

Unit 2: Cells (MCQ)

A certain type of specialized cell contains an unusually large amount of rough endoplasmic reticulum (ER).

1. Which of the following functions is this cell type most likely specialized to perform?

- A. The production and secretion of steroids
- B. The destruction of toxic materials produced in other cells of the organism
- C. The synthesis of polysaccharides for energy source
- D. The production and secretion of proteins

2. The fluid mosaic model of cell membranes describes proteins and steroids associated with a phospholipid bilayer. Which of the following membrane components affect membrane stability?

- A. Embedded proteins give plasma membranes less stability.
- B. Steroids, such as cholesterol, give membranes more stability.
- C. Proteins in the hydrophilic region of the plasma membrane create more stability.
- D. Polar heads of phospholipids give plasma membranes less stability.

A scientist is studying the various prokaryotic and eukaryotic species found floating in a sample of water taken from a marine ecosystem.

3. Which cellular component will be found in the widest range of organisms in the sample?

- A. The chloroplast, since all organisms need a source of energy.
- B. The ribosome, since all organisms need to synthesize proteins.
- C. The mitochondrion, since all organisms need to break down glucose.
- D. The cell wall, since all marine organisms need them for support.

In an experiment, researchers provided a radiolabeled amino acid to living plant cells. After one hour, the researchers determined the amount of the radiolabeled amino acid that was in each of several subcellular compartments. The results of the experiment are represented in the table.

RELATIVE AMOUNTS OF RADIOLABELED AMINO ACID

Nucleus	Mitochondria	Endoplasmic Reticulum	Cytosol
2.1	2.7	1.9	1

4. Which of the following conclusions about the radiolabeled amino acid is best supported by the results of the experiment?
- A. It was mostly incorporated into nucleic acids that store the biological information..
 - B. It was mostly incorporated into proteins that regulate and manage metabolic reactions.
 - C. It was mostly incorporated into lipids that help separate cells from their surrounding environment.
 - D. It was mostly incorporated into carbohydrates that form protective structures outside the cells.
5. Which of the following statements accurately describes the facilitated diffusion of materials across a cell membrane?
- A. Energy is required to move charged substances across the membrane.
 - B. Small, polar molecules require transport proteins to cross the membrane.
 - C. Oxygen molecules move directly across the membrane.
 - D. Ions move down their concentration gradient across the membrane.

The antibiotic blasticidin S is a large molecule that can inhibit protein synthesis in mammalian cells. A researcher is investigating how blasticidin S enters mammalian cells. The researcher identified two proteins that might be associated with blasticidin S transport into the cell.

6. Which of the following claims most likely explains how the two proteins are directly involved in the antibiotic's ability to enter the cell?
- A. They form a receptor complex that selectively binds to blasticidin S in the cell cytoplasm.
 - B. They are regulatory proteins that control the expression of other proteins involved in antibiotic transport.
 - C. They are transport proteins that facilitate the movement of blasticidin S across the cell membrane.
 - D. They are enzymes that chemically modify blasticidin S to make it more soluble inside the cell.

Some cells, such as intestinal cells, exchange a lot of material with their surroundings. The surface-to-volume ratio of these cells affects the efficiency of material exchange.

The table provides measurements of four different eukaryotic cells.

Cell	1	2	3	4
Total surface area (μm^2)	40	60	80	100
Total volume (μm^3)	20	10	30	20

7. Based on the data, which cell is likely to be most effective in the exchange of materials?
- A. Cell 1
 - B. Cell 2
 - C. Cell 3
 - D. Cell 4

Hereditary spherocytosis (HS) is a disorder of red blood cells that causes the cells to be smaller and spherical instead of having the usual flattened, biconcave shape. The average diameter of normal red blood cells is $7.2\text{ }\mu\text{m}$, and the average diameter of red blood cells in a person with HS was found to be $6.7\text{ }\mu\text{m}$. The normal red blood cell has an average surface area of $136\text{ }\mu\text{m}^2$ and an average volume of $91\text{ }\mu\text{m}^3$.

