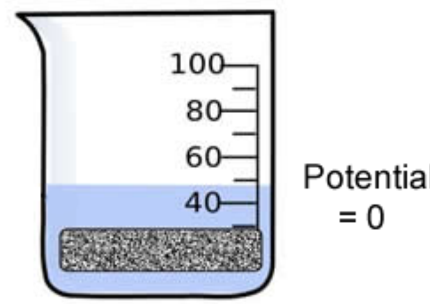
Name:____

Investigation: Water Potential and Molarity

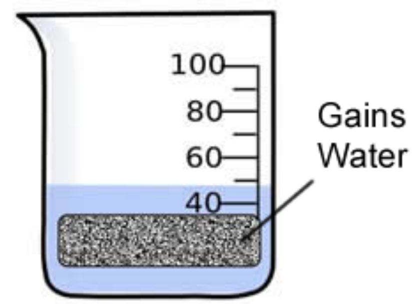
In animal cells, the movement of water into and out of the cell is influenced by the relative concentration of solute on either side of the cell membrane. If placed in a **hypertonic** solution, water will move out of the cell and the cell will shrink. In a **hypotonic** solution, water will move into the cell and it will swell.

In plant cells, the cell wall prevents the cells from bursting, but pressure does eventually build up inside the cell and affects the process of osmosis. When the pressure inside the cell becomes large enough, no additional water will accumulate in the cell. Movement of water through the plant tissue cannot be predicted simply by knowing the relative solute concentrations on either side of the plant cell wall. Instead, the concept of **water potential** is used to predict the direction in which water will move. Put simply, it is a measure of how likely water is to move from one location to another.

Consider a potato cell placed in pure water. Initially the water potential outside the cell is 0. Under these conditions there will be a net movement of water into the cell by **osmosis**.



Pressure potential is an important component of the total water potential within plant cells. Pressure potential increases as water enters a cell. As water passes through the cell membrane, it increases the total amount of water present inside the cell, which exerts an outward pressure that is opposed by the rigidity of the cell wall. By creating this pressure, the plant can maintain **turgor**, which allows the plant to keep its rigidity and not wilt.



Water Potential is made up of two parts, the solute potential and the pressure potential. **Solute potential** refers to the amount of solutes in the solution. The greater the concentration of solute, the lower the water potential. It is measured in kilopascals (kPa) and is represented by the Greek letter Psi (Ψ).

Water potential is never positive but has a maximum value of zero, which is that of pure water. When it comes water that has solutes in it, the more solute there is, the more negative Ψ becomes, since the solute molecules will attract the water molecules and restrict their freedom to move.

$$\Psi = \Psi_P + \Psi_S$$

Water potential = Pressure Potential + Solute Potential

To summarize:

- Pure water has a water potential of ZERO.
- Solutes added to pure water decrease water potential (negative numbers)
- Water potential predicts the movement of water
- Water potential is determined by pressure potential and solute potential

Check for Understanding: (Circle correct choice)

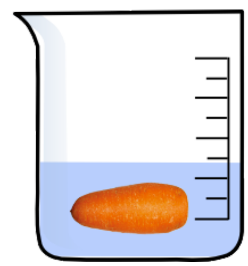
1. What is the solute potential of pure water? [1 / 0 / -1]

2. The solute potential of a plant cell is [greater / lesser] than pure water. Therefore, the greater water potential is [in the cell / in the solution].

3. If a potato is allowed to dehydrate by sitting in open air, the water potential of the potato cells [increases / decreases]

4. What can we expect to observe if we place a cell inside a solution where the cell's Ψ is equal to -0.3 kPa and that of the solution is -0.9 kPa?
   a) Water will move out of the cell   b) Water will move into the cell

5. Simply put, water potential is:
   a) The amount of water that roots can take up per day
   b) The combination of osmotic pressure and gravitational forces
   c) The combination of solute potential and pressure potential



6. How does water potential vary in relation to solute concentration?
   a) It increases the higher the solute concentration
   b) It decreases the higher the solute concentration
   c) It is not affected by the concentration of solute

The Experiment

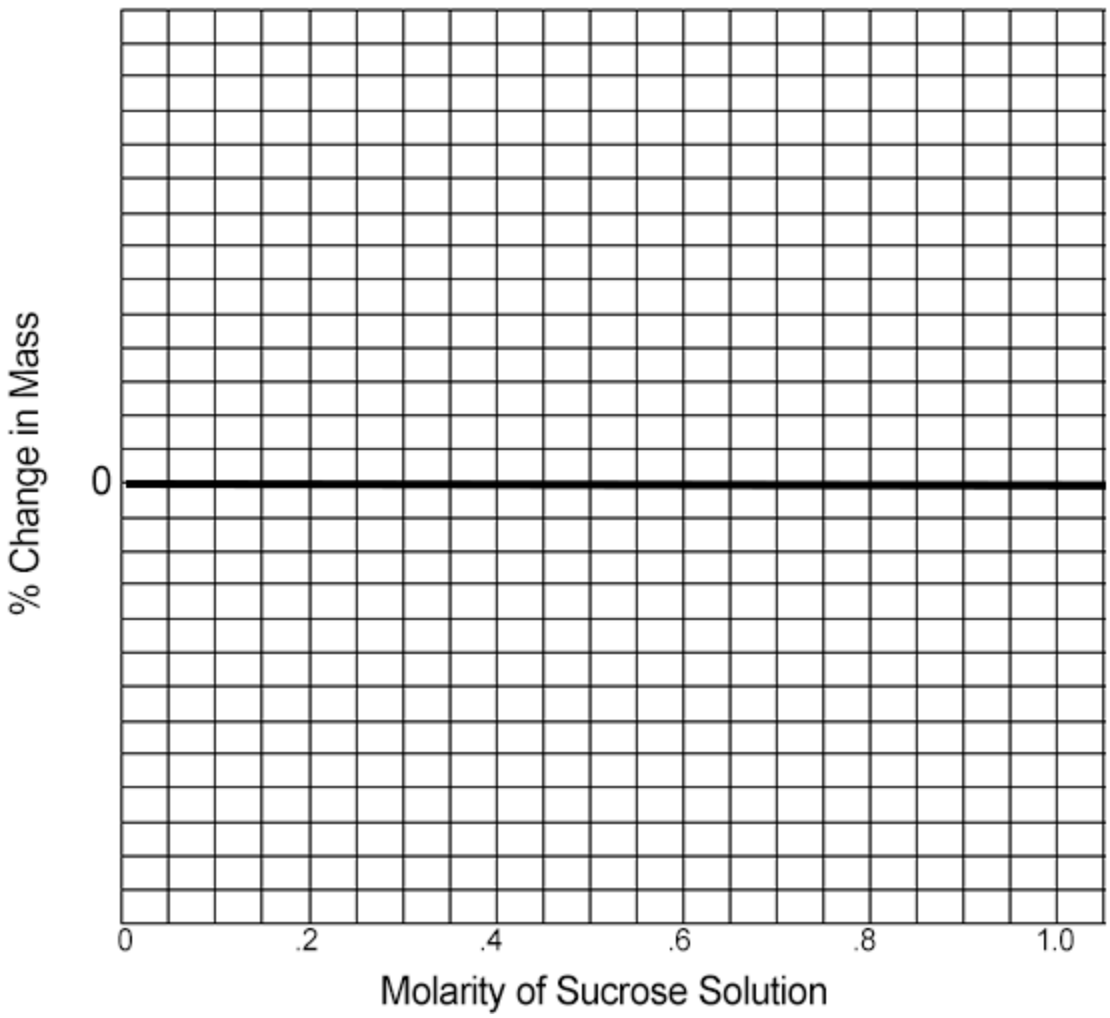
Molarity	Sucrose (g)
1.0	34.2
0.8	27.4
0.6	20.5
0.4	17.7
0.2	6.9
0.0	0

1. Create a sucrose solution of each molarity by adding sugar to **100 ml** of distilled water. (See chart)
2. Record the initial mass of each of the 6 carrots and enter into the data table. Keep track of each carrot's mass.
3. Place a carrot into the beaker with your solution and cover with plastic wrap. Leave overnight.
4. Determine the temperature of the room and record it on the table.
5. Remove the plants from the beakers and record the mass in the table.

Temperature:				
Solution	Initial Mass (g)	Final Mass (g)	Mass Difference (final - initial)	%Change in Mass*
1.0 M				
0.8 M				
0.6 M				
0.4 M				
0.2 M				
DI Water (0)				

*To calculate: percent change in mass= (final mass-initial mass)/ initial mass. Then multiply the answer by 100.

Data Analysis - Graph the Results



1. Draw a straight line on your graph that best fits your data (Line of best fit). The point at which this line crosses the x axis represents the molar concentration of sucrose with a water potential that is equal to the potato tissue water potential. **CIRCLE this point on your graph.**

What is the Molar concentration of the cores? ___________

2. Calculate the solute potential (Ψ) for the sucrose solution using the formula below. Solute potential: _____

Solute Potential Formula → $\Psi = -iCRT$

i = ionization constant (for sucrose, this is 1 because sucrose does not ionize in water)
C = molar sucrose concentration at equilibrium (determined from graph)
R = pressure constant (0.0831 liter bar/mol °K) T = temperature °K (273 + °C)

SHOW WORK!

3. **Final Synthesis** (Summary): Explain how you determine the water potential of a carrot. Use specific terms from the lab and describe how those concepts inform your procedure and determination. This is where you show me what you have learned! (Submit on Google Classroom)

Rubric

Proper Use of biology terminology ___4 ___3 ___2___1___0
Explanation of how to determine molarity ___3 ___2___1___0
Connection between terms and procedure ___3 ___2___1___0