**Osmosis**

**Topic**

Water enters and leaves cells by *osmosis*.

**Introduction**

Water molecules have a natural tendency to move from an area where they are highly concentrated to an area where they are less concentrated. That is why water molecules flow from a solution in which the solute concentration is low to one where the solute concentration is high. When this movement occurs across a membrane, the process is called *osmosis*. Osmosis in living systems occurs across cell membranes, the structures that regulate what can enter and leave cells.

The process of osmosis explains why a shipwrecked sailor, stranded on a deserted island without fresh water, is in serious trouble. If he does not drink water, he will die of dehydration in just a few days. However, if he drinks salt water, water in his cells will move out, causing him to dehydrate even faster. The same principle can be seen when someone swims in the ocean for a long time; when they emerge, their skin is wrinkled because water moved out of the tissues of their skin.

Medical science has put the principle of osmosis to work in the kidney-dialysis machine. If the kidneys stop working, the body has no way to remove dangerous waste products in the blood. As these wastes increase in volume, they begin to cause feelings of sickness and fatigue. The accumulation of wastes can eventually cause death. That is why people who have lost the use of their kidneys spend several hours a week hooked to a kidney-dialysis machine. This device circulates the patient’s blood through a tube made of a semipermeable membrane. The tube is immersed in a fluid that contains a lower concentration of water and blood chemicals than the blood contains. As a result, accumulated water and wastes in the blood move by osmosis through the membranes and into the solution.
**Time Required**

30 minutes on day 1
20 minutes on day 2

**Materials: Day 1**

- raw potato
- paring knife
- 2 small disposable cups or two 50-milliliter (ml) beakers
- ruler
- table salt
- balance or scale
- water
- 50-ml graduated cylinder
- stirring rod
- plastic wrap
- paper towels
- masking tape or peel-and-stick labels
- black pen
- science notebook

**Materials: Day 2**

- ruler
- science notebook

**Safety Note**

When using the knife, take care not to cut your hand. Please review and follow the safety guidelines.
Procedure: Day 1

1. With the masking tape or labels and black pen, label one disposable cup as “salt water” and the other as “fresh water.”

2. Prepare the salt water solution by massing 1.7 grams (g) of table salt on the balance. Pour the 1.7 g of salt into the graduated cylinder, then add water to the 50-ml mark. Stir well.

3. Pour this solution into the cup labeled “salt water.” Add an equal amount of water to the other cup.

4. From the potato, slice two small pieces that are the same size. Use the ruler to measure the length, height, and width of each piece (Figure 1).

5. Copy the data table in your science notebook. Record the length, height, and width of each piece of potato in the appropriate column labeled “day 1.” (Be sure to include proper units of measurement with your numbers.)

6. Put one piece of potato in each cup.

7. Cover the two cups with plastic wrap. Let them sit overnight.
**Procedure: Day 2**

1. Remove the potato from the cup labeled “salt water.” Gently blot it on a paper towel, then measure its length, width, and height. Record its measurements on the data table in the appropriate “day 2” column.

2. Find the difference in the length, height, and width of the potato piece in the “salt water” from day 1 to day 2. Enter that difference on the data table.

3. Do the same for the potato in the cup labeled “fresh water.”

<table>
<thead>
<tr>
<th>Data Table: Measurements of potatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato</td>
</tr>
<tr>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Salt water</td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td>Fresh water</td>
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</tbody>
</table>

**Analysis**

1. Did either piece of potato increase in size? If so, do you think that this slice took on, or lost, water?

2. Did either piece of potato get smaller? If so, do you think that this slice absorbed or lost water?

3. Red blood cells floating in blood serum normally look like doughnuts whose holes have not been punched out. The concentration of solutes within red blood cells and within blood serum is the same. If blood cells were immersed in pure water, would water molecules flow into, or out of, the blood cells? Why?
What’s Going On?

