

Review questions for osmosis, diffusion, and membrane transport lecture

Multiple choice review questions:

- 1) Diffusion of solutes through a membrane with the use of a transport protein is called
 - A) osmosis.
 - B) facilitated diffusion.
 - C) carrier-mediated transport.
 - D) active transport.

- 2) If transport through a cell membrane requires the expenditure of energy, it is called
 - A) facilitated diffusion.
 - B) active transport.
 - C) simple diffusion.

- 3) Extracellular fluid contains up to 10,000 times more calcium than intracellular fluid, and yet all cells continue to pump out even more calcium. They could only do this by means of
 - A) passive transport
 - B) facilitated diffusion.
 - C) osmosis.
 - D) active transport.

- 4) Primary active transport proteins get energy from
 - A) Solutes entering the cell by passive transport
 - B) Fats and amino acids
 - C) ATP
 - D) all of the above

- 5) Na^+/K^+ pumps are examples of
 - A) passive transport
 - B) facilitated diffusion
 - C) primary active transport
 - D) secondary active transport

- 6) Some cells transport Ca^{2+} out of the cell against its concentration gradient. The energy to do this comes from passive inward diffusion of Na^+ . This best describes
 - A) a membrane which is impermeable to Ca^{2+} and will not let it into the cell.
 - B) primary active transport of Ca^{2+} out of the cell.
 - C) facilitated diffusion of Ca^{2+} out of the cell.
 - D) secondary active transport of Ca^{2+} out of the cell.

- 7) There is a higher concentration of K^+
 - A) outside the cell than inside
 - B) inside the cell than outside

8) Insulin will cause glucose transport into cells by the insertion of a _____ transporter for glucose into the plasma membrane.

- A) DEX2
- B) Sodium-potassium
- C) Insulina
- D) GLUT

10) Which of the following substances is least able to pass through a living cellular membrane?

- A) glucose
- B) steroid hormone
- C) cholesterol
- D) water

13) The tissue fluid comprises what percentage of the extracellular fluid?

- A) 80%
- B) 50%
- C) 33%
- D) 20%

14) Solutes that cannot pass through a membrane are said to be

- A) non-penetrating
- B) penetrating
- C) isotonic.
- D) isosmotic.

15) Red blood cells placed in a 0.3 m urea solution (urea is permeable) will exhibit

- A) shrinkage.
- B) no change.
- C) crenation.
- D) lysis.

Answers to multiple choice questions:

- 1 = B
- 2 = B
- 3 = D
- 4 = C
- 5 = C
- 6 = D
- 7 = B
- 8 = D
- 10 = A

13 = A
14 = A
15 = C

Fill-in-the-blank review questions:

- 2) The type of molecule that cannot diffuse through cell membranes is hydrophilic/hydrophobic/water (circle one of the three).
- 3) The difference in concentration of a solute between two adjacent areas is known as a _____.
- 4) The two forms of bulk transport (vesicles moving substances through the membrane) are _____ and _____.
- 5) In _____, a vesicle inside the cell merges with the plasma membrane and discharges the vesicle's contents to the cell's exterior.
- 6) In _____, a region of the cell's membrane invaginates (folds inward) and forms a vesicle which brings a portion of the extracellular material into the cell.
- 7) The movement of a solute directly through a cell membrane (no membrane transport protein needed) from a high concentration area to a low concentration area is called _____.
- 8) Give three examples of molecules that move through cell membranes by simple diffusion.
- 9) Carrier-mediated transport (movement of solutes across a membrane by membrane transport proteins) may be divided into _____ and _____ transport, based on whether energy is required for the transport.
- 10) Neither simple diffusion nor facilitated diffusion require energy, so neither one is considered _____ transport.
- 11) Whenever energy is being used to move a solute from low to high areas of concentration, the process is called _____.
- 12) Primary active transport requires a membrane transport protein and the use of cellular energy in the form of _____.
- 13) When the energy to transport a solute across a membrane against its concentration gradient comes not from ATP but instead from another solute being transported down its concentration gradient, this is called _____.
- 14) Molecule X can only pass through a membrane with the assistance of a membrane transport protein. The membrane transport protein transports only molecule X and the direction of molecule X's travel is

always from its high concentration side to its low concentration side. This process is an example of _____.

15) Molecules Y and Z can only pass through a membrane with the assistance of a membrane transport protein. The membrane transport protein transports molecule Y against its concentration gradient and molecule Z against its concentration gradient. ATP is used as the energy source. This process is an example of _____.

16) Molecules Q and R can only pass through a membrane with the assistance of a membrane transport protein. The membrane transport protein transports molecule Q against its concentration using energy from transporting molecule Z down its concentration gradient. This process is an example of _____.

17) There is one type of primary active transport protein that is found in almost every cell of the body. The protein is called the _____. It uses ATP to move two ions simultaneously across the membrane against their concentration gradients. One ion is pumped into the cell and one ion is pumped out.

18) Thanks to the protein described in the question above, the concentration of sodium is always highest outside/inside (circle one) the cell, whereas the potassium concentration is always highest outside/inside (circle one) the cell.

24) Since 5% dextrose, normal saline (0.9%), and Ringer's lactate all have the same osmolarity (total solute concentration) as plasma, they are thus said to be _____ to plasma.

25) Solutions with a lower solute concentration than plasma are _____ relative to plasma.

27) How many total liters of fluid are there in the body, if you include all the fluid compartments together? _____

28) The extracellular compartment is comprised of the _____ (which has about _____ liters of fluid) and the _____ (which has about _____ liters of fluid).

29) The intracellular compartment is comprised of _____. It has a total of about _____ liters of fluid.

30) If you add a solution to the plasma (such as by giving a patient a solution intravenously) the solution will mix with easily and quickly with the tissue fluid/intracellular fluid (circle one) but not with the tissue fluid/intracellular fluid (circle one).

31) Solute A can pass easily through the cell membrane. Therefore, we say that the membrane is _____ to solute A and that solute A is a _____ solute.

32) Solute B cannot pass through the cell membrane. Therefore, we say that the membrane is _____ to solute B and that solute B is a _____ solute.

- 33) In order for osmosis to occur, there must be a different concentration of _____ solutes inside the cell compared to the outside of the cell.
- 34) When describing body fluids such as plasma, the total molar concentration of all solutes in the fluid is called its _____. This is the correct concentration unit to use for solving osmolarity problems.
- 35) A certain cell has 0.5 OsM solute A (a non-penetrating solute) inside the cell, The cell is placed into a beaker containing a 0.7 OsM solution of solute B (a non-penetrating solute). These are the only solutes present. The cell will gain water/lose water/have no water movement (circle one of the three).
- 36) A certain cell has 1.3 OsM solute C (a non-penetrating solute) inside the cell, The cell is placed into a beaker containing a 1.9 OsM solution of solute D (a penetrating solute). These are the only solutes present. The cell will gain water/lose water/have no water movement (circle one of the three).
- 37) A certain cell has 1.0 OsM solute G (a non-penetrating solute) inside the cell, The cell is placed into a beaker containing a solution of 0.7 OsM solute E (a non-penetrating solute) and 1.4 OsM solute F (a penetrating solute). These are the only solutes present. The cell will gain water/lose water/have no water movement (circle one of the three).
- 38) A certain cell has 1.0 OsM solute Q (a non-penetrating solute) inside the cell, The cell is placed into a beaker containing a solution of 0.7 OsM solute R (a penetrating solute) and 1.4 OsM solute S (a non-penetrating solute). These are the only solutes present. The cell will gain water/lose water/have no water movement (circle one of the three).