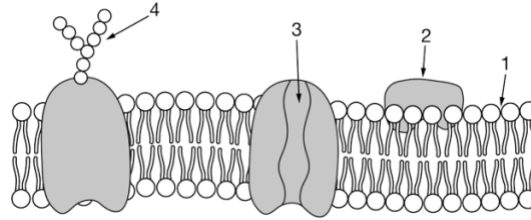
8. Which of the following provides an accurate calculation of the surface area to volume ratio of an HS red blood cell, as well as a prediction of its effect on the efficient transferring of oxygen compared to a normal red blood cell?
- A. The ratio is 0.45, and the cells are more efficient at transferring oxygen.
 - B. The ratio is 1.12, and the cells are less efficient at transferring oxygen.
 - C. The ratio is 0.89, and the cells are less efficient at transferring oxygen.
 - D. The ratio is 141, and the cells are more efficient at transferring oxygen.

Stomata are pores on the surfaces of the leaves and stems of plants that regulate gas exchange between the plants and the atmosphere.

Researchers found that the stomata density on the leaves of a species of plant change as the concentration of CO_2 in the atmosphere changes. When grown at 350 ppm CO_2 the plant has an average density of 300 stomata per mm^2 , but when grown at 400 ppm CO_2 the plant has an average density of 250 stomata per mm^2 .

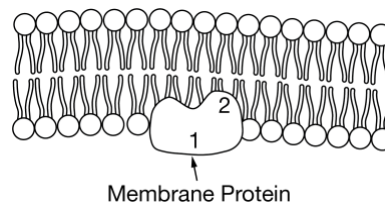
9. Which of the following best describes how the ratio of the density of stomata (stomata per mm^2) per CO_2 concentration (ppm CO_2) changes as the CO_2 concentration increases?
- A. The ratio decreases from 0.86 to 0.63, because fewer stomata are needed at higher CO_2 concentrations.
 - B. The ratio decreases from 1.6 to 1.2, because fewer stomata are needed at higher CO_2 concentrations.
 - C. The ratio increases from 0.63 to 0.86, because more stomata are needed at higher CO_2 concentrations.
 - D. The ratio increases from 1.2 to 1.6, because more stomata are needed at higher CO_2 concentrations.

Figure 1. Testosterone movement across the cellular membrane



10. Testosterone is a small steroid hormone that is important in cell signaling. Which of the following describes where testosterone enters a cell and why it is able to cross at that point?
- A. 1, testosterone is nonpolar and can diffuse through the membrane.
 - B. 2, testosterone covalently binds to a surface protein and transports into the cell.
 - C. 3, testosterone dissolves in water and flows through the channel.
 - D. 4, testosterone is filtered out of the extracellular fluid and taken into the cell by endocytosis.

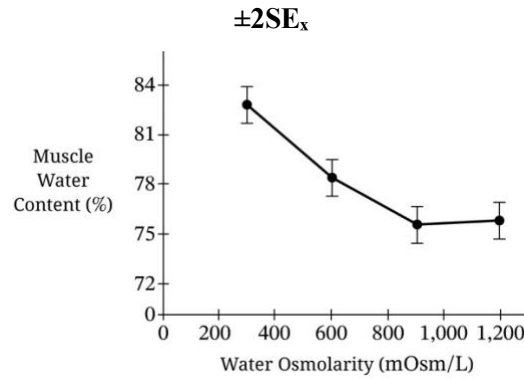
The figure shows a representation of a protein embedded in a cell membrane. The numbers indicate different structural regions of the protein.



11. Based on the figure, which of the following statements best describes the relationship between regions 1 and 2 of the protein?
- A. Region 1 is hydrophilic because it interacts with the interior of the membrane, whereas region 2 is hydrophobic because it interacts with an aqueous environment.
 - B. Region 1 is hydrophilic because it interacts with an aqueous environment, whereas region 2 is hydrophobic because it interacts with the interior of the membrane.
 - C. Region 1 is hydrophobic because it interacts with the interior of the membrane, whereas region 2 is hydrophilic because it interacts with an aqueous environment.
 - D. Region 1 is hydrophobic because it interacts with an aqueous environment, whereas region 2 is hydrophilic because it interacts with the interior of the membrane.

