**BIO 183 Lab – Due May 25, 2023 Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Microscopes and Cells Lab**

**15 points**

The purpose of this assignment is to familiarize you with osmotic pressure and the factors that affect it.

In lecture, we learned that the presence of solutes in water generates an osmotic force that has the ability to “pull” water through a cell membrane, from an area of low solute concentration to an area of high solute concentration. Osmotic pressure is said to be a “**colligative property”** of solutions. In the space below, please define colligative properties of solutions in your own words **(1 points)**:

In the space below, please list 3 other colligative properties of solutions **(3 points)**:

Let’s look at an application of osmotic pressure:

In an attempt to mimic hypothetical cells, a scientist created 2 identical spheres whose outer membrane was made of a phospholipid bilayer only (see figure 1 below). The scientist then proceeded to fill those spheres with an equal volume of 1 millimolar solution of potassium (K+) (sphere 1), and 1 millimolar solution of NaCl ( sphere 2). A millimolar concentration is equal to 1 millimole of solute per liter of solution. Hence, in this experiment, both spheres contain the same number of K+ and NaCl molecules. The scientist then placed both spheres in a beaker of deionized water for an hour. At the end of the hour, the scientist observed that the sphere that contained potassium had increased in volume by about 10%, while the sphere that contains NaCl had increased in volume by about twice as much. Considering the fact that both spheres contained the same concentrations of salts, and that they were placed in identical environments, how can we explain the difference in the observed volume increase?



 **Figure 1:** Sphere made of phospholipid bilayer

In order to correctly answer this question, you will have to familiarize yourself with the van ’t Hoff factor (*i*). In the space below, explain what the van ’t Hoff factor is **(1 points)**:

Based on your description of the van ‘t Hoff factor, how do you explain the difference of volume observed in the experiment described above **(2 points)**?

Puzzled by her discovery, the scientist decided to expand on her first experiment by testing similar mechanisms as the one described above, using dialysis tubes. Dialysis tubes are essentially pieces of flexible porous tubing, with pore size ranging from approximately 10 to 100 Angströms. Although not completely identical to cell membranes, dialysis tubing may sometimes be used to address questions related to osmotic forces across a semipermeable membrane. Water and small molecules can cross the membrane of dialysis tubes, while larger molecules (larger than 100 Angstroms) are unable to pass through the pores.

In this second experiment, the scientist used dialysis tubes to assess the osmotic force exerted by five different solutions. The scientists designed her experiment to have 3 replicates for each tested solution. She weighed each tube separately before completely submerging all of them into separate beakers of distilled water (see figure 2 below). After 2 hours, she removed all the dialysis tubes and recorded the final masses in Table 2.



 **Figure 2:** Filled dialysis tube in distilled water

**Step 1:** Find and record the molecular weight for each tested solute in Table 1 below. Remember that various starches may have different molecular weights based on the size of the glucose chains (just get a feeling for a reasonable range of molecular weights). Keep in mind that the weight of proteins is often expressed in Daltons (Da) or KiloDaltons (kDa). 1 Da = 1g/mol. **(1 point)**

**Table 1. Osmosis Experimental Set Up**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tube # for Replicates** | **Solute being tested** | **Molecular weight of solute tested (in g/mol)** | **Amount used in experiment** | **Initial mass (in g) of all 3 tubes** |
| Tubes 1-3 | Glucose |  | 5% by weight | 100 |
| Tubes 1-3 | Starch |  | 5% by weight | 100 |
| Tubes 1-3 | Aprotinin |  | 5% by weight | 100 |
| Tubes 1-3 | Lysozyme |  | 5% by weight | 100 |
| Tubes 1-3 | Glass beads |  | 5% by weight | 100 |

**Step 2:** Calculate and fill in empty cells Table 2. **(2 points)**

**Table 2. Osmosis Experimental Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Contents** | **Final mass, g tube 1** | **Final mass, g tube 2**  | **Final mass, g tube 3**  | **Average Final mass, g** | **+/- Change in Average Final mass, g** |
| Glucose | 102.1 | 99.8 | 98.6 |  |  |
| Starch | 204.2 |  206.8 | 199.4 |  |  |
| Aprotinin | 111.2 | 110.6 | 112.4 |  |  |
| Lysozyme | 105.1 | 104.3 | 106.0 |  |  |
| Glass beads | 100.0 | 99.9  | 100.1  |  |  |

Explain the observed results for each of these solutes. Consider how much of each substance the scientist placed into the various tubes **(5 points)**.

1. Glucose tube:

2. Starch tube:

3. Aprotinin tube:

4. Lysozyme tube:

5. Glass beads tube: