### Diffusion and Osmosis Practice

<table>
<thead>
<tr>
<th></th>
<th>a. Where does it occur in the membrane</th>
<th>b. Does it require a transport protein?</th>
<th>c. Does it require input of energy?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple diffusion</td>
<td>Across phospholipid bilayer</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Osmosis</td>
<td></td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Facilitated diffusion</td>
<td>Thru membrane proteins</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Active transport</td>
<td></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Endocytosis</td>
<td>At the membrane surface</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Exocytosis</td>
<td></td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>

**Exercise 2**  (Modules 5.3 - 5.9)

Review diffusion and the function of cell membranes by matching each of the phrases on the right with the appropriate mechanisms from the list on the left. Two questions require more than one answer.

- E 1. Diffusion across a biological membrane
- B 2. Moves solutes against concentration gradient
- A 3. Any spread of molecules from area of higher concentration to area of lower concentration
- F 4. Diffusion with the help of a transport protein
- D 5. Three types of endocytosis
- H 6. Engulfing of fluid in membrane vesicles
- G 7. Diffusion of water across selectively permeable membrane, from hypotonic to hypertonic solution
- B 8. Transport molecules need ATP to function
- H 9. Enables cell to engulf bulk quantities of specific large molecules
- E 10. How oxygen and carbon dioxide enter and leave cells
- C 11. Two types of passive transport
- D 12. Ingulping of particle in membrane vesicle
- H 13. Fusion of membrane-bound vesicle with membrane, and dumping of contents outside cell
- D 14. How a cell might capture a bacterium
- C 15. Helped by aquaporins

A. Diffusion  
B. Active transport  
C. Osmosis  
D. Phagocytosis  
E. Passive transport  
F. Facilitated diffusion  
G. Pinocytosis  
H. Receptor-mediated endocytosis  
I. Exocytosis
Osmosis is an important process that has many effects on living things. Test your understanding of osmosis by predicting in each of the following cases whether water will enter the cell (In) or leave the cell (Out), or whether there will be no net movement of water (None). Assume that the plasma membrane is permeable to water but not solutes.

1. Cell is exposed to a hypertonic solution.  
2. Cell is placed in a salt solution whose concentration is greater than that of the cell contents.  
3. Due to disease, the solute concentration of the body fluid outside a cell is less than the solute concentration inside cells.  
4. Cell is immersed in an isotonic solution.  
5. A single-celled organism is placed in a drop of pure water for examination under a microscope.  
6. Cell is immersed in solution of sucrose and glucose whose individual concentrations are less than concentration of solutes in cytoplasm, but whose combined concentration is greater than concentration of solutes in cytoplasm.  
7. Solute concentration of a cell is greater than the solute concentration of the surrounding fluid.  
8. Cell is exposed to a hypotonic solution.  
9. Concentration of solutes in a cell’s cytoplasm equals the solute concentration of extracellular fluid.  
10. Cytoplasm is more dilute than surrounding solution.
Exercise 4 (Modules 5.1–5.9)

Try to picture membranes and their functions close up by completing the following story.

Your first mission as a Bionaut requires you to enter a blood vessel and observe the structure and functions of cell membranes. You step into the water-filled chamber of the Microtron, which quickly shrinks you to a size much smaller than a red blood cell.

