

## First Midterm Exam, Biol 2021, Jan 31, 2012

Each question has only one best answer. There are 25 questions and all questions are worth equal weight. Four figures are at the end. Indicate the correct answer by filling in the appropriate letter on the scantron answer sheet.

Questions 1 and 27 identify which version of the exam you have. If you do not fill them in correctly your exam will be incorrectly graded. These questions will not count in your grade.

Don't forget to put your name and student number on your scantron sheet. You may take this question sheet with you when you leave. Answers and scores will be posted on the class website a few days after the exam.

1. Your version of the exam is version "a". Fill in bubble "a" for question 1 on your scantron sheet.
2. Which of the following is (are) TRUE about ABC transporters?
  - a. They can make ATP by using the  $H^+$  gradient in mitochondria.
  - b. They are often found pumping small molecules out of mammalian cells.
  - c. They contribute about 10% to the membrane potential of mammalian cells.
  - d. The amplification of an ABC transporter is responsible for the development of chloroquine resistance in the malarial parasite *Plasmodium falciparum*.
  - e. a and c only
  - f. b and d only
3. During the propagation of an action potential along the axon of a neuron, what is happening at the leading edge (the front) of the region of depolarization as it moves down the axon?
  - a. Ligand-gated  $Na^+$  channels are opening.
  - b. Voltage-gated  $Na^+$  channels are opening.
  - c. Ligand-gated  $K^+$  channels are opening.
  - d. Voltage-gated  $Na^+$  channels have become inactive and refractory.
  - e. Voltage-gated  $Na^+$  channels are closing.
4. During transcellular transport of glucose across epithelial cells, how does glucose exit the cell into the extracellular fluid?
  - a. by active transport in a  $Na^+$ /glucose symporter
  - b. by active transport in a  $Na^+$ /glucose antiporter
  - c. by active transport in a glucose uniporter
  - d. by passive transport in a glucose uniporter
  - e. by passive transport in a  $Na^+$ /glucose symporter

5. Chloride ion  $\text{Cl}^-$  is close to equilibrium across the plasma membrane of many neurons. What would happen to the membrane potential of a neuron if ligand-gated  $\text{Cl}^-$  channels opened at the same time that the ligand-gated  $\text{Na}^+$  channels opened?
- There would be no effect of the  $\text{Cl}^-$  channel opening and the membrane would depolarize normally.
  - The membrane potential would become more negative.
  - The depolarization would be suppressed and the membrane potential would depolarize less than normal.
  - The membrane potential would become more depolarized than normal.
6. What is the usual energy source for the transport protein in Fig. C?
- light
  - ATP
  - the  $\text{H}^+$  gradient
  - the  $\text{Na}^+$  gradient
  - none of the above
7. How is  $\text{Ca}^{2+}$  involved in the events at the neuromuscular junction when a signal from a neuron causes a muscle to contract?
- Voltage-gated  $\text{Ca}^{2+}$  channels open in the presynaptic neuron to cause the release of neurotransmitter into the synaptic cleft.
  - Voltage-gated  $\text{Ca}^{2+}$  channels open in the muscle cell plasma membrane.
  - $\text{Ca}^{2+}$ -gated  $\text{Ca}^{2+}$  release channels open in the sarcoplasmic reticulum.
  - $\text{Ca}^{2+}$  enters the muscle cell cytoplasm and causes muscle contraction.
  - all of the above
  - a and d only
8. In what way(s) are channel proteins NOT like enzymes?
- Channels are not inhibited by small molecule inhibitors.
  - The rate of transport through channels does not saturate at high solute concentrations.
  - Channels do not have to undergo conformational changes every time something is transported.
  - Channels are not specific for transporting certain molecules.
  - all of the above
  - b and c only
9. What do the nerve gas Sarin and the antidepressant Prozac have in common?
- They both act primarily on the central nervous system.
  - They both primarily cause muscle paralysis.
  - They both primarily affect the binding of neurotransmitters to ligand-gated ion channels.
  - They both primarily prevent the removal of neurotransmitters from the synaptic cleft.
  - They both primarily affect the release of neurotransmitters into the synaptic cleft.

10. What does the following equation describe?

$$\Delta G = zFV$$

- a. the free energy available for work due to the membrane potential
- b. the electrical portion of the electrochemical gradient
- c. the total electrochemical gradient
- d. the chemical portion of the electrochemical gradient
- e. the total change in entropy when an ion crosses a membrane

11. Why are the endoplasmic reticulum, Golgi, endosomes and lysosomes considered to be members of the same family of organelles?

- a. They are all connected to each other with aqueous pores.
- b. They all evolved from endosymbiotic bacteria and have their own DNA and protein synthesis mechanisms.
- c. They are all connected to mitochondria through transport vesicles.
- d. They transport proteins between members of the family using vesicular transport.
- e. They are topologically equivalent spaces.
- f. d and e only
- g. a and e only

12. You are investigating the function of a membrane protein in epithelial cells and you have labeled it with a fluorescent tag such as GFP. While observing it under the fluorescence microscope, you carry out a FRAP (Fluorescence Recovery after Photobleaching) experiment by bleaching a patch of your labeled proteins with a high-powered laser and then watching what happens. What do you predict would happen if your protein is a component of the tight junctions that are found between epithelial cells?

- a. The fluorescence would not recover because the protein mobility is restricted.
- b. The fluorescence would recover very quickly because fresh GFP-labelled proteins would insert into the membrane from the cytosol.
- c. The fluorescence would recover quickly because unbleached GFP-labelled proteins would diffuse into the patch from surrounding membrane areas and replace the bleached proteins.
- d. The fluorescence would not recover because the lipid membrane is much less fluid in that region.

13. Where would you find the structures shown in Fig. D?

- a. nuclear envelope
- b. mitochondria
- c. chloroplasts
- d. rough endoplasmic reticulum
- e. smooth endoplasmic reticulum
- f. plasma membrane

14. Which of the following statements about beta barrel transmembrane proteins is (are) TRUE?

- a. They can be found in bacteria.
- b. The structure is stabilized by hydrogen bonding between amino acids four peptide bonds away in the same chain.
- c. Some beta barrel proteins have only a single peptide chain passing through the membrane.
- d. Some beta barrel proteins have many (8 or more) peptide strands passing through the membrane.
- e. all of the above are true
- f. a and d only are true

15. Which of the following is NOT required for the gated transport of a protein into the nucleus?

- a. energy from the hydrolysis of GTP by Ran GTPase
- b. binding of HSP70 to the protein during transport
- c. a nuclear localization signal in the protein sequence
- d. nuclear transport receptors that bind to nucleoporins
- e. None of the above; they are all required for gated transport.

16. Which of the following statements about membranes is (are) TRUE?

- a. Lipid rafts are found only on the outer leaflet of the plasma membrane.
- b. Cholesterol is found only on the inner leaflet of the plasma membrane.
- c. The asymmetry of the lipid composition of the plasma membrane is formed as lipids spontaneously and rapidly flip-flop to one side or the other.
- d. The large amount of PtdSer normally found on the outer leaflet of the plasma membrane causes the outside of the cell to have a negative charge.
- e. None of the above- all statements are FALSE.

17. Which of these statements is (are) TRUE about protein translocation through the TOM complex of mitochondria?

- a. The membrane potential across the inner mitochondrial membrane is required to translocate a protein through the TOM complex.
- b. Chaperone proteins in the intermembrane space help pull the protein through the TOM complex.
- c. The signal sequence at the N-terminal end of the protein binds to the import receptor associated with TOM.
- d. TOM cleaves off the signal sequence after the protein is translocated.
- e. none of the above
- f. a and b only

18. If you grew a culture of the bacterium *E. coli* at room temperature (22°C) and then shifted it to a warm incubator at 30°C, what would you expect to happen to the lipid composition of the bacterial plasma membrane after you shifted it?

- a. Nothing. The lipid composition is genetically determined and does not change with changes in the environment.
- b. More cholesterol would be found in the membrane.
- c. Less cholesterol would be found in the membrane.
- d. The fatty acid composition would change so there were more saturated fatty acids.
- e. The fatty acid composition would change so there were more unsaturated fatty acids.

19. If you genetically engineered a protein so that its sequence contained only a nuclear export signal and a stop-transfer signal, where would you be most likely to find the protein?

- a. in the nucleus
- b. in the lumen of the endoplasmic reticulum
- c. in the cytosol
- d. cycling repeatedly in and out of the nucleus
- e. inserted into a membrane as a single-pass transmembrane protein
- f. in the mitochondria

20. Which of the following lipids is NOT commonly found in the plasma membranes of animal cells?

- a. cardiolipin
- b. cholesterol
- c. glycolipids
- d. phospholipids
- e. none of the above – they are ALL commonly found in plasma membranes

21. The process of protein transport into chloroplasts shows some similarities to the process of protein transport into mitochondria. Why?

- a. Both mitochondria and chloroplasts came from the same endosymbiotic bacteria.
- b. Mitochondria and chloroplasts regularly fuse with each other inside cells and share proteins.
- c. Mitochondria and chloroplasts need to import exactly the same proteins and so they have evolved the same mechanisms.
- d. Mitochondria and chloroplasts both need to import proteins that are synthesized in the cytosol across membranes and into internal spaces so they have evolved similar mechanisms.

22. Identify the molecule in Fig. B:

- a. Phosphatidylethanolamine
- b. Phosphatidylserine
- c. Phosphatidylcholine
- d. Sphingomyelin
- e. Cholesterol
- f. Glycolipid

23. What determines whether a particular mRNA will become bound to the endoplasmic reticulum (ER) during protein synthesis?
- whether the mRNA has a particular RNA secondary structure that binds to a receptor in the ER membrane
  - whether there is a signal sequence on the protein being made
  - whether the mRNA is recognized by a special pool of membrane-bound ribosomes
  - whether the mRNA is exported into the ER when it leaves the nucleus
  - random chance
24. Which of the following is NOT a technique that is used with fluorescence microscopy?
- DNA-binding dyes such as DAPI
  - staining with heavy metals
  - fusion proteins
  - ion-sensitive indicators
  - tagged antibodies
25. Which of the following statements is TRUE about the synthesis of a multipass transmembrane protein?
- It must have at least one start-transfer sequence and one stop-transfer sequence.
  - Depending on the protein, the NH<sub>4</sub>-end of the protein could end up either in or out of the ER lumen.
  - The signal recognition particle will bind to the start-transfer sequence shortly after the sequence is translated.
  - all of the above
  - a and c only
  - none of the above
26. What technique was used to visualize the cell in Fig. A?
- bright field light microscopy
  - transmission electron microscopy
  - scanning electron microscopy
  - phase contrast light microscopy
  - none of the above
27. To double-check, identify your version of the exam again by filling in bubble “a” for question 27.

Fig. A

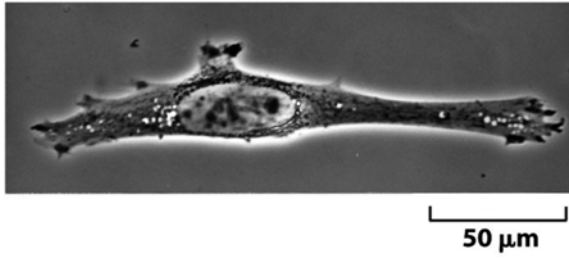


Fig. B

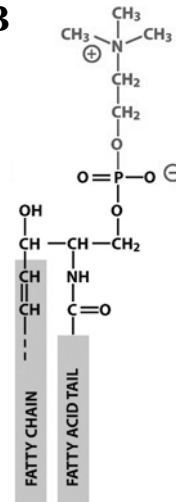


Fig. C

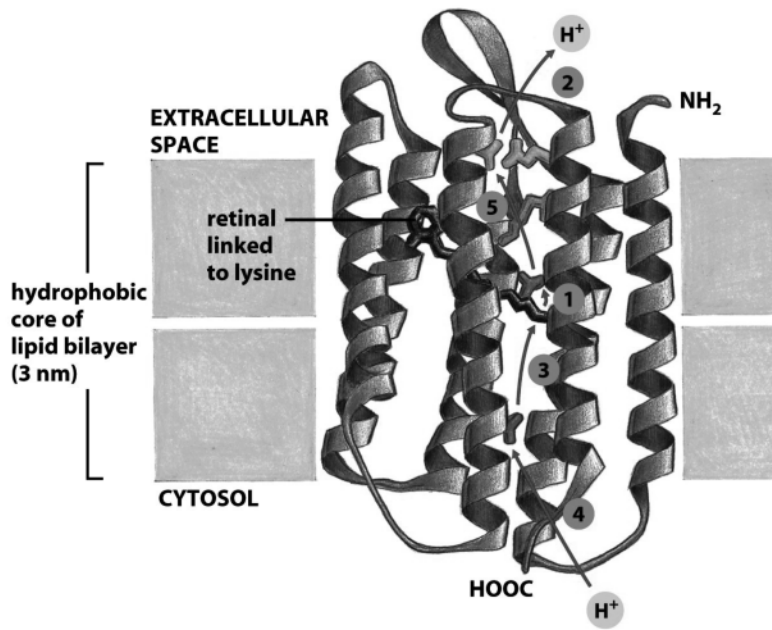


Fig. D

