PHYSIOEX 9.0

REVIEW SHEET - KEY

EXERCISE 1

Cell Transport Mechanisms and Permeability

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ACTIVITY 1: Simulating Dialysis (Simple Diffusion)

1. Describe two variables that affect the rate of diffusion.

    a. *Multiple factors affect the rate of diffusion. For example, diffusion rate increases as solute concentration increases, and diffusion rate increases as solute molecular weight decreases.*

2. Why do you think the urea was not able to diffuse through the 20 MWCO membrane? How well did the results compare with your prediction?

    a. *Predictions may vary. The urea molecules were not able to diffuse through the 20 MWCO membrane because they were too large to fit through the pores.*

3. Describe the results of the attempts to diffuse glucose and albumin through the 200 MWCO membrane. How well did the results compare with your prediction?

    a. *Predictions may vary. Glucose molecules were able to diffuse through the 200 MWCO membrane, but albumin could not.*

4. Put the following in order from smallest to largest molecular weight: glucose, sodium chloride, albumin, and urea.

    a. *Sodium chloride, urea, glucose, albumin.*

ACTIVITY 2: Simulated Facilitated Diffusion

1. Explain one way in which facilitated diffusion is the same as simple diffusion and one way in which it differs.

    a. *Simple diffusion and facilitated diffusion both proceed passively (without the input of energy) down their concentration gradients. However, unlike simple diffusion, facilitated diffusion requires a carrier protein.*

2. The larger value obtained when more glucose carriers were present corresponds to an increase in the rate of glucose transport. Explain why the rate increased. How well did the results compare with your prediction?

    a. *Predictions may vary. Glucose transport can only occur via glucose carriers, so increasing the density of the carriers increases the rate of transport.*

3. Explain your prediction for the effect $Na^{+}Cl^{-}$ might have on glucose transport. In other words, explain why

you picked the choice that you did. How well did the results compare with your prediction?

a. *Predictions may vary. In this case, the glucose carrier is solely for the transport of glucose; it does not co-transport Na^+ or Cl^- and is not sensitive to the concentrations of these ions. (This is consistent with 10th Martini Figure 3-18, though different from what is pictured in 10th Martini Figure 3-20).*

ACTIVITY 3: Simulating Osmotic Pressure

1. Explain the effect that increasing the Na^+Cl^- concentration had on osmotic pressure and why it has this effect. How well did the results compare with your prediction?

   a. *Osmotic pressure is defined as the pressure needed to oppose the diffusion of water (by osmosis) into a region of higher solute concentration. Since solutes draw water toward them, a higher solute concentration draws water more strongly, so the osmotic pressure needed to oppose water's diffusion is higher.*

2. Describe one way in which osmosis is similar to simple diffusion and one way in which it is different.

   a. *Osmosis is an example of simple diffusion; both are passive processes. Osmosis could be said to be different from simple diffusion in that osmosis, by definition, involves a selectively permeable membrane and specifically concerns the movement of water, whereas simple diffusion in general does not necessarily involve a membrane and usually is considered in terms of solutes rather than water.*

3. Solutes are sometimes measured in milliosmoles. Explain the statement, "Water chases milliosmoles."

   a. *Water moves toward regions of higher solute concentrations, so water goes where the milliosmoles are the highest.*

4. The conditions were 9 m*M* albumin in the left beaker and 10 m*M* glucose in the right beaker with the 200 MWCO membrane in place. Explain the results. How well did the results compare with your prediction?

   a. *Predictions may vary. The results were that half of the glucose diffused from the right beaker to the left beaker, following its concentration gradient; some water diffused from the right beaker to the left beaker because the left beaker had a higher solute concentration; and albumin did not move because it was too large to get through the filter.*

ACTIVITY 4: Simulating Filtration

1. Explain in your own words why increasing the pore size increased the filtration rate. Use an analogy to support your statement. How well did the results compare with your prediction?

   a. *Predictions may vary. Pore size increased filtration rate because, as pore size increases, resistance to flow decreases. Many analogies are possible: electricity flows more quickly down a wider wire; sand falls more quickly through a sieve with bigger openings; etc.*

2. Which solute did not appear in the filtrate using any of the membranes? Explain why.

   a. *The powdered charcoal did not appear in the filtrate because it was too large to pass through any of the membranes.*

3. Why did increasing the pressure increase the filtration rate but not the concentration of solutes? How well did the results compare with your prediction?

a. *Predictions may vary. Since the solutes are dissolved in water, they simply go where the water goes unless the filter prevents them from coming with the water.*

ACTIVITY 5: Simulating Active Transport

1. Describe the significance of using 9 m*M* sodium chloride inside the cell and 6 m*M* potassium chloride outside the cell, instead of other concentration ratios.

    a. *This 3:2 ratio corresponds to the fact that the Na^+/K^+ pump removes 3 sodium ions from cells for every 2 potassium ions that are pumped in.*

2. Explain why there was no sodium transport even though ATP was present. How well did the results compare with your prediction?

    a. *Sodium and potassium are both required for the pump to operate. If only one is present, the pump cannot complete its full cycle of conformational changes.*

3. Explain why the addition of glucose carriers had no effect on sodium or potassium transport. How well did the results compare with your prediction?

    a. *In this simulation, glucose transport is not linked to sodium and potassium transport; it passes through its own carrier.*

4. Do you think glucose is being actively transported or transported by facilitated diffusion in this experiment? Explain your answer.

    a. *Glucose is moving down its concentration gradient, so this must be facilitated diffusion rather than active transport.*