WHAT IS LIFE?
What can we learn about life using some basic biological techniques?

OVERVIEW

Our current understanding of the structure and function of biological organisms and systems was gathered over many years of observation, study and experimentation. In this lab, you will review/learn some of the most basic techniques of biological research. For example, you will determine wet versus dry weights and organic versus inorganic composition of various animal and plant tissues (muscle, root, stem, leaf and fruit). You will investigate factors that affect rates of osmosis and diffusion in a model cell system and learn to do simple biochemical tests for major types of organic compounds.

As you learn the techniques, you will use them to answer some basic questions relating to the characteristics of living organisms.

- How much of living tissue is free water?
- What types of chemicals make up life forms?
- How do the concentrations of these vary among tissue types?
- Which of these characteristics are similar among life forms?
- What types of molecules are more likely to cause a change in the osmotic potential of a cell?
- Why do organisms use starch and fats as storage compounds instead of sugars?

As a result, you should get an understanding of the characteristics common to all of life. In addition, practicing some basic biological techniques will allow you to determine when these might be used in other studies and what their limitations might be.

BEFORE COMING TO LAB

1. Read all of the lab titled "WHAT IS LIFE? What can we learn about life using some basic biological techniques?."

2. Read all of the Reading Assignment for this lab.

3. Answer the "Pre-Lab Questions."

4. Bring the following with you to lab:
   Lab manual
   Lab notebook - 3 ring binder for lab manual and 3-hole punch paper.
   Safety goggles
   An IBM formatted 3.5 inch 2HD computer dis or a memory stick.

PRE-LAB QUESTIONS

1. A student wants to determine the density of a pine cone. He weighs the cone and prepares to find its volume. He submerges the pine cone in a graduated cylinder filled with water and records the water level. He realizes he forgot to record the initial water level of the graduated cylinder. Because he wants to get done with the lab, he removes the pine cone and records the water level. He uses this water level as the initial water level when he calculates density. Will his calculated density differ from the true density? If so, how and why?

2. If 90% of the fresh tissue is water and 2 g of dried apple burns down to 0.4 g of ash:

a) What is the original wet weight of the 2 grams of dried apple?

b) What is the organic content of an apple expressed as a percent of fresh weight? Show all work to receive credit.

c) What is the inorganic content expressed as a percent of fresh weight. Show all work to receive credit.

Set up both Exercises 1 and 4 at the beginning of the lab period.
Each of these exercises takes about 1.5 to 2 hours to run.

EXERCISE 1: What types of organic compounds can diffuse through a model cell membrane of dialysis tubing?

A. What can we learn about diffusion using a model system?

At the beginning of the lab, you will set up a "model unicellular organism". This "model organism" will be constructed by placing one of the unknown cell saps (mixtures of organic compounds in aqueous solution) into dialysis tubing. Then the "model organism" is placed into a beaker half filled with distilled water.

1. Before you begin, brainstorm ideas about how you can use this system to determine:

- What types of organic compounds are in the solution that was placed inside the dialysis tubing?
- Whether the dialysis tubing, like the cell membrane, is differentially permeable to the compounds placed inside of it?
- What kinds of measurements you will need to take and how you will take these?
- How often and how long you will need to take the measurements? (Hint: You will need to record results periodically for at least 1.5 hours.)

2. Come up with an experimental design and record your experimental design or protocol on the following page. You can use the same page to record your results also.

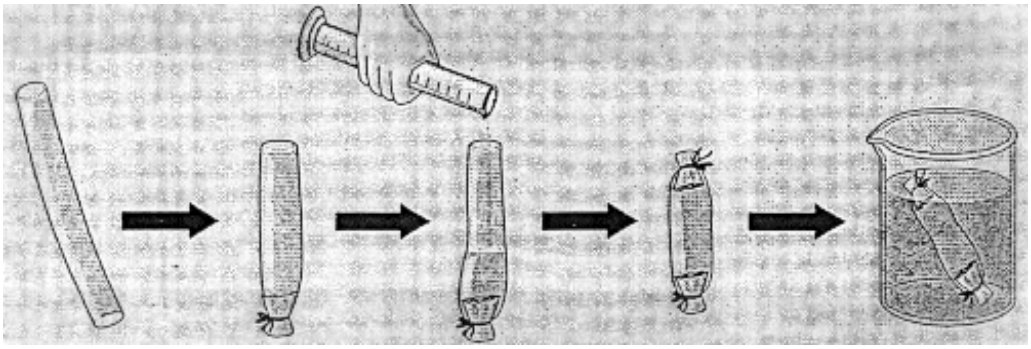

Figure 1: Making a model unicellular organism using semipermeable dialysis tubing

B. How should we report our experimental design and our findings?

Name(s) : _____ Lab # _____

1. Introduction: What question(s) are you trying to answer by doing this experiment?

2. Materials and Methods: What system are you using? What method(s) are you using?

3. Results: What type(s) of data are you collecting? How will you analyze the data?

	Test/Method Used	Compound present in dialysis bag?	Compound present in beaker (outside bag)?
Protein			
Reducing Sugars			
Starch			
Lipids			

4. Discussion:

a. What do the data indicate about the permeability of the dialysis tubing? About the effect(s) these types of organic molecules have on the osmotic potential of a cell?

b. What additional questions do you have about the system that weren't answered by doing this experiment? What additional experiments would you propose to answer these?

