDK-2
D. CB+CDK-2
E. CD-CDK-4
18. In mitosis, cell division acts in a complex.

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- A. CE+CDK2
 - B. CE+CDK1
 - C. CD+CDK4
 - D. CD+CDK-6
 - E. CA+CDK-2
19. A mitosis-stimulating factor is considered to be a complex of
- A. CK+CDK-1
 - B. CE+CDK2
 - C. CD+CDK-4
 - D. CK+CDK-6
 - E. CA+CDK-2
20. Cyclin-cyclin-dependent complexes of the presynthetic cycle specific proteins.
- A. hydrolyse
 - B. neutralise
 - C. inhibit
 - D. phosphorylate
 - E. dephosphorylate
21. Cyclin-cyclin-dependent synthetic period complexes provide synthesis of any site of DNA.
- A. repeated
 - B. repeated
 - C. single and precise
 - D. partial
 - E. terminal
22. Anaphase securing factor is specific ... for mitosis-stimulating factor
- A. protein kinase
 - B. caspase
 - C. hydrolase
 - D. phosphatase
 - E. ubiquitin ligase
23. In anaphase of the cell cycle, proteins phosphorylated in prophase are
- A. are phosphorylated
 - B. dephosphorylated
 - C. are hydrolysed
 - D. synthesised
 - E. carboxylated
24. Mitosis-stimulating factor (CV+CZK1) phosphorylates ..., which ensures chromosome condensation.
- A. H1
 - B. H2A
 - C. H2B
 - D. H3
 - E. H4
25. In the synthetic period of the interphase of mitosis
- A) conjugation occurs.
 - B) chromosomes diverge to opposite sides.
 - C) the DNA content doubles.

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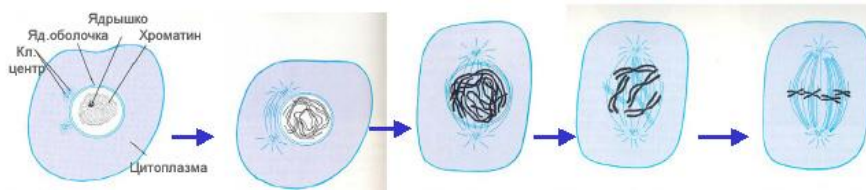
- D) bivalents are formed.
E) a cell centre is formed.
26. The amount of genetic material of the nucleus in the presynthetic period of interphase is equal to
A) 2p 4s.
B) 1p 4s.
C) 1p 2s.
D) 2p 2s.
D) 3p.
27. The amount of genetic material of the nucleus in the post-synthetic period of interphase is equal to
A) 2p 4s.
B) 1p 2s.
C) 2p 2s.
D) 1p 4s.
D) 3p.
28. In the first half of the pre-synthetic period of the cell cycle, the ... complex.
A) CE+cdk 3
B) CA+cdk1
C) CB+cdk1
D) CB+cdk 2
E) CD+cdk4
29. In the second half of the presynthetic period of the cell cycle, the complex.
A) CA+cdk1
B) CE+ cdk 2
C) CB+ cdk 1
D) CB+cdk 2
E) CD+cdk 1
6. In the synthetic period of the cell cycle, a complex.
A) CA+cdk2
B) CE+ cdk2
C) CB+ cdk 1
D) CB+ cdk2
E) CD- cdk 4
7. In cell division mitosis acts complex.
A) CB+ cdk 1
B) CE+ cdk 2
C) CD+ cdk 4
D) CD+ cdk 6
E) CA+ cdk 2
8. The mitosis-stimulating factor is considered to be a complex of
A) CD+ cdk4
B) CE+ cdk 2.
C) CB+ cdk-1.
D) C3 plus cdk6.
D) CA+ cdk2.
9. Cyclin-cyclin-dependent complexes of the presynthetic cycle certain proteins.

