An Example for Final Exam – Biophysics 2021

1. Which of the following combinations of factors determine the activation time of the voltage-gated ion channels?

a) the level of membrane depolarization and the specific ion channel kinetics;

b) the level of hyper-polarization of the membrane and the specific channel gate kinetics;

c) the membrane potential and the pH of the cytosol

2. Which of the following descriptions refers to ion channels?

a) protein structures formation of pores in the lipid bilayer;

b) protein structures that transport ions across the membrane with the expense of energy;

c) protein structures that allow passive transport of inorganic ions.

3. Depolarization of the plasma membrane activates which type of ion channels:

a) receptor-regulated (ligand-gated) channels;

b) voltage-gated channels;

c) none of the above.

4. The passive trans-membrane transport of neutral molecules, when possible, is driven by:

a) their electrochemical gradient;

b) their electrical gradient;

c) their concentration gradient.

5. The bonding of a specific channel blocker with a target ion channel will result in:

a) inhibition of the passive transport of the particular ion species;

b) inhibition of the active transport of the particular ion species;

c) inhibition of the passive ion transport and a part of active one.

6. In which of the following cases will a voltage-gated (potential-dependent) ion channel be activated?

a) when the membrane potential is higher than the activation threshold for the ion channel

b) when the membrane potential is at resting level

c) when the membrane potential is lower than the activation threshold for the ion channel

7. An ion channel that could be activated by a hormone, neurotransmitter, mediator, or other biologically active substance is called:

a) potential-dependent channels;

b) ligand-gated channels;

c) ligand-potential dependent channels.

8. Choose the correct statement:

a) the action potential propagates along the membrane with constant speed;

b) the action potential propagates across the membrane with constant speed;

c) the action potential propagates in the form of longitudinal electric current.

9. What is the meaning of "threshold stimulus"?

a) the maximal stimulus that reaches the membrane threshold potential

b) the minimal stimulus that reaches the membrane over-threshold depolarization;

c) a stimulus that changes the membrane potential below threshold.

10. Is there a correlation between the propagation speed of the action potential along the axon, and the number of voltage-gated Na+ channels on the membrane?

a) the speed increases with the number of voltage-gated Na^+ channels;

b) the speed decreases with the number of voltage-gated Na^+ channels;

c) no correlation.

11. How is the equilibrium potential for given ion species established across the membrane?

a) when forces due the concentration gradient are balanced with forces due to the electrical gradient acting on the ion species;

b) when the concentrations of the ions species are on both sides of the membrane are equal;

c) when the total amount of electric charge due to ion distribution becomes equal on both sides of the membrane.

12. How is the "resting potential" of the cellular membrane defined?

a) the intracellular electric potential in close proximity to the membrane during rest;

b) the extracellular electric potential in close proximity to the membrane during rest;

c) the electric potential difference between the intracellular and extracellular regions in close proximity of the membrane during rest.

13. Equilibrium potential for given ion species is:

a) the membrane potential during the resting state of the cell, when the membrane is not permeable to the ion species;

b) the membrane potential when the ion species are free to move across, and concentration and electrical gradients are balanced;

c) the state when the membrane is equally permeable to K^+ and Na^+ ion species.

14. During the resting state of the axonal membrane the ratio of the ion permeabilities for potassium and sodium is $P_K : P_{Na} = 1 : 0.04$. During the depolarization phase of the action potential this ratio changes as follows:

a) $P_K : P_{Na} = 1 : 0.0004$;

b) $P_K : P_{Na} = 1 : 20$;

c) $P_K : P_{Na} = 20 : 0.04$.

15. What type of membrane allows for the generation of diffusion potential?

a) a permeable membrane: all ions can pass;

b) non-permeable membrane: no ions can pass;

c) semipermeable membrane: only certain type of ions can pass.

16. Which of the following muscles do not have an ordered sarcomere structures?

a) skeletal muscles;

b) cardiac muscle;

c) smooth muscles.

17. What type of transport takes place through ion channels when they are activated?

a) passive;

b) active;

c) passive when moving in, and active when moving out of the cell.

18. The major protein component of the thick myofilaments in striated muscle cells is:

a) myosin;

b) actin;

c) troponin.

19. When placed in the following type of solution, cells will retain water and will inflate:

a) isotonic solution;

b) hypotonic solution;

c) hypertonic solution.

20. Which of the following membrane potentials propagates without attenuation (decrease in amplitude) along the length of the membrane?

a) trace potential;

b) action potential;

c) electrotonic potential.

21. Viscosity of biological membranes is:

a) an electrical property;

b) a mechanical property;

c) chemical property.

22. Which of the following formulas refers to the capacitive reactance (Xc)?

a) Xc = ω·C;

b) Xc = 1/(ω·C);

c) Xc = √(ω·C).

*Where: **ω = 2πf** is the angular frequency (of electric field oscillation), and **C** is the capacitance*

23. What type of current is used in rheography?

a) alternating current with frequency range: 30,000 Hz -100,000 Hz;

b) direct current with magnitude: 3 μA- 5 μA;

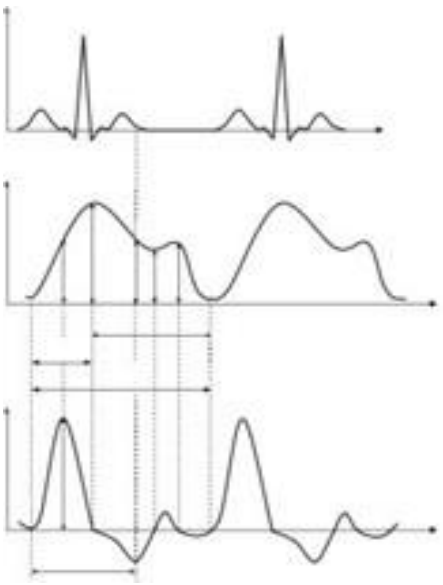
c) low frequency current with low power.

