Osmosis and Imbibition of Water

Gary Busby

Topic

Osmosis and imbibition of water

Time

Part 1: 3 hours; Part 2: ½ hour preparation and observation; 24 hours between observations

Safety

Please click on the safety icon to view the safety precautions. Adult supervision is required. Have a teacher or other adult place the glass tubing into the rubber stoppers. Use glycerol or petroleum jelly to lubricate glass tubes before attempting to push them through stoppers. Hold the tube with a rag or towel. Be careful when handling hot wax and the sharp nail.

Materials

two large potatoes
knife
two one-hole rubber stoppers
cork borer (optional)
two pieces of glass tubing graduated in centimeters (or make a scale for the tubes with tape as described below in the procedure)
1 lb dried lima beans
two plastic margarine tubs with lids, or similar plastic containers
large bowl or wide-mouthed jar
two identical beakers (large enough for a potato to rest on the bottom)
masking tape
nail
½ cup corn syrup
ruler graduated in millimeters
candle
graph paper
matches
glycerin or petroleum jelly

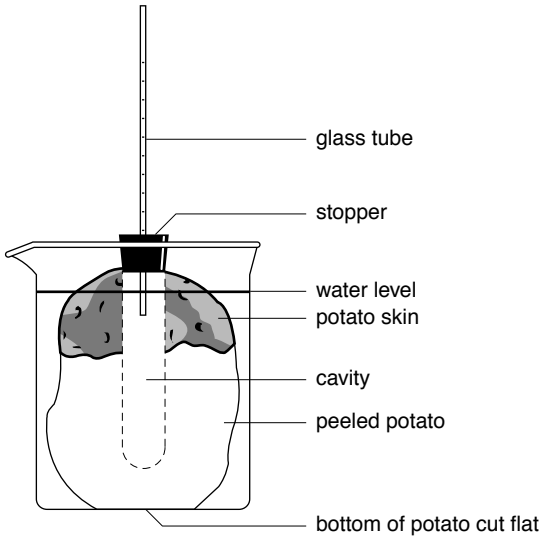
Procedure

Part A

Do steps 1 to 3 for both potatoes. See figure 1 before beginning.

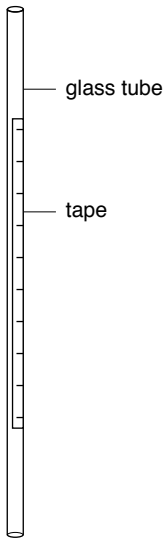
1. Cut off the end of the potato so that it will stand upright. Peel the bottom three-quarters of the potato.
2. Using the knife, or a cork borer if available, cut a hole into the potato and down about three-quarters of its length. Make sure the diameter of the hole is a little smaller than that of the rubber stopper.

Figure 1



3. Insert the glass tubing into the stopper (see safety precautions). Make sure the end of the tube protrudes out of the bottom of the stopper. If your tubing is not graduated, take some masking tape and make a scale with 1 to 10 cm along one edge. Cut the tape down so that you can still see the tube and any liquid in it (see figure 2).