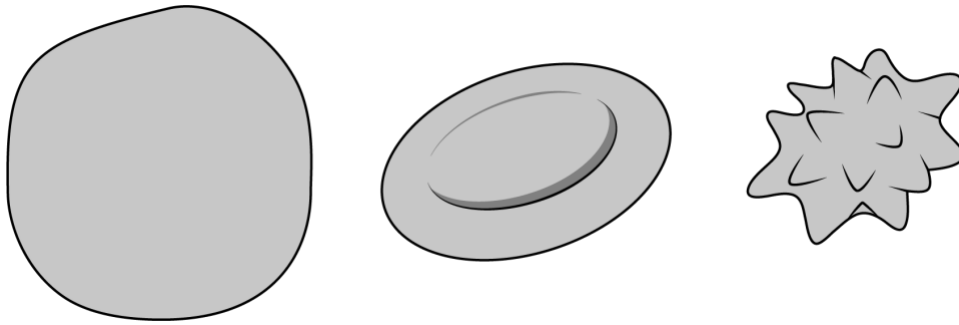
Researchers studying osmoregulation in a specific crab species measured the change in water content within the crabs' muscles when the crabs were exposed to water with different salt concentrations (Figure 1).

Figure 1. Muscle water content in crabs at different saltwater osmolarities. Error bars represent



12. Which of the following claims about the crab's muscle water content is most likely supported by the data shown in Figure 1?
- A. The water content remains relatively constant across different levels of water osmolarity.
 - B. The water content increases and then decreases as water osmolarity increases.
 - C. The water content decreases as water osmolarity increases,
 - D. The water content increases as water osmolarity increases.

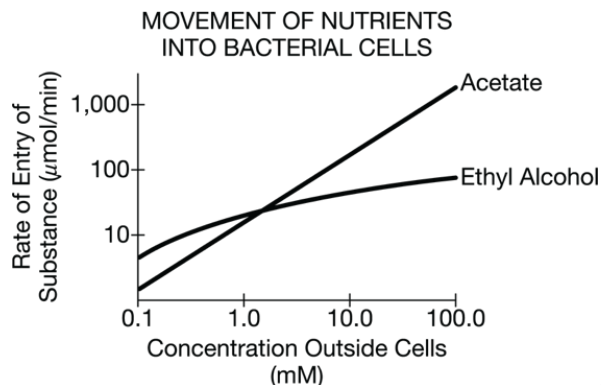
Intravenous (IV) therapy is used for fluid replacement in instances of dehydration in humans and other animals. One type of IV fluid is essentially a saltwater solution. To determine the best concentration for therapy in people, a team of students is researching the effects of solutions of different salt concentrations on red blood cells. The following observations were made from three different red blood cell samples viewed under a microscope.



0.3% Saline (Cells swell) 0.9% Saline (Cells unchanged) 1.5% Saline (Cells shrink)

13. The team wants to extend the research project. What should the team of students do next to obtain data that are more conclusive?
- A. Repeat the process with other salt concentrations.
 - B. Develop a model to explain why the cells react differently to different salt concentrations.
 - C. Repeat the process using red blood cells from other animals.
 - D. Develop an experimental procedure that uses a stain that makes the organelles of red blood cells more visible

Certain bacteria can use both ethyl alcohol and acetate as sources of nutrients. In an experiment where both nutrients are available to a bacterial population, the following results were obtained and graphed.



