PBIO 375 **NAME**_____

First Midterm **KEY**

Friday, Oct 22nd, 2021

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)**

Correct Answers are given in **red boldface**.

1. Which of the following statements about a covalent bond is true?
   a) Positive and negative ions are held together by covalent bonds.
   b) Covalent bonds are called covalent because they all have the same valence.
   c) Covalent bonds form between dissolved lipids and water dipoles.
   d) Covalent bonds are either polar or nonpolar depending on the distribution of electrons.
   e) Covalent bonds have either long or short bond lengths depending on their hydrophobicity

2. Water is a dipole because:
   a) oxygen is an electron hog; it has a stronger attraction for electrons than hydrogen.
   b) it has two identical magnetic poles.
   c) it makes ionic bonds between two water molecules.
   d) it carries either a net positive or a net negative charge.
   e) by convention all diatomic molecules are called dipoles, meaning two (di) parts (poles).

3. The cell membrane is
   a) a bilayer of proteins with positive or negative surface charges
   b) formed by a phase transition between cytoplasm and an aqueous salt solution.
   c) the optimal structure to accommodate amphipathic phospholipids in an aqueous solution.
   d) a rigid mosaic monolayer of proteins and phospholipids.
   e) a rigid mosaic of polar lipids and proteins with cytoskeletal attachment sites.

4. Which of the following statement about the permeability of a pure lipid bilayer is FALSE?
    a) Large polar molecules (sugars, amino acids) cannot move across a pure lipid bilayer.
    b) Small polar molecules (water, ethanol) can move across a pure lipid bilayer.
    c) Small nonpolar compounds can move across a pure lipid bilayer.
    d) Large nonpolar compounds can move across a pure lipid bilayer.
    e) Certain anions can move across a pure lipid bilayer.

5. Diffusion
    a) is not influenced by concentration gradients.
    b) is the consequence of molecular collisions driven by thermal energy.
    c) time decreases with increasing diffusion distance.
    d) is necessary for transmembrane transport of liposomes.
    e) is the basis for long distance cellular communication using chemical messengers.

6. The size of a cell will
    a) decrease (shrink) when placed in an isotonic solution.
    b) not change when placed in an isotonic solution
    c) decrease (shrink) when placed in a hypotonic solution
    d) increase (swell) when placed in a hypertonic solution
    e) increase (swell) when placed in an isotonic solution

7. Osmotic water flow
    a) moves water down an osmotic gradient through a water permeable membrane.
    b) between two solutions depends on solute identity not solute number.
    c) moves water up an osmotic gradient through a water permeable membrane.

8. Cell membrane voltage or membrane potential:
    a) is potential energy stored in the separation of charges across the membrane.
    b) is the consequence of cytoplasmic osmotic pressure.
    c) is the voltage difference between intracellular organelles.
    d) is negative inside relative to outside in every circumstance.
    e) is the energy source that maintains the hydrophobic core of the lipid bilayer.

9. For a typical cell in the body
    a) the Ca^{2+} concentration inside the cell is in the millimolar range, similar to the Ca^{2+} concentration in the extracellular fluid.
    b) the Na^{+} concentration inside the cell is higher than in the extracellular fluid.
    c) the K^{+} concentration inside the cell is higher than in the extracellular fluid.
    d) the Cl^{-} concentration inside the cell is higher than in the extracellular fluid.

10. The two things needed for a cell to have membrane potential are:
    a) membrane protein receptors and amphipathic phospholipids.
    b) transmembrane ion concentration gradients and ion-selective ion channels.
    c) voltage-gated ion channels and ATP driven anion transport.
    d) selective solute permeability and electroneutral lipids.
    e) ion-selective anion channels and mechanically gated non-selective cation channels.

11. Which of the following is TRUE about ion channels?
    a) Ion channels require the energy from ATP hydrolysis to allow ion transport down a concentration gradient.
    b) Ion channels have a central pore that is permeable to both anions and cations.
    c) Ion channels are either open all the time or they are gated between open and closed states.
    d) Voltage-gated ion channels are always non-selective cation channels
    e) Inactivated ion channels are more permeable to anions than monovalent cations.

12. The electrochemical gradient
    a) is the same for all ions.
    b) for an ion depends on the ion's concentration gradient and the membrane potential.
    c) is equivalent to the osmotic gradient at the cell's resting membrane potential.
    d) for a specific ion only influence that ion's flow thru gated ion channels.
    e) of a nerve cell is set by the concentration of divalent ions in the extracellular solution.

13. Na^+ and K^+ leak channels are:
    a) ligand-gated ion channels that are inactivated at the cell's resting potential.
    b) non-selective ion channels that are permeable to amphipathic lipids in the open state.
    c) voltage dependent channels that are opened by hyperpolarization.
    d) open all the time and participate in setting and maintaining the resting potential of all cells.
    e) are only found in cells that do not have temperature-gated ion channels.

14. The Na^+-K^+ ATP_{ase} is
    a) a cytoplasmic enzyme that hydrolyzes cyclic nucleotides in the presence of Na^+ and K^+.
    b) is an ion channel that is permeable to both Na^+ and K^+.
    c) an enzyme that triggers the phosphorylation of water channels.
    d) a membrane protein that is required for anion–cation exchange.
    e) a protein that uses energy from ATP hydrolysis to pump Na^+ out of the cell and K^+ into the cell.

15. The "voltage-sensor" of a voltage-gated ion channel
    a) **is a transmembrane segment with a series of positively charged amino acids.**
    b) pulls on a linker that closes the channel when it senses a voltage change.
    c) responds to the electric field produced by the dehydration of monovalent ions.
    d) is important for determining which ion can flow through the channel.
    e) is a cluster of divalent cations that move laterally during a voltage change.

16. Which of the following statements about the inactivation "ball" (or "flap") of a voltage-gated ion channel is correct?
    a) The movement of the inactivation ball in response to depolarization pulls on a linker that opens the channel gate.
    b) The inactivation ball is positively charged and prevents anions from entering the channel pore by electrostatic attraction.
    c) **The inactivation ball of voltage-gated Na^+ channels is a part of the channel that is swept into the open channel and closes it.**

17. Mechanically gated ion channels
    a) are anion channels that are opened by an applied force.
    b) are opened by the release of an intracellular mechanosensitive ligand.
    c) produce a hyperpolarizing voltage change in response to mechanical stimuli.
    d) **are non-selective cation channels that may be opened by membrane stretch.**
    e) are mainly located at the nodes of Ranvier.

18. There are ion channels that are
    a) **opened by either an increase or decrease in temperature**
    b) cation selective at one voltage and anion selective at another voltage.
    c) temperature sensitive when dephosphorylated by phosphodiesterase.
    d) also ATP-driven membrane transporters for monovalent anions.
    e) closed by membrane stretch driven by low temperature.

19. Which of the following is TRUE about ligand-gated ion channels?
    a) Ligand-gated ion channels may be non-selective cation channels.
    b) Ligand-gated ion channels may be opened by an intracellular or an extracellular ligand.
    c) Certain neurotransmitter receptors are ligand-gated ion channels.
    d) **ALL of the above statements are TRUE.**
    e) NONE of the above statements are TRUE.

20. Graded potential changes

a) are produced by ion channels that are open all the time.
b) carry electrical signals that are conducted without decrement in axons.
c) may be either depolarizing or hyperpolarizing.
d) have fixed amplitudes with graded recovery times.
e) are only present in neurons with axons.

21. Which of the following statements about changes in intracellular Ca^{2+} is false?

a) Stimulus evoked graded potential changes can cause changes in intracellular Ca^{2+} by acting on voltage-gated Ca^{2+} channels.
b) Changing intracellular Ca^{2+} concentration is the only way that electrical signals are turned into biological actions.
c) Since Ca^{2+} carries two positive charges all changes in intracellular Ca^{2+} produce changes in membrane potential.
d) Changes in intracellular Ca^{2+} are detected by intracellular Ca^{2+} switch proteins that control a variety of biochemical and genetic pathways.
e) Changes in intracellular Ca^{2+} may occur as a result of Ca^{2+} release from intracellular stores.

22. Which of the following statements about the action potential is correct?

a) The action potential is a large transient "all or none" change in membrane potential that increases in amplitude with increasing stimulus intensity.
b) The depolarizing phase of the action potential overshoots zero mV and is generated by voltage-gated Na^+ channels that open rapidly and then rapidly inactivate.
c) The rapid recovery of the resting membrane potential (repolarizing phase of the action potential) is due in large part to regenerative Na^+ entry.
d) The amplitude and duration of the conducted action potential in an axon are variable due to fluctuations in the relative numbers of Na^+ and K^+ leak channels.
e) All cells generate action potentials in response to graded depolarizing potential changes produced by ligand-gated K^+ channels.

23. The G-protein coupled receptor (GPCR)

a) is a transmembrane protein that activates G-proteins when it binds a ligand.
b) is a protein at the neuromuscular junction endplate that binds acetylcholine and opens an ion channel.
c) diffuses in the fluid mosaic lipid bilayer and when activated binds to the IP3 receptor.
d) is a membrane protein with 7 transmembrane loops that binds to and activates a kinase.
e) is a phospholipase that catalyzes the generation of cAMP from ATP.

24. The release of Ca^{2+} from intracellular stores
    a) controls gene expression in all cell types.
    b) is controlled by cAMP activated Ca^{2+} pumps.
    c) is a feedback mechanism that controls the endocytosis of vesicles.
    d) is triggered by the binding of IP3 to ligand-gated Ca^{2+} channels.
    e) is required for the recovery of the resting membrane potential following an action potential.

25. Synaptic transmission at the neuromuscular junction
    a) is mediated by acetylcholine binding to a receptor that is a G-protein coupled receptor (GPCR).
    b) has a high safety factor and always results in the generation of a muscle action potential.
    c) involves multiple neuronal inputs to a single muscle cell.
    d) can cause either a depolarizing or hyperpolarizing endplate potential.
    e) produces a graded depolarizing potential that inhibits acetylcholinesterase irreversibly.

26. Which of the following statements about synaptic transmission in the central nervous system (CNS) is correct?
    a) There are three kinds of synaptic transmission in the CNS: excitatory, inhibitory, and electrical.
    b) Transmission of signals at CNS synapses always triggers an action potential in the post synaptic cell.
    c) Electrical transmission in the CNS is carried by ions permeating pairs of ligand-gated channels.
    d) Excitatory synaptic transmission in the CNS is mediated by a neurotransmitter that closes a ligand-gated chloride channel.
    e) There are chemical synapses on the dendrites of CNS neurons that are second messenger selective gap junctions.

27. The axon initial segment (AIS):
    a) releases neurotransmitters by vesicle exocytosis that reduce the excitability of both apical and basal dendrites.
    b) generates graded potentials that influence nerve conduction by being coupled to changes in intracellular cAMP.
    c) has a high density of voltage-gated Na^{+} channels that participate in the initiation of action potentials in the axon.
    d) is only excited by electrical transmission mediated by metabolic coupling with adjacent axons via intercellular gap junctions.
    e) is located at branch points to initiate action potential propagation in both branches of the axon.

28. Which of the following is true about myelinated axons?
    a) have uniform distribution of voltage-gated ion channels along their axon
    b) the myelin forms a continuous sheet of insulation along the entire length of the axon
    c) have slowed conduction velocity in multiple sclerosis (MS) and Guillain-Barré Syndrome
    d) are found in the apical dendrites of inhibitory neurons
    e) conduct action potentials more slowly than unmyelinated axons

29. What is thought to be a key mechanism underlying the process of learning and memory in the CNS?
    a) changes in astrocytes and microglia
    b) increases in the speed of axon potential conduction
    c) changes in shape of the neuronal cell body
    d) changes in the strength of synaptic transmission between neurons

30. Long term potentiation (LTP)
    a) involves the increase in Ca^{2+} release from intracellular stores in skeletal muscle after long lasting mechanical stimulation.
    b) involves increased release of NMDA from the presynaptic cell.
    c) refers to the increase in the amplitude of a stimulus evoked EPSP following a brief period of repetitive stimulation of the synapse.
    d) does not require the activation of biochemical signaling pathways by intracellular second messengers.
    e) involves the conversion of an inhibitory synapse to an excitatory synapse.

END OF TEST

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