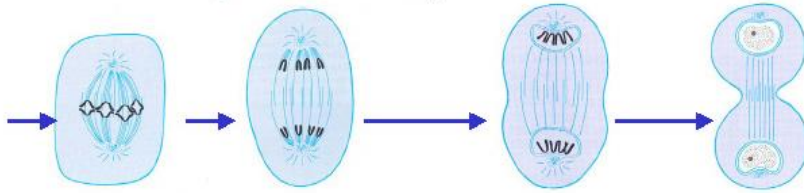
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- A) inhibit
 - B) hydrolyse
 - C) neuralise
 - D) phosphorylate
 - E) dephosphorylate
10. Cyclin-cyclin-dependent synthetic period complexes provide synthesis of any stretch of DNA.
- A) single and precise
 - B) multiple
 - C) repeated
 - D) partial
 - E) terminal
11. In anaphase of the cell cycle, proteins phosphorylated in prophase
- A) are hydrolysed.
 - B) are phosphorylated.
 - C) dephosphorylated.
 - D) are synthesised.
 - D) are carboxylated.
12. Activation of cyclin-dependent kinases requires
- A) cyclic AMP.
 - B) cyclin.
 - C) cyclic FMF.
 - D) cyclosporine.
 - D) cholestylin.
13. The checkpoint in G1 is a restriction point
- A) where the decision to enter the cell cycle is checked.
 - B) where the correctness of DNA replication is checked.
 - C) where the completeness of DNA replication is detected.
 - D) checks whether all kinetochores are attached to microtubules.
 - E) the onset of S becomes irreversible, i.e. processes leading to the next cell division are triggered.
14. The S point is a restriction point
- A) where the correctness of DNA replication is checked.
 - B) where the decision to enter the cellular is checked.
 - C) where the completeness of DNA replication is detected.
 - D) checks whether all kinetochores are attached to microtubules.
 - E) the onset of S becomes irreversible, i.e. processes leading to the next cell division are triggered.
15. Low molecular weight substances enter the cell and are excreted by
- A) biotransportation.
 - B) cellular transport.
 - C) transmembrane transport.
 - D) transcytosis.
 - D) recreation.
16. Transport of substances that does not require the expenditure of additional energy and occurs along a concentration gradient by diffusion is called
- A) passive.
 - B) active.

- C) uniportal.
 D) symport.
 D) osmotic.
17. The transport of substances against a concentration gradient of substances and requiring ATP energy expenditure is called
 A) uniportal.
 B) passive.
 C) active.
 D) symport.
 D) osmotic.
18. Vesicles that originate from the membrane of one organelle and travel to the membranes of another organelle provide
 A) vesicular transport of proteins and lipids synthesised in the plasmalemma.
 B) transport of substances that does not require the expenditure of additional energy.
 C) transport of substances against a concentration gradient.
 D) vesicular transport of proteins and lipids synthesised in EPS.
 E) transport of substances through the collagen cell.
19. The process by which a substance absorbed from the cell surface is first bound to specific receptors on the plasmalemma and then transported into the cell as part of a fringing vesicle is called receptor-mediated
 A) endocytosis.
 B) exocytosis.
 C) transcytosis.
 D) phagocytosis.
 D) pinocytosis.
40. Molecular structures of membranes that allow ions to move across the membrane in both directions: inside the cell and outside, are called
 A) ion channels.
 B) transporters.
 C) ion pumps.
 D) ion conductors.
 D) translocases.

II Describe the phases of mitosis that are represented in the figure





III. Situational tasks

Fill in the blanks in the following statements.

- A. During _____, the contents of the nucleus condense to form chromosomes visible in the microscope.
- B. During _____, the cell divides into two daughter cells
- C. The easily observable events of mitosis and cytokinesis together occupy only a short period of the cell cycle, called _____.
- D. The interval between successive mitoses is called _____.
- E. The period of the cell cycle designated for DNA synthesis is called _____.
- F. The cytoplasm of cells in M phase contains a factor called _____; it can bring the nucleus into a state of mitosis at any phase of the cell cycle.

2. State which of the following statements are correct and which are not. If the statement is incorrect, explain why.

- A. The doubling of most cellular components during cell division does not require strict control.
- B. The duration of the cell cycle varies by cell type, with the greatest variation being in the G1 phase.
- C. It is not possible to measure cell cycle duration in animal tissues.
- D. Synchronous cell populations can be obtained by centrifugation.
- E. In phase G1, cells undergo a transient state called the start point; it is associated with internal changes leading to the initiation of DNA synthesis.
- F. The rates of synthesis of most proteins vary depending on the stage of the cell cycle.
- G. If a cell in S phase fuses with a cell in early G1 phase, DNA synthesis begins immediately in the nucleus that is in G1 phase.
- H. When cells in G2 phase fuse with cells in S phase, DNA synthesis is blocked in the nuclei of S phase cells. This phenomenon is known as blockade of DNA repeat replication.
- I. When mitotic cells fuse with cells in any other phase of the cell cycle, all nuclei in the shared cytoplasm enter mitosis.
- J. In normal cells, each stage of the cell cycle depends on the proper completion of the preceding stage.
- K. Neither RNA synthesis nor protein synthesis is necessary for cells to enter mitosis.

IV. Oral Answer Questions:

1. Cell cycle of a cell and its periods - G1-, G2- and S-periods;
2. Mitosis. Phases of mitosis.
3. Cell cycle regulation: cyclins and cyclin-dependent kinases, their role in mitotic cycle regulation.
4. Mitosis-stimulating factor, its role in the mitotic cycle.
5. Mechanism of action of cyclin-Cdk complexes:
 - in G1 - period;
 - in S and G2 periods;
6. Cell cycle arrest and transition to apoptosis;