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BIOL 305L Spring 2020
Laboratory Six
Osmosis in potato and carrot samples

Introduction

Osmosis is the movement of water molecules through a selectively permeable membrane into a region of higher solute concentration, until there is an an equal solute concentration on the two sides.

Osmosis is essential in biological systems, as biological membranes are semipermeable. In general, these membranes are impermeable to large and polar molecules, such as ions, proteins, and polysaccharides, while being permeable to non-polar and/or hydrophobic molecules like lipids as well as to small molecules like oxygen, carbon dioxide, nitrogen, nitric oxide. (Haynie *et al.*, 2001)

Tonicity is the osmolarity of a solution--the amount of ***solute*** in a solution. A Solute is any dissolved substance in a solution, such as sugars and salts. The term Tonicity is commonly used when describing the response of cells immersed in an external solution. Like osmotic pressure, tonicity is influenced only by solutes that cannot cross the membrane, as only these exert an osmotic pressure. Solutes able to freely cross the membrane do not affect tonicity because they will always be in equal concentrations on both sides of the membrane.

There are two things to ***always*** remember about osmoses and tonicity:

- Tonicity is always in comparison to a cell.
- The cell has a specific amount of sugar and salt

Remember the three key terms:

A ***Hypertonic*** solution has more solute (**so *LESS* water**) than the cell. A cell placed in this solution will give up water (osmosis) and shrink.

A ***Hypotonic*** solution has less solute (**so *MORE* water**) than the cell. A cell placed in this solution will take up water (osmosis) and expand.

An **Isotonic** solution has just the right amount of solute for the cell. A cell placed in this solution will stay the same.

An example of the effects of each of these osmotic environments on a typical plant cell is shown in Figure 1.

The flexible cell membrane pulls away from the rigid cell wall but remains joined to the cell wall at points called plasmodesmata. The cell takes on the appearance of a pincushion, and the plasmodesmata almost cease to function because they become constricted — a condition known as plasmolysis.

In plant cells the terms isotonic, hypotonic and hypertonic cannot strictly be used accurately because the pressure exerted by the cell wall significantly affects the osmotic equilibrium point.

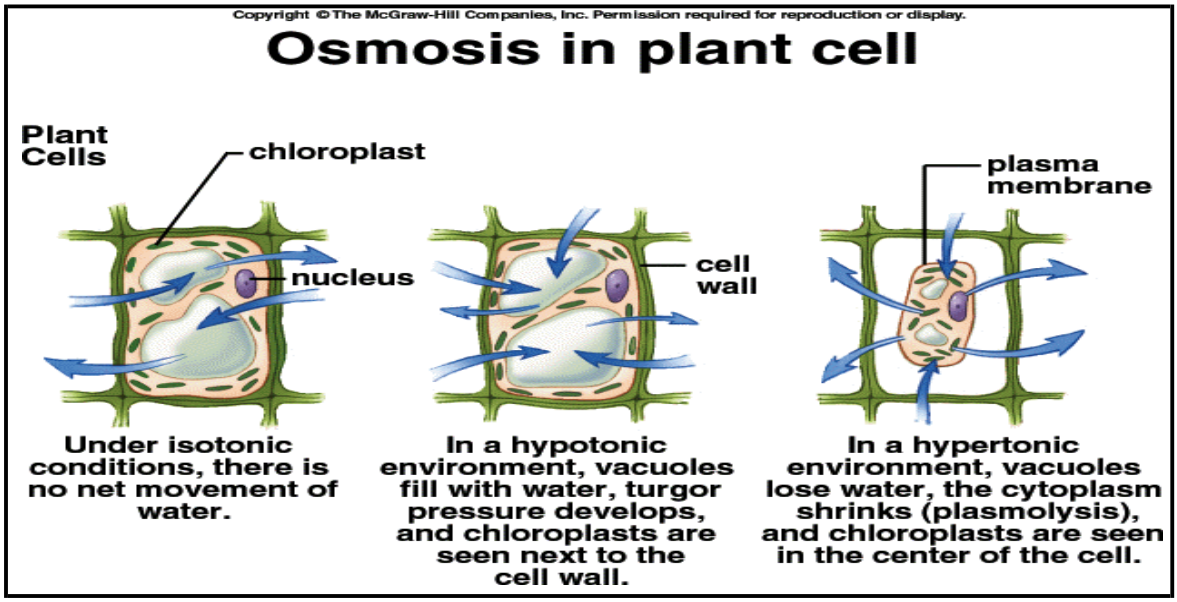

Figure 1 The effect on plant cells under different osmotic environments.

In a hypotonic environment, animal cells will swell until they burst, a process known as cytolysis. Fresh water fish urinate constantly to prevent cytolysis. Plant cells tend to resist bursting, due to the reinforcement of their cell wall, which provides effective osmolarity or osmolality (Kramer *et al.*, 2012).

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OBJECTIVES:

During this lab, you should be able to:

1. Determine the effect of molecular mass on the diffusion rate of particles through a media.
2. Measure the osmotic pressure in cells of a potato using a gradient of solutions.

Solution preparations:

You will be provided with a 0.5 M stock solution of NaCl and firstly you will learn how to calculate dilutions for varying molar solutions

Calculating and making 10 ml of varying molar solutions from 0.5 M NaCl:

$$\frac{\text{Molar Solution needed in dilution X 10 ml}}{\text{0.5 M}} = \text{ml of 0.5 M NaCl}$$

Show the values in the table below

Table 1: Determination of NaCl and dH_20 to add to each beaker

	ml of 0.5 M NaCl	ml of dH_20
0.5 M		
0.4 M		
0.3 M		
0.2 M		
0.15 M		
0.10 M		
0.05 M		
0.025 M		
dH_2O		

Make above solutions and put into clearly labelled beakers

a. Using a cork borer cut cylinders from a single potato and carrot (the cuts are made parallel).

b. A razor blade is used to cut the ends of the potato cylinders square (all cylinders are equal in length). A length of about 30 mm gives good data.

c: All cylinders of samples must be equal in length, width, and appearance.

d. Measure and record the weight of each sample.

e. Place a sample into a beaker.

f. Each of the test tubes is labeled and filled about 2/3 full of a different one of the salt solutions.

g. Weigh the potato and carrot cylinders after 10 mins and every 10 mins up to about 1 ½ hours. Then remove the cylinders from the test tubes.

Table2: Record of the initial weights(in grams) of plant samples

Sample	dH_2O	0.025 M	0.05 M	0.1 M	0.15 M	0.2 M	0.3 M	0.4 M	0.5 M
Potato									
Carrot									

Table 3: Weight (in grams) of samples after incubation periods

Time	dH_2O	0.025 M	0.05 M	0.1 M	0.15 M	0.2 M	0.3 M	0.4 M	0.5 M
0 P C									
10 P C									
20 P C									
30 P C									
40 P C									
50 P C									
60 P C									
70 P C									
80 P C									
90 P C									

Get the data from the other groups. Fill in table four with the mean values of initial weights and table five with the mean values for each incubation period.

Table 4: Class mean of the initial weights(in grams) of plant samples

Sample	dH_2O	0.025 M	0.05 M	0.1 M	0.15 M	0.2 M	0.3 M	0.4 M	0.5 M
Potato									
Carrot									

Table 5: Class mean weight (in grams) of samples after incubation periods

Time	dH_2O	0.025 M	0.05 M	0.1 M	0.15 M	0.2 M	0.3 M	0.4 M	0.5 M
0 P C									
10 P C									
20 P C									
30 P C									
40 P C									
50 P C									
60 P C									
70 P C									
80 P C									
90 P C									

From all class data, determine the mean % weight change for each sample cylinder:

$$\frac{\text{(Incubation weight at each [NaCl] - Initial weight of plant sample)}}{\text{Initial weight of plant sample}} \times 100 = \text{\% change}$$

If the % change is negative, it is a decrease; if positive, it's an increase.

Enter all mean % weight change values for the mean potato and carrot cylinders for each NaCl concentration in tables six and seven respectively.

Table 6: Mean % weight change for potato samples.

Time	dH_2O	0.025 M	0.05 M	0.1 M	0.15 M	0.2 M	0.3 M	0.4 M	0.5 M
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									

Table 7: Mean % weight change for carrot samples.

Time	dH_2O	0.025 M	0.05 M	0.1 M	0.15 M	0.2 M	0.3 M	0.4 M	0.5 M
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									

Right. Now that you have finished the somewhat arduous task of gathering and tabulating secondary data, it is time to look at tables six and seven and think about osmosis and the general properties of a plant cell.

Take a breath, get a hold of your course notes, have a good look at figure 1 on page two, and answer the following questions.

1) Describe any visible trend in mean % weight change over the 90 min incubation period.

2) What NaCl concentration shows the greatest change?

3) What time period shows the greatest change?

4) Are such trends the same between both plant species? Explain briefly.

On the graph paper plot the concentration of NaCl from 0 M (dH_2O) to 0.5 M on the horizontal X – axis against the mean % weight change for the *90 min incubation period* on the vertical Y - axis. Do this for both the potato and carrot mean values on the same graph.

On the graph, identify and label which NaCl concentration, relative to the tonicity of the cells in the plant sample, were isotonic, hypotonic, or hypertonic. **Explain your reasoning in the space provided below**.

Isotonic

Hypotonic

Hypertonic

References

Haynie, Donald T. (2001). Biological Thermodynamics. *Cambridge University Press*, pp. 130–136

Kramer, Eric M., and David R. Myers. (2012). Five Popular Misconceptions about Osmosis. *American Journal of Physics* **80**, **no**. 8 698

1-CENTIMETER GRID PAPER