14. What additional procedure would best help determine whether these movements are due to active transport or to passive transport?
- Repeat the original experiment, but at three different temperatures. Compare the transport rates among the three temperatures.
 - Repeat the original experiment, but add a substance known to block movement of molecules across aquaporins. Compare the rates on the two graphs.
 - Use two additional treatments, one containing only ethyl alcohol and one containing only acetate. Compare the graphs of these two treatments with the original graph.
 - Use two additional treatments, one containing only ethyl alcohol and one containing only acetate. Include a substance known to block ATP use by the plasma membrane. Compare the graphs of these two treatments to the original graph.

Researchers investigate the transport of a certain protein into cells by endocytosis. In an experiment, the researchers incubate the cells in the presence of the protein and measure the amount of the protein that is absorbed into the cells over a five-minute period.

15. Based on their observations, what should the researchers do to further clarify how the availability of the protein outside the cells affects the rate of endocytosis of the protein?
- Incubate the cells in the absence of the protein.
 - Incubate the cells in the presence of several different proteins.
 - Incubate the cells in the presence of several different concentrations of the protein.
 - Incubate the cells in the presence of the protein for several different lengths of time.

Lysosomes digest food particles brought into a cell by endocytosis. After a vesicle containing food particles fuses with a lysosome, H^+ ions are transported into the lysosome from the cytosol. This significantly lowers the pH of the lysosome relative to the cytosol and activates the enzymes that digest the particles.

16. Which of the following best predicts what will happen to the lysosomal enzymes if the proteins that transport H^+ ions from the cytosol into the lysosome are damaged?
- A. The lysosomal enzymes will not become active, since there will be no active transport of H^+ ions.
 - B. The lysosomal enzymes will not become active, since H^+ ions will diffuse out of the lysosome.
 - C. The lysosomal enzymes will become active, since facilitated diffusion will move H^+ ions into the lysosome.
 - D. The lysosomal enzymes will become active, since passive diffusion will move H^+ ions into the lysosome.

17. Which of the following transport mechanisms will be affected most directly by a temporary shortage of ATP molecules inside the cell?
- A. The movement of water molecules through aquaporins
 - B. The diffusion of oxygen molecules across the plasma membrane
 - C. The transport of glucose molecules against a concentration gradient
 - D. The facilitated diffusion of Ca^{2+} ions into the cell

Some membrane proteins help maintain the concentrations of ions inside a cell by transporting the ions across the cell's plasma membrane. Other membrane proteins form pores in the plasma membrane through which the ions can diffuse. A model showing the influence of membrane proteins on the movement of sodium (Na^+) and potassium (K^+) ions across a plasma membrane is presented in Figure 1.

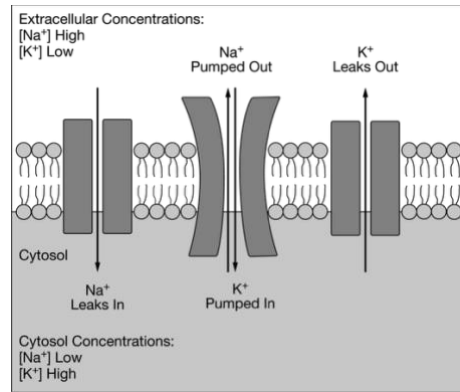
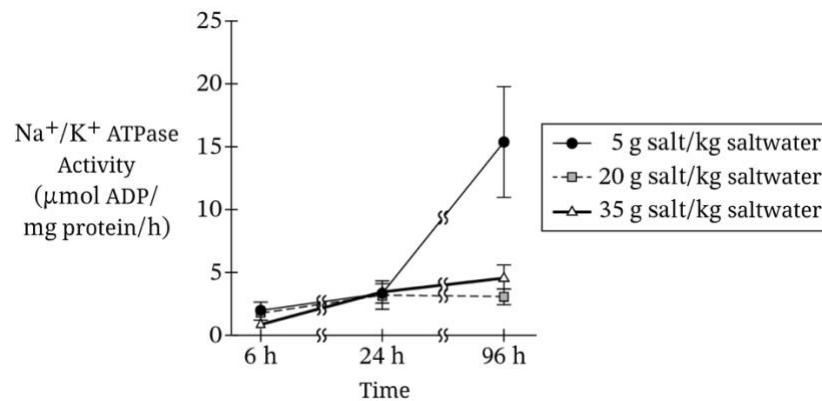


Figure 1. Section of a cell's plasma membrane, showing ion concentrations and membrane proteins

18. Based on the model presented in Figure 1, which of the following changes will most likely result from a depletion of available ATP stores inside the cell?
- A. The Na^+ concentration outside the cell will increase.
 - B. The Na^+ concentration inside the cell will increase.
 - C. The K^+ concentration inside the cell will increase.
 - D. The K^+ concentration outside the cell will decrease.

