“Osmosis, Diffusion, and Membranes” Laboratory

Experiments with Artificial Cells

Objectives

In this lab, you will learn to:

1. Define and differentiate

1. diffusion and osmosis

2. permeable, semi-permeable, and impermeable

3. solute and solvent

4. hypertonic, hypotonic, and isotonic

2. Identify components of the scientific method

3. Apply the scientific method

4. Explain the processes of osmosis and diffusion

5. Describe properties of membranes

6. Predict the movement of solutes and solvents across a membrane, given information about concentration and permeability

7. Interpret experimental outcomes

Introduction

Science is often thought of as simply a list of facts about the natural world. But science is more than that. Science is an approach to understand the natural world and how it works. While other disciplines also try to understand the world around us, science relies on observable physical evidence and applies a systematic process commonly referred to as the scientific method.

The Scientific Method

The scientific method is a systematic approach to problem solving. Although some argue that there is not one single scientific method, but a variety of methods, each of these approaches, whether explicit or not, tend to incorporate a few fundamental steps: observing, questioning, hypothesizing, predicting, testing, and interpreting results of the test. Sometimes the distinction between these steps is not always clear. This is particularly the case with hypotheses and predictions. But for our purposes, we will

differentiate each of these steps in our applications of the scientific method.

Observation

WSBCTC 2

An observation is something that the scientist notices. This may be a direct observation using one or more of his or her senses or it may be an observation made by someone else that has been communicated to the scientist. An everyday example might be ``when I flip the light switch, the light does not come on.''

Question

The observation leads to a question. In the case of our example, an obvious question is ``why won't the light come on?''

Hypothesis

An hypothesis is often described as an educated guess. It is a possible answer to the question that has been asked. It is inevitable that there is more than one possible answer. If multiple answers are proposed, these are referred to as alternative hypotheses. In our example, an hypothesis might be that ``the light bulb is dead.'' Alternative hypotheses might include ``the power is out,'' ``the circuit is broken,'' or ``the fuse has been tripped.'' Hypotheses must be testable and falsifiable. If the hypothesis is wrong, we must have an opportunity to demonstrate that it is false.

Prediction

WSBCTC 3

Membranes

Membranes are vital components of living organisms. All cells have a cell membrane and eukaryotic cells are characterized by membrane-bound organelles within the cell membrane.

Membranes are composed of a phospholipid bilayer, proteins, cholesterol, and carbohydrates associated with some of the proteins. The structure of biological membranes makes them semi-permeable, meaning that some things will passively move across the membrane, while other things will not. Generally, small molecules move across the membrane more easily than large molecules. The long hydrophobic

tails in the interior of the membrane make it easier for non-polar molecules to move across the membrane than polar molecules and ions. As a result, membranes are vital to isolating the products and localizing reactants of various chemical reactions, as well as maintaining concentration gradients. Imagine what would happen, for example, if membranes didn't isolate DNA from various chemicals that react with it and change its structure or if ion concentration differences necessary for nerve functioning could not be maintained.

Movement of Molecules Across Membranes

As a group, define the following terms in order to interpret and test the hypotheses indicated later in this document. Record your definitions in your notebook.

- diffusion
- osmosis
- permeable
- semi-permeable
- impermeable
- solute
- solvent
- hypertonic
- hypotonic
- isotonic

Procedure

In groups of 3 to 4 people, design a set of experiments to test the hypotheses indicated below. You will have all chemical tests and equipment available that you have used previously. In addition, you will have items necessary to create an ``artificial cell.'' You will have a total of three lab periods to work on these experiments.

Materials Available

- Iodine
- Benedict's Reagent

 Water

 Sucrose solution

 Sucrose solution

 Glucose solution

 Starch solution

 Dialysis tubing

 String

 Beakers

 Triple beam balances

 Other equipment may be available at request

Creating Artificial Cells

Artificial cells can be created using sections of dialysis tubing with string tied around the ends. Dialysis tubing mimics a biological membrane. The dialysis tubing should soak in water for several minutes before use. Fold one side about 1 cm from the end. Bunch the fold together and tie a string tightly around it.

Next, open the tubing by working the other end between your thumb and finger. Once the tube is open, it can be filled with approximately 15 mL of solution. Which solution will depend on your experimental design, which you should determine before gathering any equipment. Once the solution is added, the open end can be folded and tied like the other end. Generally, it is best to try to minimize extra air space within the tube, but try to do this without losing liquid.

Hypotheses to Test

The following hypotheses should be tested by your experiment(s).

1. Membranes are semipermeable.

2. Solutes diffuse from an area of high concentration to an area of low concentration.

3. Water diffuses from an area of low solute concentration to an area of high solute concentration.

Record Keeping

In your notebook, you should:

1. Describe your experimental design(s) in enough detail that someone else could repeat the process.
2. Explain how the design will test each hypothesis (i.e., your predicted results with a brief explanation of your reasoning behind the predictions).
3. Document your results.
4. Provide an interpretation of your results.

You will need all of these when writing your lab report a little later in the quarter. The lab report is a significant proportion of your lab grade; it will be used to evaluate your ability to apply the scientific method, interpret scientific data, and to effectively communicate scientific information.

About this document ...

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The command line arguments were:

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The translation was initiated by Scott Rollins on 2011-07-22