PBIO 375 **NAME**_____
First exam

Friday, October 18th, 2024

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.

PLACE ALL ANSWERS ON THE MARK-SENSE FORM

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

1. Which of the following is true about water?
   a. The body is about 5% water.
   b. Water molecules are unable to form hydrogen bonds.
   c. Nonpolar substances readily dissolve in water.
   d. Water is amphipathic.
   e. Electrons are not shared equally in the covalent bonds between hydrogen and oxygen.

2. The cells in the body live in the internal environment, which is
   a. mostly lipid.
   b. the intracellular fluid.
   c. the extracellular fluid.
   d. not regulated in terms of volume.
   e. not regulated in terms of osmolarity.

3. A cell placed in a solution with a higher number of solutes than the intracellular fluid (a hypertonic solution)
   a. will shrink due to osmosis.
   b. will swell due to osmosis.
   c. will neither shrink nor swell because cell membranes are impermeable to water.
   d. will neither shrink nor swell because cell membranes are impermeable to solutes.

4. Which of the following has a higher concentration in the extracellular fluid than in the intracellular fluid? (choose best, most complete answer)
   a. only K^+
   b. only Na^+
   c. only Ca^{++}
   d. both Na^+ and Ca^{++}
   e. both K^+ and Ca^{++}

5. Saturation occurs at high concentrations of glucose for the Na^+/glucose cotransporter because
   a. transport requires specific binding of glucose, and all the binding sites are occupied.
   b. glucose starts to competitively inhibit Na^+ binding to the protein.
   c. stores of ATP are depleted.
   d. glucose blocks the pore that allows Na^+ to flow down its concentration gradient.
   e. glucose inhibits the Na^+/K^+-ATPase.

6. Membrane transport that utilizes a cotransporter protein and the energy inherent in the Na^+ gradient is called
   a. transcytosis.
   b. passive diffusion.
   c. facilitated diffusion.
   d. secondary active transport.
   e. active transport.

7. Which of the following is most important for establishing the <u>resting membrane potential</u> of a cell?
   a. gradients of Na^+ and K^+ ions
   b. voltage-gated Na^+ channels
   c. glucose transporters
   d. acetylcholine receptors
   e. Cl^- (chloride ions) in the extracellular fluid

8. In a typical cell, the largest proportion of ungated leak channels are selective for
   a. Cl^-
   b. K^+
   c. Ca^{++}
   d. glucose
   e. Na^+

9. Take a cell with the normal physiological ion gradients and a membrane potential of +60mV. (It is possible to hold a cell at +60mV using a technique called voltage clamp). If you open a Na^+ channel at +60mV, which way do Na^+ ions flow?
   a. into the cell
   b. out of the cell
   c. there is no net movement of Na^+ ions at +60mV

10. In a cell with a resting membrane potential of -70mV, what happens to the membrane potential if you open some ligand-gated K^+ channels?
    a. K^+ ions enter the cell
    b. Na^+/K^+-ATPase becomes inhibited
    c. the membrane potential depolarizes
    d. the membrane potential hyperpolarizes
    e. the membrane potential doesn't change

11. Which of the following is the ligand for an intracellular receptor that binds to DNA and acts as a ligand-activated transcription factor?
    a. interferon-gamma, a cytokine
    b. oxytocin, a peptide hormone
    c. norepinephrine, a neurotransmitter
    d. cAMP, a second messenger
    e. estrogen, a nonpolar steroid hormone

12. When a ligand binds and activates a G protein coupled receptor, the first step is recruitment of a G-protein that becomes activated by binding
    a. the beta-gamma subunits
    b. adenylyl cyclase
    c. GTP
    d. Ca^{++}
    e. GDP

13. Which of the following is the second messenger that stimulates protein kinase A?
    a. STAT dimer
    b. IP_3
    c. adenylyl cyclase
    d. acetylcholine
    e. cAMP

14. Which of the following is part of the signal transduction pathway in which the hormone oxytocin stimulates an increase in intracellular Ca^{++} concentration in order to stimulate smooth muscle contraction in the uterus?
    a. voltage-gated Ca^{++} channel
    b. cAMP
    c. norepinephrine
    d. protein kinase A
    e. IP_3

15. Which of the following is true about the neurotransmitter norepinephrine?
    a. competes for binding with acetylcholine
    b. activates a G protein coupled receptor
    c. stimulates a receptor that is stably linked to JAK kinase
    d. directly binds and activates a ligand-gated ion channel on the targets of sympathetic postganglionic neurons
    e. is released by somatic motor neurons at the neuromuscular junction

16. Alopecia areata is an autoimmune disease that causes hair loss. In 2022, the FDA approved an effective new drug treatment for alopecia areata that blocks cytokine signaling. What does this drug do?
    a. inhibits JAK kinase
    b. inhibits acetylcholinesterase
    c. blocks norepinephrine and serotonin reuptake
    d. acts as an adrenergic agonist
    e. blocks a G protein coupled receptor

17. What is the role of oligodendrocytes, a type of glial cell?
    a. make myelin in the CNS
    b. form the blood-brain barrier
    c. maintain ion concentrations in the interstitial fluid around neurons
    d. remove neurotransmitter from the interstitial fluid around neurons
    e. support cell bodies of afferent neurons in the dorsal root ganglion

18. In what way does a graded potential *differ* from an action potential?
    a. Graded potentials occur only in afferent neurons.
    b. Graded potentials involve opening of gated ion channels.
    c. A graded potential can involve a depolarizing change in membrane potential.
    d. Graded potentials can involve the movement of Na^+ ions across the membrane.
    e. The amplitude of a graded potential can vary according to the strength of the input stimulus.

19. Which of the following would increase the size of a receptor potential in an afferent neuron?
    a. nothing can increase the size because receptor potentials are all-or-nothing
    b. a longer and stronger stimulus
    c. a larger axon diameter
    d. a higher frequency of action potentials
    e. more neurotransmitter release

20. ALL the following are structural features of the voltage-gated Na^+ channel protein, EXCEPT
    a. pore-forming region
    b. selectivity filter
    c. inactivation gate
    d. voltage sensor
    e. binding site for acetylcholine

21. What is occurring during the rising phase of the action potential?
    a. a positive feedback loop that increases the opening of voltage-gated Na^+ channels
    b. a negative feedback loop that restores the membrane potential to its resting value
    c. K^+ leak channels are closing to allow for depolarization
    d. most voltage-gated Na^+ channels are inactivated
    e. voltage-gated Na^+ channels become permeable to Cl^-

22. Which of the following is TRUE about voltage-gated K^+ channels?
    a. They rapidly inactivate.
    b. They open in response to depolarization.
    c. They open more quickly than voltage-gated Na^+ channels.
    d. They close during the falling phase of the action potential, when repolarization occurs.
    e. When they open, they cause depolarization.

23. The highest density of voltage-gated Na^+ channels is found in
    a. the sensory dendrites of an afferent neuron.
    b. the cell body of a somatic motor neuron.
    c. the axon initial segment.
    d. the postsynaptic cell membrane of an excitatory chemical synapse in the CNS.
    e. the internodes, which are the regions of an axon located underneath the bundles of myelin.

24. What factor greatly increases the speed of action potential conduction?
    a. concentration of Na^+ in the extracellular fluid
    b. myelination
    c. number of dendrites
    d. size of the receptor potential
    e. microtubules in the axon

25. What kind of channel is specifically found at an electrical synapse?
    a. aquaporin
    b. ligand-gated ion channel
    c. leak channel
    d. gap junction
    e. voltage-gated Na^+ channel

26. Which of the following is TRUE about a miniature end plate potential?
    a. amplitude is always well above threshold
    b. is the response to the amount of acetylcholine found in a single synaptic vesicle
    c. conducts throughout the entire skeletal muscle cell
    d. is due to the opening of voltage-gated ion channels
    e. occurs in the sensory dendrites of an afferent neuron

27. A patient with myasthenia gravis is treated with the drug pyridostigmine, an acetylcholinesterase inhibitor. What is the goal in this treatment?
    a. to increase acetylcholine release by the somatic motor neuron
    b. to decrease acetylcholine release by the somatic motor neuron
    c. to increase the amount of acetylcholine in the synaptic cleft
    d. to decrease the amount of acetylcholine in the synaptic cleft
    e. to inhibit the transport protein involved in acetylcholine reuptake

28. What is true about inhibitory neurotransmission in the central nervous system?
    a. The neurotransmitter is usually glutamate.
    b. The neurotransmitter opens a ligand-gated Na^+ channel on the postsynaptic cell.
    c. The postsynaptic potential is always above threshold.
    d. The postsynaptic potential is hyperpolarizing.
    e. The neurotransmitter opens a ligand-gated Ca^{++} channel on the postsynaptic cell.

29. Henry Molaison (H.M.) was a famous neurological patient. He suffered severe anterograde amnesia after a surgery in which
    a. the cerebellum was removed on both sides of his brain.
    b. the hippocampus was removed from both sides of his brain.
    c. both cerebral hemispheres were removed.
    d. the prefrontal cortex was damaged on both sides of his brain.
    e. the corpus callosum connecting his two cerebral hemispheres was severed.

30. The opening of an NMDA channel requires glutamate binding AND
    a. hyperpolarization to reset the channel to an activatable state.
    b. binding of a Ca^{++} ion.
    c. strong depolarization to remove the Mg^{++} block.
    d. strong depolarization of the presynaptic cell.
    e. activation of adenylyl cyclase.

END OF TEST

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