A saltwater fish has specialized cells that contain Na^+/K^+ ATPase to help with osmoregulation. Scientists studying this fish investigated the effect of the different concentrations of salt in the saltwater on the activity of Na^+/K^+ ATPase between six and 96 hours (Figure 1).

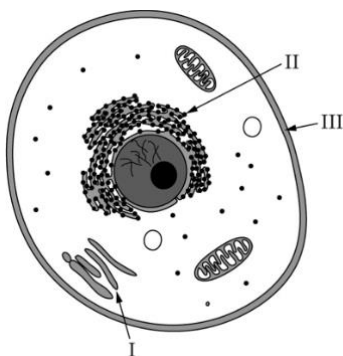
Figure 1. Activity of Na^+/K^+ ATPase at different saltwater concentrations over time. Error bars represent $\pm \text{SE}_x$



19. Which of the following statements accurately supports the data shown in Figure 1?
- A. Na^+/K^+ ATPase activity increases steadily as saltwater concentration and time increase.
 - B. Na^+/K^+ ATPase activity increases steadily as saltwater concentration decreases and time increases.
 - C. Na^+/K^+ ATPase activity stays approximately the same throughout the experiment and at all saltwater concentrations.
 - D. Na^+/K^+ ATPase activity increases only after 24 hours at the lowest saltwater concentration.

Figure 1 shows three labeled organelles (I, II, III) in a eukaryotic cell.

Figure 1. A eukaryotic cell



20. Which of the following is a claim that could be made about the relationship between organelles I, II, and III in Figure 1?
- A. All three organelles play a direct role in the production, modification, and transport of proteins that are released from the cell.
 - B. All three organelles play a direct role in the breakdown of materials that enter the cell.
 - C. Organelles I and II synthesize macromolecules that are then transported by organelle III to the electron transport chain to become part of cellular respiration.
 - D. Organelles II and III synthesize and transport proteins that are then digested into amino acids by organelle I.
21. Which of the following best explains why hydrolytic enzymes are typically transported to the lysosome after they are synthesized by ribosomes?
- A. These enzymes are essential for breaking down organic molecules.
 - B. These enzymes function most efficiently at low concentrations.
 - C. These enzymes require a continuous input of ATP to function.
 - D. These enzymes require post-translational modifications to be bound to the cell membrane.

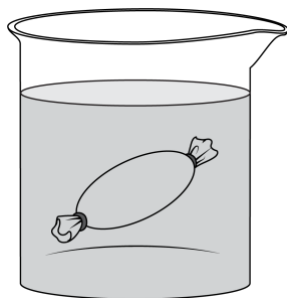
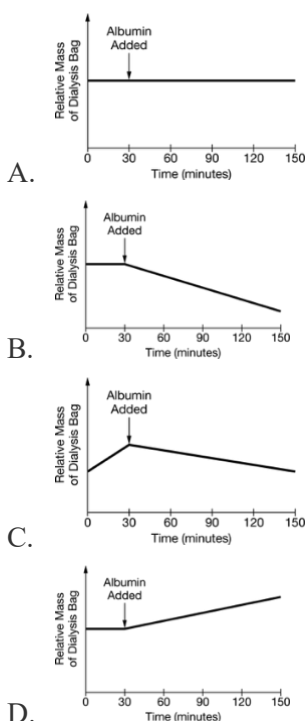


Figure 1

A student is using dialysis bags to model the effects of changing solute concentrations on cells. The student places one dialysis bag that contains 25 mL of distilled water into each of two beakers that are filled with 200 mL of distilled water. (Figure 1). The membrane of each dialysis bag membrane contains pores that allow small solutes such as monoatomic ions to pass through but are too small for anything larger to pass. After 30 minutes, 5 mL of a concentrated solution of albumin (a medium-sized, water-soluble protein) is added to one of the two beakers. Nothing is added to the other beaker. After two more hours at room temperature, the mass of each bag is determined. There is no change in the mass of the dialysis bag in the beaker to which no albumin was added.

22. Which of the graphs below best represents the predicted change in mass over time of the dialysis bag in the beaker to which albumin was added?



23. Some viral infections can lead to the rupture of the lysosome membrane. Which prediction of the effect of this disruption of cellular compartmentalization is most likely correct?
- A. Enzymes will be released that will specifically target the virus.
 - B. Cellular osmotic concentrations will change, preventing viral entry into the cell.
 - C. Hydrolytic enzymes will be released, which will cause cell death.
 - D. Intracellular digestion of organic materials will increase, which will increase the energy available to the cell for fighting the virus.

Gaucher disease is an inherited disorder in which cells of the body are unable to break down a particular type of lipid, resulting in a buildup of the lipid in some tissues and organs.

24. Based on the information provided, Gaucher disease results most directly from a defect in the function of which of the following organelles?
- A. The smooth endoplasmic reticulum
 - B. The nucleus
 - C. The lysosome
 - D. The mitochondrion

Researchers have proposed a model of chloroplast evolution. According to the model, chloroplasts evolved from a small prokaryotic organism that was engulfed by an ancestral eukaryote. The engulfed prokaryote then formed an endosymbiotic relationship with the eukaryotic host.

25. Which of the following observations best supports the model?
- A. Chloroplasts are separated from other subcellular compartments by semipermeable membranes.
 - B. Prokaryotic and eukaryotic organisms both acquire nutrients from the surrounding environment.
 - C. Eukaryotes evolved after prokaryotes and have more complex structures.
 - D. Chloroplasts and some prokaryotes share similar photosynthetic reactions.

26. Which of the following observations best supports the claim that mitochondria evolved from once-free-living prokaryotic cells by the process of endocytosis?
- A. Mitochondria produce ATP
 - B. Mitochondria contain proteins
 - C. Mitochondria exchange substances with the cytosol.
 - D. Mitochondria are surrounded by a double membrane.

Euglenids are single-cell eukaryotes that live in aquatic environments. The chloroplasts found inside euglenids are enveloped by three membranes, as represented in Figure 1. The inner membrane of euglenid chloroplasts resembles the thylakoid membrane.

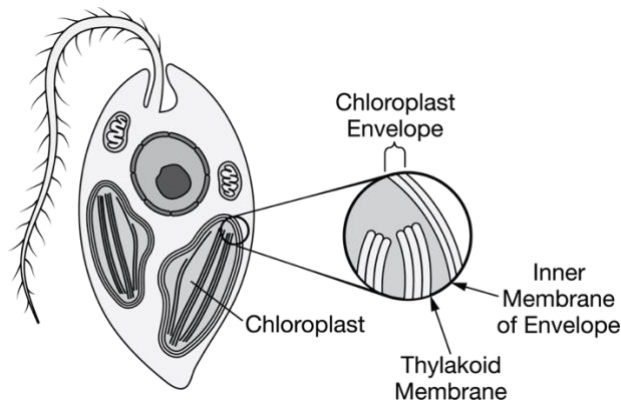


Figure 1. Simplified diagram of a euglenid, showing the structure of the chloroplast envelope

27. Which of the following claims about the origin of the euglenid chloroplast is best supported by the three-membrane structure of the envelope?
- A. It originated from the spontaneous assembly of organic molecules into a lipid bilayer inside a free-living prokaryote.
 - B. It originated from the fusion of the plasma membranes of two different free-living photosynthetic prokaryotes.
 - C. It originated from the incorporation of a photosynthetic prokaryote into a eukaryotic cell by a single endosymbiotic event.
 - D. It originated from the incorporation of a photosynthetic prokaryote into a eukaryotic cell by two endosymbiotic events.

Beetroot cells contain a family of dark red pigments called betalains. The selectively permeable nature of the beetroot cells keeps the internal environment of the cell separate from the external environment of the cell. Researchers are interested in determining whether the selective permeability of beetroot cells is due to the cell membrane or if it is due to the cell wall.

Exposure to cellulase is known to damage the structure of the cell wall. An experiment is set up in which beetroot cells are placed in an aqueous solution with cellulase and in one without cellulase.

28. Which of the following results best refutes the alternative hypothesis that selective permeability is a consequence of the cell wall?
- A. When beetroot cells are placed in a solution with cellulase, the solution turns dark red.
 - B. When beetroot cells are placed in a solution with cellulase, the solution remains clear.
 - C. When beetroot cells are placed in a solution, it turns dark red with or without cellulase present.
 - D. Since plant cells contain cell membranes, not cell walls, the alternate hypothesis cannot be tested.

Two competing hypotheses exist regarding the cell membrane structure. One hypothesis states that membrane structure is static and membrane components throughout the bilayer are rigidly bound. Alternatively, the other hypothesis states that cell membranes are a fluid mosaic in which membrane components may drift within the bilayer around the surface of the cell. An experiment is set up in which membrane proteins of two different cells are fluorescently labeled with two different colors and then fused as shown in Figure 1.

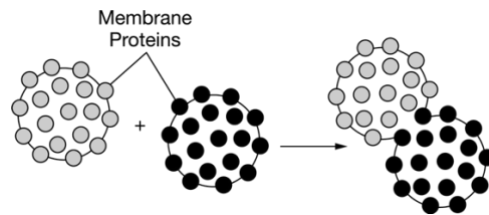
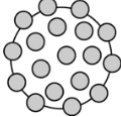
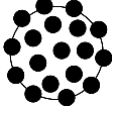
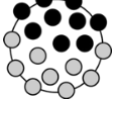


Figure 1. Model of initiation of cell fusion experiment

29. Which of the following results, one hour after membrane fusion, best supports the alternative hypothesis that the cell membrane is a fluid mosaic?

- A. 
- B. 
- C. 
- D. 

The cell membrane is selectively permeable due to its structure. Thus, the internal environment of the cell is distinct from the external environment of the cell. One biologist hypothesizes that small nonpolar molecules readily pass through the membrane. Another biologist alternatively hypothesizes that these types of molecules require channel and transport proteins that are embedded in the membrane in order to move across the membrane.

30. Which of the following data would best refute this alternative hypothesis?

- A. Ethanol is found in the cytosol of cells when they are briefly exposed to a ten percent ethanol solution.
- B. Cells become oxygen deficient when membrane protein activity is blocked.
- C. CO₂ and N₂ movement in and out of cells is unaffected when membrane protein activity is blocked.
- D. Sodium ions cannot move across the cell membrane when membrane protein activity is blocked.

31. Which of the following best describes the relationship between the size and shape of a cell and the ability of the cell to move substances across the membrane?

- A. Larger and more round-shaped cells are more efficient at moving substances across the membrane than small round-shaped cells.
- B. Smaller and more oval-shaped cells release waste more slowly than large oval-shaped cells.
- C. Larger cube-shaped cells obtain nutrients more quickly than small cube-shaped cells.
- D. Smaller irregularly shaped cells are more efficient at dissipating heat than large irregularly shaped cells.

<Answer Key>

1. D
2. B
3. B
4. B
5. D
6. C
7. B
8. C
9. A
10. A
11. B
12. C
13. A
14. D
15. C
16. A
17. C
18. B
19. D
20. A
21. A
22. B
23. C
24. C
25. D
26. D
27. D
28. B
29. D
30. C
31. D