The potato is made up of many cells, each of which is surrounded by a cell membrane and a cell wall. In a very salty solution of water, there are more water molecules per volume inside the potato cell than outside. Therefore, water molecules travel from inside the cell, through the cell membrane, into the water outside the cell. Loss of water causes the potato to shrink. In the cup of tap water, the concentration of water molecules was greater outside the potato cells than inside, so the cells took on water. As a result the piece of potato in tap water expands in size.

Want to Know More?

See Our Findings.
OSMOSIS

Analysis

1. Yes, the slice of potato in fresh water increased in size; it absorbed water.
2. Yes, the slice of potato in salt water decreased in size; it lost water.
3. Water would flow into cells, which would become swollen. The concentration of solutes is higher inside the cells than outside.
SAFETY PRECAUTIONS
Review Before Starting Any Experiment

Each experiment includes special safety precautions that are relevant to that particular project. These do not include all the basic safety precautions that are necessary whenever you are working on a scientific experiment. For this reason, it is necessary that you read and remain mindful of the General Safety Precautions that follow. Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly while you are performing an experiment. Materials can spill, break, or even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following the basic safety guidelines during the entire experiment, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual experiments. For one reason, we want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical.

Read the safety precautions here and at the beginning of each experiment before performing each activity. It is difficult to remember a long set of general rules. By rereading these general precautions every time you set up an experiment, you will be reminding yourself that lab safety is critically important. In addition, use your good judgment and pay close attention when performing potentially dangerous procedures. Just because the text does not say “be careful with hot liquids” or “don’t cut yourself with a knife” does not mean that you can be careless when boiling water or punching holes in plastic bottles. Notes in the text are special precautions to which you must pay special attention.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking an unnecessary risk can be avoided by practicing safety procedures and being alert while conducting experiments. Be sure to check the individual experiments in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone. When you are working off site, keep in
groups with a minimum of three students per group, and follow school rules and state legal requirements for the number of supervisors required. Ask an adult supervisor with basic training in first aid to carry a small first-aid kit. Make sure everyone knows where this person will be during the experiment.

**PREPARING**

- Clear all surfaces before beginning experiments.
- Read the instructions before you start.
- Know the hazards of the experiments and anticipate dangers.

**PROTECTING YOURSELF**

- Follow the directions step-by-step.
- Do only one experiment at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure there is adequate ventilation.
- Do not horseplay.
- Keep floor and workspace neat, clean, and dry.
- Clean up spills immediately.
- If glassware breaks, do not clean it up; ask for teacher assistance.
- Tie back long hair.
- Never eat, drink, or smoke in the laboratory or workspace.
- Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult.

**USING EQUIPMENT WITH CARE**

- Set up apparatus far from the edge of the desk.
- Use knives or other sharp-pointed instruments with care.
- Pull plugs, not cords, when removing electrical plugs.
- 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 alcohol-filled thermometers, not mercury-filled thermometers.

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

HEATING SUBSTANCES
• Wear safety glasses, apron, and gloves when boiling water.
• Keep your face away from test tubes and beakers.
• Use test tubes, beakers, and other glassware made of Pyrex™ glass.
• Never leave apparatus unattended.
• Use safety tongs and heat-resistant gloves.
• If your laboratory does not have heat-proof workbenches, put your Bunsen burner on a heat-proof mat before lighting it.
• Take care when lighting your Bunsen burner; light it with the airhole closed, and use a Bunsen burner lighter in preference to wooden matches.
• Turn off hot plates, Bunsen burners, and gas when you are done.
• Keep flammable substances away from flames and other sources of heat.
• Have a fire extinguisher on hand.
FINISHING UP

- Thoroughly clean your work area and any glassware used.
- Wash your hands.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Do not dispose of materials in the sink unless instructed to do so.
- Clean up all residues and put them in proper containers for disposal.
- Dispose of all chemicals according to all local, state, and federal laws.

BE SAFETY CONSCIOUS AT ALL TIMES!