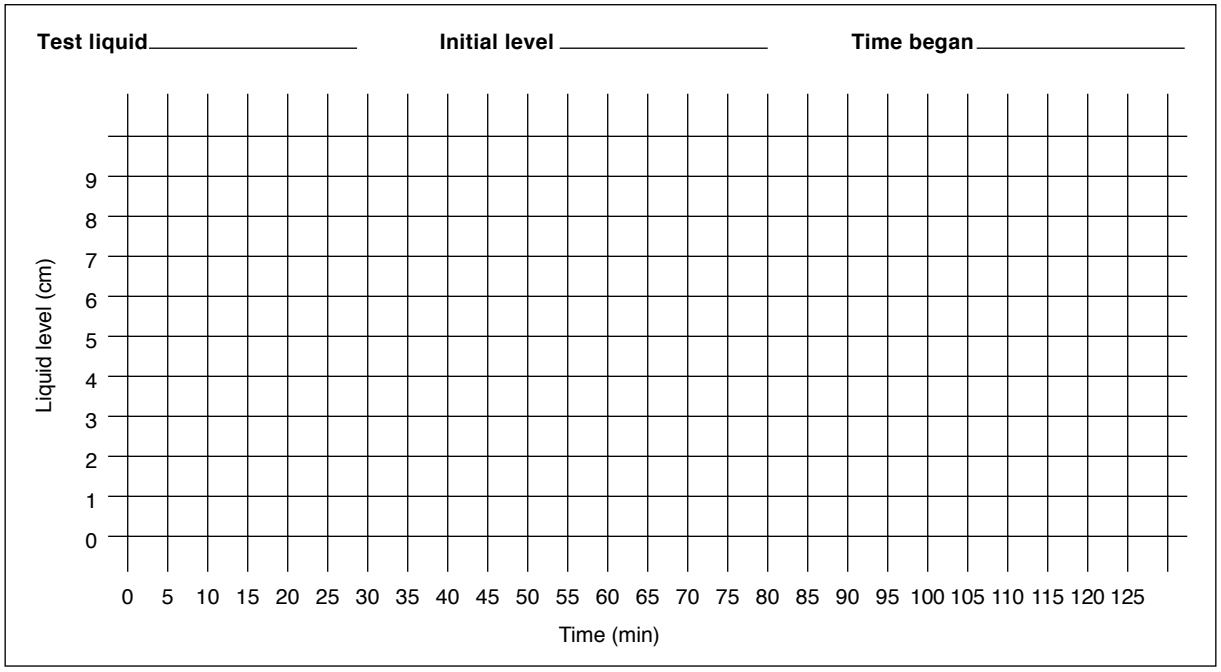
Figure 2



4. On two sheets of graph paper, set up two graphs as shown in figure 3. Label the vertical (*Y*) axis "Liquid level (cm)"; label the horizontal axis "Time (min)." Take the horizontal axis out to a time of 125 min, as you will be making observations for 2 hr. Extend the vertical axis up as high as your scale in centimeters on the tubing. In the spaces marked "Test liquid," label one graph "Corn syrup" and the other "Water."

5. Fill the hole in one potato with corn syrup and the other with water. Leave some room at the top for the stoppers.
6. Fit the stoppers in the holes in the potatoes. If the liquid in a potato leaks out, clean off the liquid. You can seal the stopper by melting candle wax around it. The liquid in the potatoes should show in the tubes around the 1-cm mark. Allow the liquid in both tubes to settle, and record their levels on the graphs in the spaces labeled "Initial level."

Figure 3



7. Place the potatoes into the beakers or bowls, and fill the bowls with water to a level between the stopper and the peeled part of the potatoes (see figure 1). Make sure the potatoes stand upright.
8. Record on the graphs as "Time began" the time at which you added the water to the beakers. Check the liquid levels every 5 min for at least 2 hr, recording your observations on the two graphs.

PART B

1. Observe the physical characteristics of the lima beans, and record the characteristics on the data table for later reference. Use the ruler to measure the length and width of 10 of the beans. Record these measurements on the data table, on the page after item 15. Add the 10 widths and divide by 10 to get the average bean width. Do the same for the lengths. Record these results on the data table.
2. Using the nail, punch 10 evenly spaced holes in the plastic lids.
3. Fill both containers with as many beans as possible while still allowing you to put the lids on securely.
4. Put the lids on the containers, and tape them securely shut. It's best to do this around the lip so as not to block the holes.

5. Place one of the containers in a large bowl or wide-mouthed jar, and fill this three-quarters full with water. Make sure that the container of beans is completely covered with water. Place the second container of beans on the table near the jar. Allow the container to stand overnight.
6. The following day remove the container from the water. Compare the appearance of the two containers with each other and with their appearance the day before. Note any changes on the data table. Remove the beans from both containers. With the ruler, measure the length and width of 10 beans from each container. Take averages as you did before, and record these figures on the data table.
7. What happened to the liquid in the tube containing water?
8. What happened to the liquid in the tube containing corn syrup?
9. Explain your observations (refer to "Connections" for help).
10. Which method of water intake was observed in Part A, osmosis or imbibition?
11. What happened to the two containers?
12. What happened to the lima beans in each container?
13. At the end of the experiment, how did the average measurements of the beans in the two containers compare with the initial average measurements you recorded?
14. Explain any changes in bean size.
15. Which method of water intake was observed in Part B, osmosis or imbibition?

(data table follows)

DATA TABLE

Initial bean characteristics (texture, hardness, color, etc.):

Initial bean size (mm):	Width	Length	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total			
Initial average (total/10)			

Observations after 24 hours
Bean characteristics: _____

_____

_____

Container characteristics, changes: _____

_____

_____

Bean sizes (mm) after 24 hours	Container in water		Dry container	
	Width	Length	Width	Length
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Total				
Initial average (total/10)				

What's Going On

Part A. The water in the tube remains at the same level. The corn syrup in the tube rises. The corn syrup's rising in the tube is caused by *osmosis*, since osmosis is the movement of water across a membrane from an area of greater water concentration to an area of lower water concentration. The water surrounding the potato moves through its cells, towards the area of lower water concentration, which is the cavity containing the corn syrup. Since the other potato cavity contains water, there is no movement because there is no area of lower water concentration. Osmosis needs an imbalance in concentration to begin. The water level in the tube might actually descend to the level of the water in the beaker.

Part B. The dry container remained unchanged. The container that was placed in water expanded, and may even have burst open, because of the pressure exerted by the swelling lima beans. The lima beans in the dry container remained unchanged. The lima beans in the container that was placed in the water swelled. The skin on these beans became wrinkled (in some cases fell off), and the seeds themselves became much softer. A day later, the average measurements of the beans in the dry container were equal or close to the initial average bean size. The average size of the beans that were in water increased to at least twice their initial size. The beans that increased in size did so because they absorbed water, causing them to swell.

Connections

Plants, animals, and other living things need water to survive and grow. Plants get water through their roots, and animals drink through their mouths. Amoebas and other one-celled organisms take in water through a process called *osmosis*. In osmosis, water passes through a membrane from an area of higher water concentration to an area of lower water concentration. This is also how water spreads through the cells that make up larger animals and plants to maintain the proper balance of fluids throughout their bodies. *Imbibition* is the process through which a seed absorbs water. The seed swells with its water intake, preparing for germination, which cannot take place without the presence of water in the seed. In this experiment you observed these two methods of water intake in action.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say "be careful with hot liquids" or "don't cut yourself with the knife" does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don't use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES