CHAPTER 5: MEMBRANE TRANSPORT AND CELL SIGNALING

FOCUS QUESTIONS

5.1. **a.** phosphate head (hydrophilic)
b. hydrocarbon tail (hydrophobic)
c. phospholipid bilayer
d. hydrophobic region of integral protein
e. hydrophilic region of integral protein
f. peripheral protein (hydrophilic)

5.2. **a.** In hybrid human/mouse cells, membrane proteins rapidly intermix (Frye and Edidin, 1970).
b. The cell membranes of the cold lake species would have a higher proportion of unsaturated fatty acids in their phospholipids than that of the species living in warm temperatures.

5.3. transport, enzymatic activity, signal transduction, cell–cell recognition, intercellular joining, attachment to cytoskeleton and ECM (providing support and communication)

5.4. Ions and larger polar molecules, such as glucose, are impeded by the hydrophobic center of the plasma membrane's lipid bilayer. Passage through the center of a lipid bilayer is not fast even for small, polar water molecules.

5.5. Side A initially has fewer free water molecules; side B initially has more. More water molecules are clustered around the glucose in the 1 *M* solution than around the fructose and sucrose, whose combined concentration is 0.9 *M*. Water will move by osmosis from side B to side A.

5.6. **a.** The protist will gain water from its hypotonic environment. It has contractile vacuoles that expel excess water. Its plasma membrane is also less permeable to water.

b. Animal cells fare best in isotonic environments, in which they neither gain nor lose water. Plant cells are healthiest in hypotonic environments, in which the inward movement of water creates turgor pressure, providing mechanical support to the cell.

5.7. Although it speeds diffusion, facilitated diffusion is still passive transport because the solute is moving down its concentration gradient; the process is driven by the concentration gradient and not by energy expended by the cell.

5.8. Three Na^+ are pumped out of the cell for every two K^+ pumped in, resulting in a net movement of positive charge from the cytoplasm to the extracellular fluid.

5.9. **a.** Human cells use receptor-mediated endocytosis to take in cholesterol, which is used for the synthesis of other steroids and membranes.
b. In people with this disease, LDL receptor proteins in the plasma membrane are defective, and low-density lipoprotein particles cannot bind and be transported from the blood into the cell.

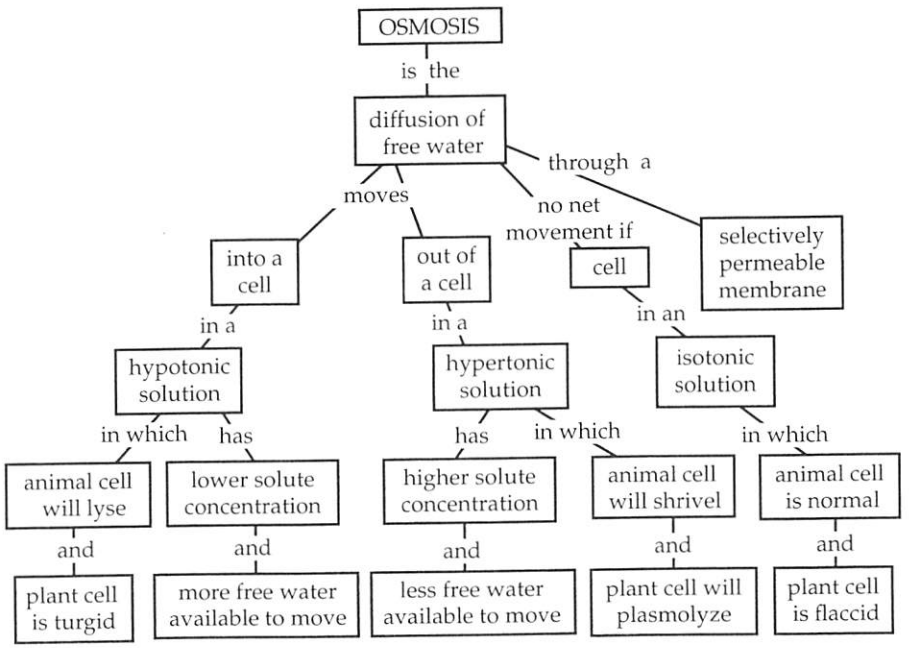
5.10. Large, hydrophobic signaling molecules cannot cross the plasma membrane. They bind to cell-surface receptors such as G protein-coupled receptors or ligand-gated ion channels. Small, hydrophobic signaling molecules, such as steroid hormones or the gas NO, can diffuse across the plasma membrane and bind with receptors within the cytoplasm or nucleus of target cells.

5.11. **a.** A protein kinase transfers a phosphate group from ATP to a protein; adding a charged phosphate group causes a shape change that usually activates the protein.
b. A protein phosphatase is an enzyme that removes a phosphate group from a protein, usually inactivating the protein. Protein phosphatases effectively shut down signaling pathways when the initial signal is no longer present.
c. A phosphorylation cascade is a series of protein kinase relay molecules that sequentially phosphorylate the next kinase in the pathway.

5.12. **a.** signaling molecule (first messenger)
b. G protein-coupled receptor
c. activated G protein (GTP bound)
d. adenylyl cyclase
e. ATP
f. cAMP (second messenger)
g. protein kinase A
h. phosphorylation cascade to cellular response

SUGGESTED ANSWERS TO STRUCTURE YOUR KNOWLEDGE

1.



2. **a.** II represents facilitated diffusion. The solute is moving through a transport protein and down its concentration gradient. The cell does not expend energy in this transport. Polar molecules and ions may move by facilitated diffusion.
   b. III represents active transport because the solute is clearly moving against its concentration gradient and the cell is expending ATP to drive this transport against the gradient.
   c. In order to diffuse through the lipid bilayer, solute molecules must be hydrophobic (nonpolar) or very small polar molecules.
   d. I and II. Both diffusion through the lipid bilayer and facilitated diffusion are considered passive transport because the solute moves down its concentration gradient and the cell does not expend energy in the process.
3. Cell signaling occurs through signal transduction pathways that include reception, transduction, and response. First, a signaling molecule binds to a specific receptor. The message is transduced as the receptor activates a protein that may relay the message through a sequence of activations, finally leading to the specific cellular response.
4. A signal transduction pathway often results in the activation of cellular proteins. When the signal is transduced to activate a transcription factor, however, the cellular response is a change in gene expression and the production of new proteins.

ANSWERS TO TEST YOUR KNOWLEDGE

Multiple Choice:

1. b	**4.** b	**7.** e	**10.** d**	**13.** d	**16.** b	**19.** b	**22.** d
2. c	**5.** d	**8.** a*	**11.** a	**14.** a	**17.** d	**20.** a	**23.** c
3. e	**6.** c	**9.** c	**12.** b	**15.** e	**18.** a	**21.** b	**24.** c

*Explanation for answer to question 8: This problem involves both osmosis and diffusion. Although the solutions are initially equal in molarity, glucose will diffuse down its concentration gradient until it reaches dynamic equilibrium with a 1.5 *M* concentration on both sides. The increasing solute concentration on side A will cause water to move into this side, and the water level will rise.

**Explanation for answer to question 10: As the solute in the solution crosses the cell membrane, it increases the concentration of solutes within the cell, reducing the hypertonicity of the solution. As the solute reaches an equal concentration inside and outside the cell, it no longer causes osmotic changes in the cell.