24. Which of the following curves is a "volume rheography curve"?

a) first curve;

b) second curve;

c) third curve.



25. Choose the correct order of excitation of components of the electrical conducting system of the heart. (Ranking question?)

a) bundle of His;

b) SA-node;

c) Purkinje fibers;

d) AV-node;

e) atrial myocytes;

f) ventricular myocytes.

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26. Which of the following formulas gives the closest approximation of the membrane potential at all times?

a) Henderson's equation: $$E = \frac{u^+ - u^-}{u^+ + u^-} \frac{RT}{zF} ln \frac{[c]_{out}}{[c]_{in}}$$

b) Nernst equation: $$E = \frac{RT}{zF} ln \frac{[c]_{out}}{[c]_{in}}$$

c) Goldman equation: $$E_m = \frac{RT}{F} ln \left(\frac{P_{Na}[Na^+]_{out} + P_K[K^+]_{out} + P_{Cl}[Cl^-]_{in}}{P_{Na}[Na^+]_{in} + P_K[K^+]_{in} + P_{Cl}[Cl^-]_{out}} \right)$$

27. Cyclic adenosine monophosphate (cAMP) function as:

a) G-protein;

b) second messenger (intracellular);

c) first messenger (inter-cellular).

28. For thermodynamic system in equilibrium, there is no change in:

a) free energy;

b) electrochemical potential;

c) internal energy.

***29.* What is expressed with the following equation?** $\varphi_e - \varphi_i = (RT/zF)\, ln\, (K_i/K_e)$

a) the membrane potential;

b) the potassium equilibrium potential;

c) the repolarization phase of the action potential

30. Explain the difference between local response and action potential.

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31. Give the reasons for appearance of accommodation.

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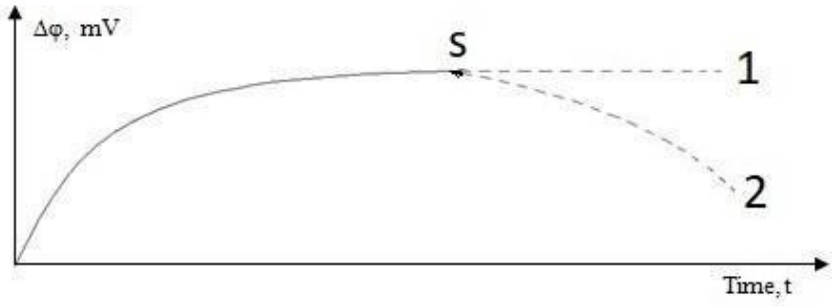
32. On the graph below, you have been represented two biophysical quantities.

A) Which are the two quantities (2 point)?

B) Define them both (2 points).

C) Describe the conditions, required for their creation. (2 point for each quantity)



A).....
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B).....
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C).....
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33. Write the missing quantities (from 1 to 5) in Goldman's equation and describe their biophysical meaning.

$$E_m = \frac{RT}{\quad} \ln \frac{[K^+]_o + P_{Na}[Na^+]_o + \quad [Cl^-]_i}{P_K[\quad]_i + P_{Na}[\quad]_i + P_{Cl}[Cl^-]_o}$$

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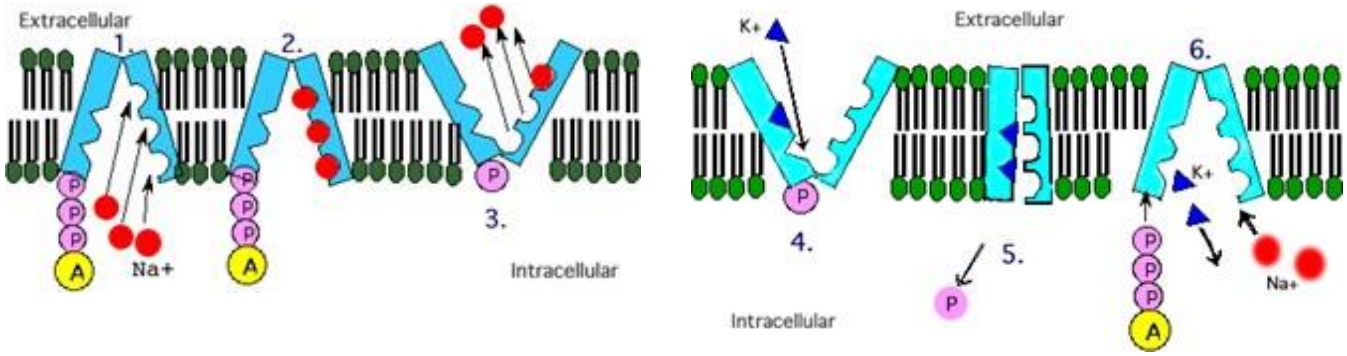
5.....

34. Fill in the blanks with appropriate words!

When this process …… many times, an imbalance of charge forms across the membrane. There will be more …… charged ions outside the membrane than inside. This creates a chemical potential energy which can be used by the cell to later ..... lots more ATP, for generating electrical impulses, or for muscle contractions. This enzyme's …… nature means that it has a chronic role in …… the resting membrane potential of the cell, in regulating the cell volume and in the signal transduction of the cell.

35. Explain the events numbered on the picture bellow in terms of Na^+/K^+ ATPase



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