Answers to fill-in-the-blank review questions:

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|---------------------------|---|
| 2) Hydrophilic | 8) O ₂ , CO ₂ , and steroids (and other hydrophobic solutes). |
| 3) Concentration gradient | 9) Active |
| 4) Endocytosis | Passive |
| Exocytosis | 10) Active |
| 5) Exocytosis | 11) Active transport |
| 6) Endocytosis | 12) ATP |
| 7) Simple diffusion | 13) Secondary active transport |

- | | |
|---|---------------------|
| 14) Passive transport (facilitated diffusion) | 30 liters |
| 15) Primary active transport | 30) Tissue fluid |
| 16) Secondary active transport | Intracellular fluid |
| 17) The sodium-potassium pump | 31) Permeable |
| 18) Outside | Penetrating |
| Inside | 32) Impermeable |
| 24) Isotonic | Non-penetrating |
| 25) Hypotonic | 33) Non-penetrating |
| 27) 45 liters | 34) Osmolarity |
| 28) Tissue fluid | 35) Lose water |
| 12 liters | 36) Gain water |
| Plasma | 37) Gain water |
| 3 liters | 38) Lose water |
| 29) Cytoplasm | |

Short answer review questions:

- 1) Cell membranes are barriers that stop most solutes from passing across the membrane. Explain, in terms of molecules, why most solutes cannot cross the cell membrane.
- 2) What is a GLUT protein and why is it found in the membrane of almost all cell types?
- 3) If you add a solution to the plasma (for example, by giving a patient a solution intravenously) the solution will mix with easily and quickly with the tissue fluid but not with the intracellular fluid (the cytosol of the patient's cells). Explain why the solution mixes with the tissue fluid but not with the intracellular fluid.
- 4) A certain cell has a concentration of 1.4 OsM of solute N (a non-penetrating solute) inside. The cell is placed into a beaker containing a 2.4 OsM solution of solute P (a penetrating solute). The principle of osmosis states that water moves by towards the side with the highest solute concentration, yet in this case water would move into the cell. Explain why the water seems to be moving in the "wrong" direction. Your explanation should include the movements of water and any solutes that move.

Answers to short answer review questions:

- 1) The cell membrane is hydrophobic (due to its phospholipids and cholesterol molecules). Most solutes outside and inside the cell are hydrophilic (because the liquids outside and inside the cell have water as their solvent). Since hydrophilic substances do not mix with hydrophobic substances, most solutes are not able to pass through the cell membrane.
- 2) GLUT proteins are membrane transport proteins for glucose. They are found in almost all cells because glucose is the major "fuel" that cells use for energy.

3) The tissue fluid and the plasma are separated from each other by the walls of the blood vessels. The blood vessel walls (especially of capillaries) have many holes through which water and many solutes can easily pass, so almost all solutions put into the plasma very easily mix with the tissue fluid. The intracellular fluid (the cytosol of the cells), however, is inside the cell membrane. The cell membrane prevents most solutes from passing, so solutions put into the extracellular fluid compartment (the plasma and the tissue fluid) do not usually mix with the intracellular fluid compartment.

4) At first, it seems that the water should move out of the cell (because the outside of the cell has a higher solute concentration than the inside of the cell). However, solute P (the solute outside the cell) is a penetrating solute, meaning it can move through cell membranes. Solute P will therefore diffuse into the cell until solute P is the same concentration inside the cell as outside (2.4 OsM). Since a solute cannot cause osmosis when it has the same concentration inside and outside the cell, solute P can be ignored when calculating water movement. If we ignore solute P, the cell is in a solution of pure water and there is 1.4 OsM of solute N inside the cell. The higher solute concentration inside will attract water by osmosis from outside the cell.

Another way of doing the same problem is this: Solute P (the penetrating solute) will diffuse into the cell until solute P is the same concentration inside the cell as outside (2.4 OsM). The total solute concentration outside the cell is 2.4 OsM. The total solute concentration inside the cell is 3.8 OsM (2.4 OsM from solute P plus 1.4 OsM from solute N). The higher solute concentration is inside the cell, so that is where water moves by osmosis.