You tumble through the tunnel-like needle and into a blood vessel in the arm of a volunteer. Huge, rubbery red blood cells slowly glide past. Floating in the clear, yellowish blood plasma, you switch on your headlamp and examine the epithelial cells of the vessel wall. Their plasma membranes seem made of millions of small balloons. These are the hydrophilic "heads" of the 1 phospholipid molecules that make up most of the membrane surface. Through the transparent surface, you can see their flexible, 2_ tails projecting inward toward the interior of the membrane and beyond them an inner layer of 3 phospholipid molecules with their tails pointing toward you. Here and there are globular 4 protein molecules embedded in the membrane; some rest lightly on the surface, but most project all the way into the interior of the cell. The membrane is indeed a 5 fluid mosaic: the proteins are embedded like the pieces of a picture, but you can see that they are free to move around. You push on one of the proteins, and it bobs like an iceberg. Some of the phospholipids and proteins have chains of sugar molecules attached to them, forming 6 _glycolipids_ and 7 _glycoproteins_. These are the molecules that act as cell identity tags. You notice that one of the proteins has a dimple in its surface. Just then a small, round molecule floating in the plasma nestles in the dimple. The molecule is a hormone, a chemical signal, and the dimpled protein is the 8 receptor that enables the cell to respond to it. From the plasma, where it is more concentrated, to the cell interior, where it is less concentrated. This movement is 10 diffusion; when it occurs through a biological membrane, it is called 11 passive transport. Similarly, carbon dioxide is flowing out of the cell, down its 12 concentration gradient, from the cell interior, where it is 13 more concentrated, to the blood, where it is 14 less concentrated.
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In your light beam, you can see the sparkle and shimmer of many molecules, large and small, in the blood and passing through the cell membrane. Oxygen is moving from the plasma, where it is more concentrated, to the cell interior, where it is less concentrated. This movement is diffusion; when it occurs through a biological membrane, it is called passive transport. Similarly, carbon dioxide is flowing out of the cell, down its concentration gradient, from the cell interior, where it is more concentrated, to the blood, where it is less concentrated.

You note that water molecules are passing through the membrane equally in both directions. The total concentration of solutes in the cell and in the blood must be equal; the solutions must be isotonic. You signal the control team to inject a small amount of concentrated salt solution into the blood, making the blood slightly hypertonic relative to the cell contents. This causes water to flow out of the cell, until the two solutions are again in equilibrium. This diffusion of water through a selectively permeable membrane is called osmosis.

Some sugar molecules floating in the blood are simply too large and polar to pass easily through the plasma membrane. The sugar molecules simply bounce off, unless they happen to pass through pores in special transport proteins. This is a type of passive transport, because the molecules move down a concentration gradient without the expenditure of energy. Because transport proteins help out, it is called facilitated diffusion.

Your chemscanner detects a high concentration of potassium ions inside the cell. Transport proteins here and there in the membrane are able to move potassium into the cell against the concentration gradient. This must be active transport; the cell expends ATP to provide energy to “pump” the potassium into the cell.

Suddenly there is a tug at your foot. You look down to see your flipper engulfed by a rippling membrane. A white blood cell the size of a house quickly pins you against the vessel wall. The phospholipids of its membrane are pressed against your face mask. The cell is engulfing you, protecting the body from a foreign invader! Taking in a substance in this way is called endocytosis, more specifically phagocytosis, if the substance is a solid particle. Suddenly the pressure diminishes, and you are inside the white blood cell, floating free in a membrane-enclosed bag, or vesicle. Another sac is approaching; it is a lysosome, full of digestive enzymes. You manage to get your legs outside of the vacuole and move it back toward the inner surface of the cell membrane. As the vacuole fuses with the plasma membrane, you tear your feet free and swim away from the voracious cell, realizing that expelled you almost as fast as endocytosis trapped you!

You swim to the exit point, and the control team removes you by syringe. You are soon back in the lab, restored to normal size, and telling your colleagues about your close call.
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Answer the following questions to the best of your ability \textit{WITH RESPECT TO OSMOSIS}

1. How does the method of salt or sugar curing (a process in which meat is packed in salt or sugar) help to preserve meat? meat goes bad from bacteria growing Salt causes bacteria to lose H$_2$O therefore dehydrating them - they can't grow

2. In some restaurants, sliced potatoes are soaked in water before they are fried. Provide an explanation for this practice.
Potatoes fill with H$_2$O
When cooked, they won't dry out

3. If you are stranded on a life raft in the ocean, you should never drink seawater, even though you may be dying of thirst. Why not?
Salt H$_2$O will cause you to lose H$_2$O from surrounding cells - dehydrating you.

4. A gardener’s favorite bush die several days after she applie twice the recommended amount of fertilizer. What probably happened?

5. A plant cell is placed in a beaker of pure water. What will happen to it?
\textbf{Fills w/ water = happy plant
turgid, high turgor pressure}

6. An animal cell is placed in a beaker of pure water. What will happen to it? If there is a difference between what happens to plant and animal cells when placed in pure water, explain why.
\textbf{Fills w/ water = cytolysis - Sad animal cell}

7. Why is it important that solutions administered intravenously be isotonic to an organism’s blood? What would happen if an injected solution were hypertonic to your blood? What if it were hypotonic?
PRACTICE PROBLEMS FOR DIFFUSION AND OSMOSIS:

1.) If a cell (with no dye in it) is in a solution of 10% dye molecules and the dye can cross the cell’s membrane, what do you predict will happen to the dye? **Dye moves into cell**

2.) If a cell (with 3% alcohol in it) is in a solution of 10% alcohol molecules and the alcohol can cross the cell’s membrane, what do you predict will happen to the alcohol? **Alcohol moves into cell**

3.) If a cell (with 10% oxygen in it) is in a solution of 3% oxygen molecules and the oxygen can cross the cell’s membrane, what do you predict will happen to the oxygen? **Oxygen moves out of cell**

4.) If a cell contains 3% carbon dioxide that can cross the cell’s membrane and is put into a solution of 2% carbon dioxide, what do you predict will happen to the carbon dioxide? **CO₂ moves out of cell**

5.) You have a cell, with a semi permeable membrane and a 1.5% potassium concentration. You put it into a solution of 2% potassium. What adjective describes the solution? What direction would you expect water to flow? What do you expect to see happen to the cell? **Hypertonic, out of cell, cell shrinks**

6.) You have a cell, with a semi permeable membrane and a 1.5% potassium concentration. You put it into a solution of 1.05% potassium. What adjective describes the solution? What direction would you expect water to flow? What do you expect to see happen to the cell? **Hypotonic, into cell, cell expands**

7.) You have a cell, with a semi permeable membrane and a 1.2% chloride concentration. You put it into a solution of 1.05% chloride. What adjective describes the solution? What direction would you expect water to flow? What do you expect to see happen to the cell? **Hypotonic, into cell, cell expands**

8.) You have a cell, with a semi permeable membrane and a 0.5% calcium concentration. You put it into a solution of 0.05% calcium. What adjective describes the solution? What direction would you expect water to flow? What do you expect to see happen to the cell? **Hypotonic, into cell, cell expands**

9.) You have a cell, with a semi permeable membrane and a 0.05% sodium concentration. You put it into a solution of 0.2% sodium. What adjective describes the solution? What direction would you expect water to flow? What do you expect to see happen to the cell? **Hypertonic, out of cell, cell shrinks**

10.) You have a cell, with a semi permeable membrane and a 0.12% sodium concentration. You put it into a solution of 0.2% sodium. What adjective describes the solution? What direction would you expect water to flow? What do you expect to see happen to the cell? **Hypertonic, out of cell, cell shrinks**
3. A plant cell is placed in a solution whose solute concentration is twice as great as the concentration of the cell cytoplasm. The cell membrane is selectively permeable, allowing water but not the solutes to pass through. What will happen to the cell?
   a. No change will occur because it is a plant cell.
   b. The cell will shrivel because of osmosis.
   c. The cell will swell because of osmosis.
   d. The cell will shrivel because of active transport of water.
   e. The cell will swell because of active transport of water.

4. A white blood cell is capable of producing and releasing thousands of antibody molecules every second. Antibodies are large, complex protein molecules. How would you expect them to leave the cell?
   a. active transport
   b. exocytosis
   c. receptor-mediated endocytosis
   d. passive transport
   e. pinocytosis

5. Which of the following would be least likely to diffuse through a cell membrane without the help of a transport protein?
   a. a large polar molecule
   b. a large nonpolar molecule
   c. a small polar molecule
   d. a small nonpolar molecule
   e. Any of the above would easily diffuse through the membrane.

6. Red blood cells shrivel when placed in a 10% sucrose solution. When first placed in the solution, the solute concentration of the cells is ____ the concentration of the sucrose solution. After the cells shrivel, their solute concentration is ____ the concentration of the sucrose solution.
   a. less than . . . greater than
   b. greater than . . . less than
   c. equal to . . . equal to

7. A nursing infant is able to obtain disease-fighting antibodies, which are large protein molecules, from its mother's milk. These molecules probably enter the cells lining the baby's digestive tract via
   a. osmosis.
   b. passive transport.
   c. exocytosis.
   d. active transport.
   e. endocytosis.