EXERCISE 2: What does its density tell us about a biological sample?

A. How can we determine the density of an irregularly shaped object?

Recall that density = mass/volume.

Use an appropriate scale to determine the weight of the specimen to the nearest 0.01 gram

Use the water displacement method to determine volume. Remember, 1 ml of water corresponds to 1 cm^3 (cc) volume at 4°C.

B. Record weight, volume and density values for your biological sample on the chart in lab (on the overhead projector or on the blackboard).

C. What do the class data on density tell us?

Using the class data, answer the following questions.

1. What variation in density exists among the biological samples tested?

2. Which of the samples floated? What densities did these samples have?

3. Are any of the density values that were recorded suspect? In other words, do you have reason to doubt the validity of any of the values? Explain.

4. Your friend suspects a ring she purchased is not pure gold, but a mixture of gold and copper. She asks you to determine if the ring is pure gold. Explain how you would do this.

EXERCISE 3: How can we determine the water content of plant and animal tissues?

Various plant tissue samples were pre-weighed and then dried in paper bags for several days at 80°C. The original wet weight in grams (of the sample only) is recorded on each bag. Fresh samples of the same tissue types will also be available in lab to determine density. What was lost when the samples were dried?

A. Use a fresh sample of the same tissue type indicated on the bag and calculate its density.

B. Weigh the dried sample. How much water did the undried sample contain? What percentage of the undried sample was water?

C. Use class data to answer the following questions.

1. Which samples have the highest density?
2. Which samples contain the highest percentage of water?
3. Which contain the lowest percentage of water? Is there any clear relationship between answers 1, 2 and 3? Explain.
4. What range of percent water and percent dry weight are observed among the various tissues?

D. The following table is provided as an example of how you can organize the wet and dry weight data into your personal lab notebooks.

Specimen name	wet wt (g)	dry wt (g)	water content	vol (ml)	density (g/cm^3)	Notes:

Notes on similarities/differences or trends in the table:

EXERCISE 4: How much of plant or animal tissue is organic vs inorganic?

You can estimate the amount of organic and inorganic material in one of the plant tissue samples by burning (ashing) about 1 to 1.5 grams of the dried sample in a crucible over a Bunsen burner. **Burning takes a minimum of one and a half to two hours.**

 If you or anyone at your lab bench is performing this exercise, you must wear goggles!

A. Ashing Technique

1. Clean the crucible and cover. Scrape out old ash and scour with the SOS or green nylon pads provided. Wipe the crucible and cover with a dry paper towel and heat them briefly over the flame to complete drying.

2. Weigh the crucible and cover together. Determine the weight of the crucible and cover to the nearest 1/100th gram.

3. Place between 1 and 1.5 grams of dried material into the crucible. Make sure you record the exact weight of the sample to be burned. Again determine the weight of crucible plus cover plus sample to the nearest 0.01 gram

Do not overfill the crucible. *The crucible should be no more than 3/4 full. If necessary, reduce the number of grams to be burned to keep from overfilling the crucible.*

4. Burn the sample in the crucible about 30 minutes.

5. Put a thermal ceramic pad on the scale. Tare the scale to 0.00 grams with the pad on it. To do this press the ZERO bar on the scale.

6. Put the crucible and cover on the thermal ceramic pad. Record this new weight.

7. Return the crucible and cover to burner and burn another 15 min.

8. Repeat steps 5 and 6. If there is no change in weight on the next weighing, all organic material has been released as carbon dioxide and water. If there is a change in weight, burn again for another 15 min. and repeat steps 5 through 8 until no change in weight is found.

Note: The dried plant or animal material may not burn down to a powdery ash. Instead, it may look more like a chunk of charcoal.

B. What should we be able to determine from our measurements?

The data you collect should allow you to answer the following questions. Record your answers in your lab notebook.

1. What was the total original wet weight of the specimen when placed in the bag?

2. What is the density of a fresh sample of the specimen? What does density indicate about the specimen?

3. What was the total dry weight of the specimen in the bag?

4. What was the weight of the subsample that was burned?

5. What was the ash weight at the following times after burning? Is the ash weight organic or inorganic content weight? Explain.

Weight of sample after burning	30 min	45 min	60 min	75 min	90 min	105 min	120 min

6. What was the final ash weight divided by the weight of subsample burned? In other words, what is the percent inorganic content of the dry sample?

7. What is the percent organic content of the dry sample?

8. What percent of the original wet weight of the specimen is organic?

9. Complete the following table. This is an example of how you can organize these data within your personal lab notebooks.

Specimen Name	Total Original Wet Weight	Density of Fresh Tissue	Total Dry Weight	Ash Weight / Sample Weight	% Inorganic of Dry Weight	% Organic of Dry Weight	% of Original Wet Weight that is Organic

Notes on similarities/differences/trends evident in the table: