PBIO 375 **NAME_____KEY_____**
First Exam

Friday, October 20th, 2023

Following directions on the mark-sense form, write your **name, and student number** in the blanks and fill in the bubbles. In addition, write your **name** on this exam.

When finished with the test, turn in both the mark-sense form and the exam at the front of the room.
Answers marked in **red bold-face**.

PLACE ALL ANSWERS ON THE MARK-SENSE FORM

MULTIPLE CHOICE: Always choose the BEST, most complete answer. (2 points each)

1. The internal environment of the body is
   a) the lumen of the digestive tract.
   b) adjacent to the apical surfaces of all epithelia.
   c) the plasma membrane.
   d) the extracellular fluid.
   e) the intracellular fluid.

2. Amphipathic molecules
   a) dissolve well in water.
   b) tend to form a bilayer in biological solutions.
   c) have two polar heads.
   d) are nonpolar.
   e) are charge carriers in biological solutions.

3. If a cell is placed in a hypoosmotic solution (lower number of solutes than the intracellular fluid)
   a) the cell shrinks.
   b) the cell swells.
   c) water flows out of the cell.
   d) water flows down its concentration gradient.
   e) there is no effect because of the barrier provided by the cell membrane.

4. Which of the following proteins is a channel and NOT a carrier protein?
   a) aquaporin
   b) sodium-potassium pump
   c) glucose transporter
   d) Na^{+}-glucose cotransporter
   e) Ca^{++}-ATPase

5. Which of the following statements about ion concentrations across the cell membrane is true?
   a) Ca^{++} concentration in the cytosol is higher than in the extracellular fluid.
   b) Na^{+} concentration in the cytosol is higher than in the extracellular fluid.
   c) Both K^{+} and Na^{+} have similar concentrations in the cytosol and extracellular fluid.
   d) K^{+} concentration in the extracellular fluid is higher than in the cytosol.
   e) Na^{+} concentration in the extracellular fluid is higher than in the cytosol.

6. Saturation occurs at high concentrations of the transported substance, where transport reaches a maximal rate. For which of the following proteins can transport become saturated?
   a) Na^{+}-glucose cotransporter
   b) ligand-gated ion channel
   c) voltage-gated Na^{+} channel
   d) ungated leak channel
   e) aquaporin

7. Which of the following is most important in <u>establishing</u> the resting membrane potential at -70 mV?
   a) an excess of Cl^{-} ions outside the cell
   b) voltage-gated Na^{+} and K^{+} channels
   c) intracellular concentration of large organic anions (mainly proteins)
   d) ionic concentration gradients and leak channels that are selective for K^{+} and Na^{+}
   e) Ca^{++} ATPases that keep the concentration of Ca^{++} very low in the cytosol

8. If you open K^{+} channels in a neuron at a membrane potential of -70mV
   a) the membrane depolarizes.
   b) K^{+} ions flow into the cell.
   c) K^{+} ions flow out of the cell.
   d) There is no net movement of K^{+} ions either into or out of the cell.

9. At the equilibrium potential for Na^{+}
   a) the concentration gradient would favor the movement of Na^{+} out of the cell.
   b) the cell is hyperpolarized.
   c) the force due to the Na^{+} concentration gradient is exactly balanced by the force due to the electrical potential difference.
   d) the inward flow of Na^{+} ions is exactly balanced by the outward flow of K^{+} ions.
   e) the outward flow of Na^{+} ions is exactly balanced by the inward flow of K^{+} ions.

10. Which of the following is involved in fast synaptic transmission?
    a) mechanically-gated ion channel
    b) temperature-gated ion channel
    c) G protein coupled receptor
    d) receptor coupled to JAK kinase
    e) ligand-gated ion channel

11. Which of the following is TRUE about the receptor for the nonpolar steroid hormone testosterone?
    a) is associated with JAK kinase
    b) is a catalytic receptor, meaning it directly activates an enzyme associated with the receptor
    c) is a ligand-activated transcription factor, meaning it binds to DNA to change gene expression
    d) is a ligand-gated ion channel
    e) activates the enzyme adenylyl cyclase

12. What is an important way that signaling via a G protein coupled receptor is turned off?
    a) the alpha subunit dissociates from the beta and gamma subunits
    b) voltage-gated GPCRs have an inactivation gate
    c) the G protein binds to the receptor
    d) the alpha subunit hydrolyzes GTP, turning it into GDP
    e) cAMP (cyclic AMP) saturates the receptor

13. IP_3 (inositol trisphosphate) is a second messenger that gets generated during signaling by the hormone oxytocin. What does IP_3 do?
    a) opens a ligand-gated K^+ channel in the plasma membrane
    b) stimulates adenylyl cyclase
    c) activates protein kinase A
    d) opens a ligand-gated Ca^{++} channel in the membrane of the endoplasmic or sarcoplasmic reticulum
    e) binds to DNA and changes gene expression

14. What does it mean if a drug is an agonist for a receptor?
    a) It inhibits signal transduction by the receptor.
    b) It binds to the receptor and activates it.
    c) It competes with the endogenous ligand for binding to the receptor. **(also marked correct)**
    d) It turns off the basal activity of the receptor.
    e) It covalently binds and inactivates the receptor.

15. Drugs that inhibit JAK kinase are used to
    a) improve synaptic transmission at the neuromuscular junction.
    b) block signaling by cytokines in autoimmune disorders.
    c) speed action potential conduction in demyelinating disorders.
    d) block signaling by nuclear receptors.
    e) activate STAT proteins.

16. The membrane potential hyperpolarizes when opening
    a) ligand-gated K^+ channels in the dendrites of a postsynaptic cell.
    b) ligand-gated Na^+ channels in the dendrites of a postsynaptic cell.
    c) mechanically-gated ion channels in the sensory dendrites of an afferent neuron.
    d) nicotinic acetylcholine receptors at the neuromuscular junction.
    e) voltage-gated Ca^{++} channels in an axon terminal.

17. When temperature gated channels in the sensory dendrites of an afferent neuron open, the result is
    a) an equilibrium potential.
    b) an action potential.
    c) a postsynaptic potential.
    d) generation of a second messenger.
    e) a receptor potential.

18. Graded potentials
    a) are produced by leak channels.
    b) are all-or-nothing.
    c) can conduct long distances without decreasing in strength.
    d) occur in the dendrites and cell body.
    e) have a refractory period.

19. What part of the voltage-gated Na^+ channel protein opens the channel in response to depolarization?
    a) selectivity filter
    b) toxin binding site
    c) 7-transmembrane domain
    d) inactivation gate
    e) voltage sensor

20. What is TRUE about voltage-gated K^+ channels involved in action potentials?
    a) They cause Na^+ channel inactivation.
    b) Channel opening initiates a positive feedback loop.
    c) They open with a delay in response to depolarization.
    d) They open rapidly in response to hyperpolarization.
    e) They inactivate at negative voltages.

21. What prevents the peak of the action potential from reaching +60mV (the Na^+ equilibrium potential)?
    a) leak channels for K^+
    b) positive feedback due to Na^+ ions entering the cell
    c) saturation of Na^+ binding sites in the pore-forming region of the channel
    d) rapid inactivation of voltage-gated Na^+ channels
    e) increased Na^+ permeability

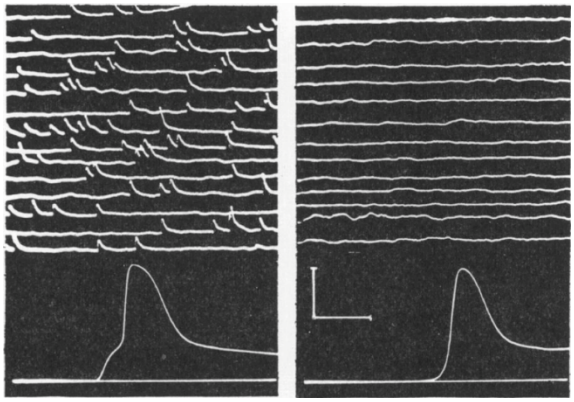
22. Action potential conduction
    a) depends upon local current flow that depolarizes the adjacent region of the axon to threshold.
    b) is slower in larger diameter axons.
    c) is unaffected in demyelinating disorders.
    d) is faster for larger amplitude action potentials.
    e) goes a longer distance for larger amplitude action potentials.

23. In an afferent (sensory) neuron, how do action potentials code for the strength of the stimulus?
    a) by their duration
    b) by their amplitude
    c) by their frequency
    d) by their speed of conduction

24. Which of the following is TRUE about myelinated axons?
    a) conduct action potentials more slowly than unmyelinated axons
    b) express voltage-gated Na^+ channels uniformly along their length
    c) are covered with bundles of myelin separated by myelin-free regions called nodes of Ranvier
    d) ALL of the above are TRUE.
    e) NONE of the above are TRUE.

25. What is an important step that leads to exocytosis of synaptic vesicles?
    a) activation of a G protein coupled receptor causing docking of synaptic vesicles
    b) depolarization in the axon terminal opening voltage-gated Ca^{++} channels
    c) binding of neurotransmitter activating a receptor linked to JAK kinase
    d) activation of transporter protein causing neurotransmitter reuptake
    e) depolarization in the axon terminal causing a miniature end plate potential

26. Observe the recordings (made by Fatt and Katz in 1952) in the figure. Which of the following is TRUE?



a) The recording on the left was made at the end plate and the recording on the right was made some distance from the end plate.

b) The recording on the left shows long term potentiation.

c) Both recordings were made at the end plate, but voltage-gated Na^+ channels were blocked in the recording on the right.

27. Myasthenia gravis causes weakness because the disease

a) reduces the activity of acetylcholinesterase.

b) causes demyelination of somatic motor neurons.

c) severely reduces the amount of acetylcholine released by sympathetic preganglionic neurons.

d) causes hyperpolarization of skeletal muscle cells.

e) reduces the number of acetylcholine receptors at the neuromuscular junction.

28. The hippocampus is important for
    a) storage of declarative memory (long-term memory for facts, events and places)
    b) encoding and consolidation of declarative memory
    c) working (short-term) memory
    d) storage of procedural memory (long-term memory for skills)
    e) encoding and consolidation of procedural memory

29. What is the endogenous ligand for an AMPA receptor, the receptor in the CNS that mediates fast excitatory neurotransmission?
    a) GABA
    b) glutamate
    c) dopamine
    d) norepinephrine
    e) serotonin

30. After induction of long-term potentiation, in what way does Ca^{++} entry into the cell lead to potentiation (enhancement) of the synaptic response?
    a) increases the number of excitatory neurotransmitter receptors on the postsynaptic membrane
    b) binds to and activates NMDA receptors
    c) depolarizes the presynaptic terminal
    d) binds to and inactivates GABA receptors
    e) reduces the number of AMPA receptors on the postsynaptic membrane

END OF TEST

Please turn in your mark-sense form and your question sheets at the front of the room.