Lab 3: Membrane Transport

*** NOTE:** You will probably want to get started on Part E before continuing because it will take some time to obtain measurable results**.** Your TA will discuss scientific methodology in the pre-lab lecture. You will be expected to be able to design and/or analyze an experiment using sound scientific methodology.

OBJECTIVES:

- To describe ways that substances move in space
- To relate the structure and function of the cell membrane
- To compare and contrast passive and active transport
- To explain the concept of selective permeability and how it relates to cellular transport
- To predict if and describe how various molecules would cross the cell membrane

A. Cellular transport terminology (Section 3.3)

Define the following terms:

concentration gradient	
filtration	
diffusion	
passive transport	
osmosis	
facilitated diffusion	
phagocytosis	
hypertonic	
hypotonic	
isotonic	
active transport	

B. Scientific Methodology (Section 1.3)

hypothesis	
controlled variable	
independent variable	
dependent variable	

C. Observing Diffusion.

Two different substances were put on an agar dish, methylene blue and potassium permanganate ($KMnO_4$). The time they were placed in their wells was noted, so use that as your start time.

Hypothesis and explanation: After seeing the molecules during the presentation, which molecule do you think is likely to diffuse faster. Explain your reasoning.

_____

_____

_____

Data collection: Using a metric ruler, determine the distance the substance diffused from each well. Continue these observations approximately every fifteen minutes for an hour.

Start time: _____

Diffusion Time (min)	Diffusion of methylene blue (mm)	Diffusion of $KMnO_4$ (mm)

What are some factors that might influence the rate of diffusion? Which were held constant in this activity?

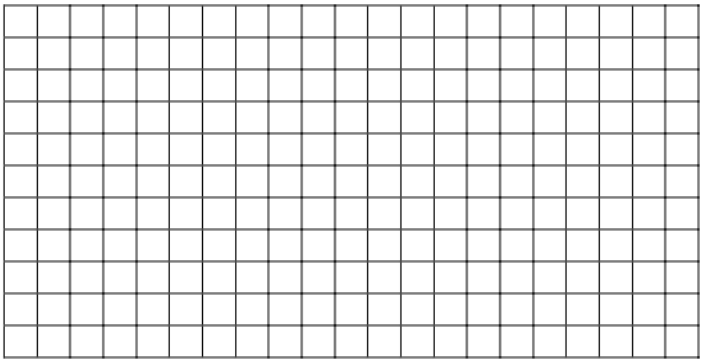
_____

_____

_____

Graph your results, properly labeling the axes.

For each substance, draw a line of best fit. Use a straight-edge to capture as much of the data as you can.



Calculate the slope ($y_1 - y_2 / x_1 - x_2$) of your lines – *be sure to include units!* What does this tell you about differences in diffusion rate? Explain.

Methylene blue: _____

_____

_____

$KMnO_4$: _____

_____

D. Molarity

Molarity describes the concentration of a solution. It simply means moles of solute per liter of solution. It is abbreviated **M.** To determine the amount of moles of a substance you have, you can refer to a periodic table and determine a solute's molecular weight. For example, NaCl is composed of Na ions and Cl ions (even though they are ions, not atoms, electrons do not significantly contribute to atomic weight, and can be ignored). The atomic weight for sodium is 23.0 and chlorine's is 35.5. This means that the mass of one mole of sodium is 23g and one mole of chlorine is 35.5g. Therefore one mole of NaCl = 23g + 35.5g = 58.5g.

That means that if you take 58.5g of NaCl and add enough water so that the volume is 1 liter, you have just made one liter of 1.0 M NaCl!

Now what if you want to make 1 liter of a 0.5 M NaCl solution? You would need *0.5 moles* of NaCl. If one mole is 58.5g, then 0.5 moles = 0.5 x 58.5g = 29.25g NaCl. To this, you would add enough water so that the total volume is 1 L.

We don't always need one liter of a solution, especially if the solutes are expensive! You would reduce (or increase) the number of moles of solute by the *same multiplier.* What if you want to make 200 ml (or 0.2 L) of 0.3 M NaCl? How much NaCl would you start with? 58.5g x 0.2 x 0.3 = 3.5g NaCl. To this, you would add enough water to make a total volume of 200ml.

For this lab we are using sucrose (molecular formula: $C_{12}H_{22}O_{11}$). What is its molecular weight? The approximate atomic weights for the atoms in sucrose are C: 12.0, H: 1.0, O: 16.0.

Calculate the molecular weight of sucrose:

The TAs have prepared 5 different solutions of sucrose for you: 0.0 M, 0.2 M 0.4 M, 0.6 M, and 0.8 M, but only 300 ml of each. How much sucrose did they need for each one?

300ml 0.0 M:

300ml 0.2 M:

300ml 0.4 M:

300ml 0.6 M:

300ml 0.8 M:

E. Osmosis

In this lab, you will use potatoes as a model to measure the process of osmosis. The cell membrane of the potato is permeable to water, but not to sucrose (table sugar). By measuring changes in mass, which is caused by loss or uptake of water, you can determine the rate of osmosis across varying concentration gradients, since water moves from higher *water* concentration to lower *water* concentration. Another way to put it is that water moves from lower *solute* concentration to higher *solute* concentration. The following is the procedure for this activity:

Procedure:

a. Obtain a potato, test tubes, test tube racks, and potato corers.
b. With the same corer, make a potato core(s) for each concentration you are testing. Cut off any skin.
   Consider sample size – you want as much potato as is practical.
c. Mass each core(s) and record as initial mass. Place each core in a separate, labeled test tube.
d. At the same time, pour just enough of each solution to cover them.
e. Let the potatoes stand in the solutions for 60 minutes.
f. Carefully remove the potatoes from the tubes and gently roll them on paper towels to remove water.
g. Record the final mass of each potato core.
h. Calculate percent mass change for each solution ($Mass_{final}$ – $Mass_{initial}$ / $Mass_{initial}$) x 100%
i. Clean up materials and dispose of the potatoes in the garbage.

Lab Writeup

i. Hypothesis: Using your knowledge of osmosis, predict what will happen to the potatoes in the various sucrose solutions.

ii. What is the independent variable? (What are you manipulating in this experiment and how is it measured?)

iii. What is the dependent variable? (What change could happen as a result varying the independent variable?)

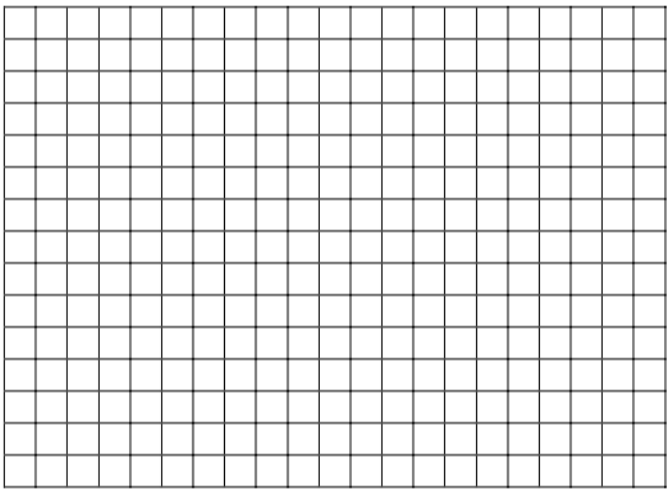
iv. What are the controlled variables in this experiment? (What factors or conditions are being held constant during this experiment?) Can you think of any others that should be addressed?

v. Data Table:

Molarity (moles/L)	Initial Mass (g)	Final Mass (g)	% Mass Change
0.0			
0.2			
0.4			
0.6			
0.8			
Unknown			

vi. Graph (Think about formatting: What would covey the best information?). Include a LINE of best fit.

Title:



vii. Analysis:

a. Using concepts of membrane transport, *explain* why you got the data that you did in this experiment.

b. Why should you determine *percent* mass change, rather than just mass change?

c. Your line crossed the x-axis. What is the significance of that point?

d. What was the molarity of the unknown? Explain.

e. If your TA made the 300mL of the unknown solution, how much sucrose was in it?