Respiration and Photosynthesis

Topic

Plants and animals carry out *cellular respiration,* but only plants conduct *photosynthesis.*

Introduction

Cellular respiration is the process in which a cell uses oxygen to convert glucose, a simple sugar, into the energy-carrying molecule, *adenosine triphosphate (ATP)*. Although the terms "cellular respiration" and "respiration" are similar, they refer to two different processes. In respiration, or breathing, animals take in oxygen and release carbon dioxide. Humans respire when they inhale air into their lungs. Inhaled oxygen moves from tiny sacs in lung tissue, the *alveoli,* into capillaries filled with blood. At the same time, carbon dioxide in the blood diffuses into alveoli, and is then exhaled (see Figure 1). The oxygen provided by respiration makes it possible for cellular respiration to take place.

Organisms that contain *chlorophyll* can carry out photosynthesis, a process that captures the sun's energy. During photosynthesis, carbon is extracted from carbon dioxide in the air and used to make glucose. The oxygen in carbon dioxide is released as oxygen gas.

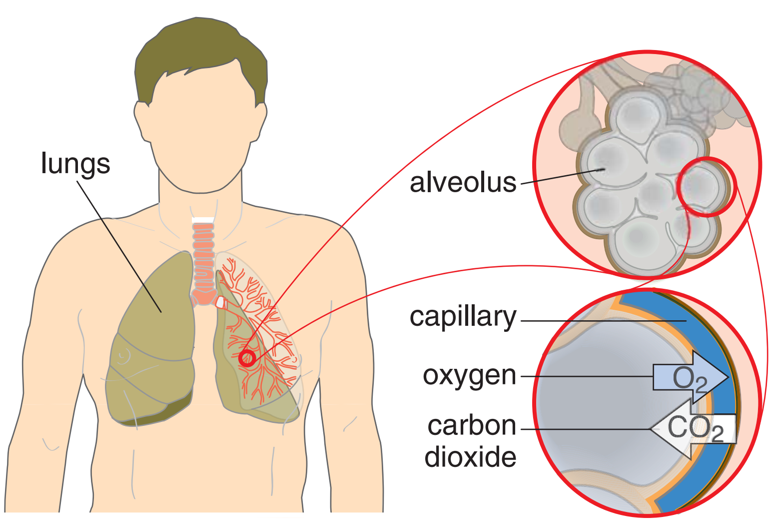

Figure 1

Since carbon dioxide is an invisible gas, experimenters use the chemical bromthymol blue to reveal its presence or absence. Bromthymol blue is an *indicator* that turns yellow or pale green when carbon dioxide is present. It remains blue in the absence of carbon dioxide. In this activity, you will use bromthymol blue and lab equipment of your choice to design an experiment to determine whether plants and animals give off carbon dioxide.

Time Required

55 minutes on day 1

30 minutes on day 2 or 3

Materials

- 3 large culture tubes with screw tops
- stirring rod
- 100-milliliter (ml) beaker
- clamp lamp with 60-watt bulb
- small cardboard box
- pH paper
- 3 small snails
- 3 pieces of *Elodea* or similar water plant
- aquarium or pond water
- bromthymol blue in dropper bottles
- access to biology textbook
- science notebook

Safety Note **Take care when working with snails and handle them humanely. Wear safety goggles when working with chemicals. Please review and follow the safety guidelines.**

Procedure

1. Your job is to design and perform an experiment to find out if plants and animals produce carbon dioxide gas.
2. You can use any of the supplies provided by your teacher, but you do not have to use all of them.
3. Before you conduct your experiment, decide exactly what you are going to do. Write the steps you plan to take (your experimental procedure) and the materials you plan to use (materials list) on the data table. Show your procedure and materials list to the teacher. If you get teacher approval, proceed with your experiment. If not, modify your work and show it to your teacher again.
4. Once you have teacher approval, assemble the materials you need and begin your procedure.
5. Collect your results on a data table of your own design.

Data Table	
Your experimental procedure	
Your materials list	
Teacher approval	

Analysis

1. A hypothesis states what you think will happen in your experiment. What was your hypothesis when you began this experiment?
2. Did your hypothesis prove to be true or false? How do you know?
3. Do snails produce carbon dioxide? How do you know?
4. Does *Elodea* produce carbon dioxide? How do you know?
5. If you wanted to set up a self-sustaining closed aquarium that could maintain itself for 1 year, what would you put in it? Why?
6. You are given an assignment to find out if the carbon dioxide in your closed aquarium is produced during the day, at night, or at both times. How would you set up this experiment?
7. Write the balanced chemical equation for cellular respiration.
8. Write the balanced chemical equation for photosynthesis.

What's Going On?

Animals and plants, along with most fungi and protists, take in oxygen because it is required for the process of cell respiration. Cellular respiration, which takes place in the mitochondria, converts glucose molecules into ATP, the energy currency of cells. Cells use ATP for all life processes, including movement, breaking down food, and reproduction. Photosynthesis only occurs in organisms that contain chlorophyll and other photosynthetic pigments. These organisms have the ability to capture the sun's energy and change it to glucose. The glucose produced by plants supports the plants as well as animals that feed on them.

Want to Know More?

See Our Findings.

OUR FINDINGS

RESPIRATION AND PHOTOSYNTHESIS

Suggestion for class discussion: Find out what students know and understand about respiration, cellular respiration, and photosynthesis
by posing these questions before they plan the activity:

1. What gas do animals inhale when they respire?
2. What gas do animals exhale when they respire?
3. Do both plants and animals respire?
4. Do both plant and animals carry our cellular respiration?
5. What gas do plants take in during photosynthesis?
6. What gas do plants release during photosynthesis?

Teacher notes: You can use large culture tubes or other containers that have lids. Snails and *Elodea* can be purchased at stores that sell aquarium supplies or collected from ponds. The experiment can run from one to three days, depending on your schedule. Let students write their experimental procedure on the first day, then check results and answer analysis questions on day two or three.

Analysis

1. Answers will vary. One example of a student hypothesis: Snails produce carbon dioxide.
2. Answers will vary depending on student results. The color of bromthymol blue helps students interpret levels of carbon dioxide in the culture tubes.
3. Yes. The bromthymol blue turned yellow when a snail was put in the culture tube.
4. Although *Elodea* cells carry out cellular respiration, the CO_2 they produce is consumed by photosynthesis. Students will most likely answer no. The bromthymol blue in a culture tube of *Elodea* remained blue.
5. Answers will vary. Students might suggest a container that has both snails and *Elodea,* along with a source of freshwater or filter system. Some may feel that the system needs decomposers to break down wastes.

6. Answers will vary. Students might conduct their original experiment in the dark (within a closed container) and again in the light, then compare the results.
7. $C_6H_{12}O_6$ + 6 O_2 ➔ 6 CO_2 + 6 H_2O + energy
8. 6 CO_2 + 6 H_2O + sunlight ➔ $C_6H_{12}O_6$ + 6 O_2

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 absolutely necessary that you read and remain mindful of the General Safety Precautions that follow this note. Experimental science can be dangerous, and good laboratory procedure always includes 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 lab 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 book 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 using knives. 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. Anytime you are working with an electrical current, it becomes possible to shock yourself on exposed wires. 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 by yourself; 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.
- Let your teacher know about broken glassware immediately.
- Do no 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 rather than 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 in proper containers for disposal.
- Dispose of all chemicals according to all local, state, and federal laws.

BE SAFETY CONSCIOUS AT ALL TIMES!