Eutrophication – Using Up Oxygen In Water

Topic

Water pollution causing oxygen depletion in water by living organisms

Introduction

Farming is a major cause of freshwater pollution. Sewage and farm animal wastes discharged into rivers then accumulate in lakes, while chemical fertilizers spread on the land can be washed into rivers and lakes by rainwater. These pollutants contain nitrates and phosphates, which act as nutrients leading to a massive growth of algae. This can kill a lake by a process called eutrophication, in which the algae cloud the water and reduce the light reaching submerged plants. These die and are decomposed by bacteria. As the bacteria feed on the algae they use up the oxygen dissolved in the water, causing fish and other water animals to suffocate. Fewer animals are then available to eat the algae, so they grow even faster. When the algae eventually die and are decomposed by bacteria, all the remaining oxygen in the lake is used up and everything in the lake dies. In this experiment, you will investigate the process of eutrophication. What is the effect of an organism on oxygen levels in water? What is the rate of oxygen depletion in the water?

Time required

1 hour to prepare the experiment
5 minutes every day for five days for inspection

Materials

- 10 g glucose (represents organic waste)
- 1 teaspoon of dried yeast* (represents algae)
- methylene blue solution (oxygen indicator; blue = oxygen present; colorless = no oxygen in water)
- eyedropper
- 3 × 250-ml beakers
- 10-ml graduated cylinder
- 100-ml graduated cylinder
- small self-adhesive labels
- teaspoon
- 100 ml tap water
- warm water (about 40°C)
- –10°C to 100°C thermometer
- transparent plastic wrap

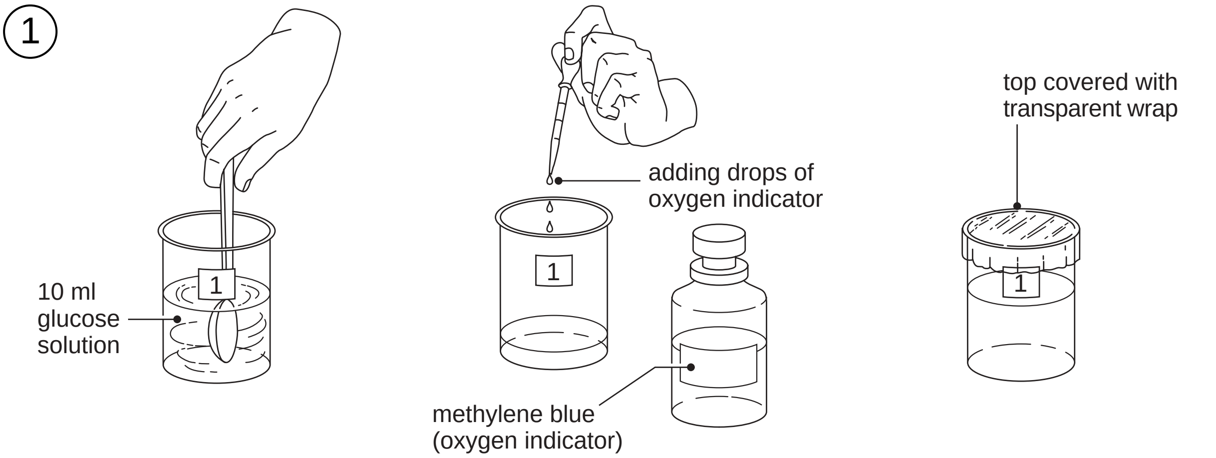
* Check that the dried yeast is still active by mixing one teaspoon of yeast with 1/2 teaspoon of sugar in 1/2 cup of warm water – if left in a warm place, it should be frothing after half an hour.

Safety note

Click on the safety icon to view the safety instructions.

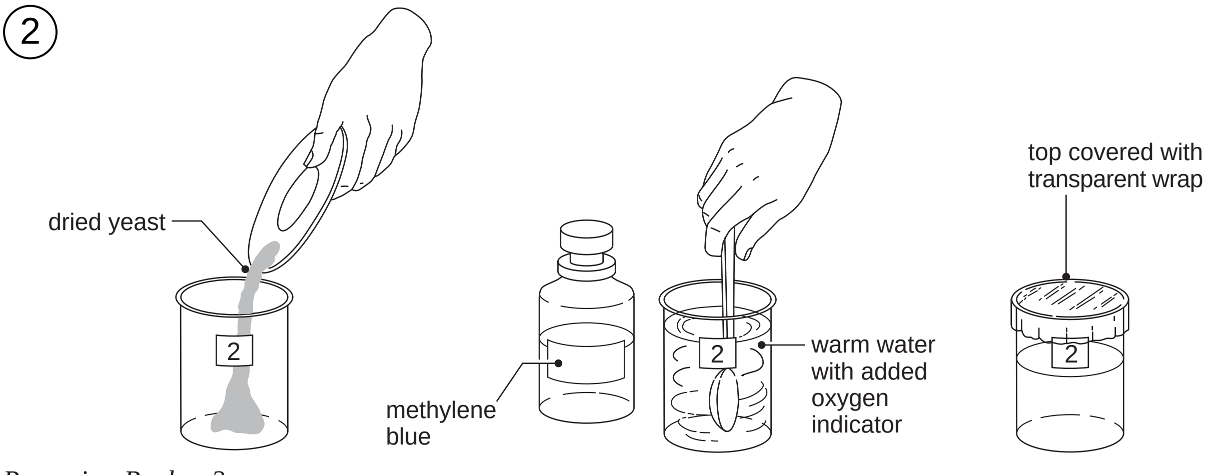
Procedure

1. Label the beakers “Beaker 1,” “Beaker 2,” and “Glucose.”
2. Make a 10 per cent glucose solution by pouring 100 ml of tap water into the beaker marked Glucose, adding 10 g of glucose, and stirring with the teaspoon.
3. Measure out 10 ml of glucose solution using the 10-ml graduated cylinder and pour into Beaker 1. Add 5 drops of methylene blue using the eyedropper (see diagram 1 below).
4. Add warm water at about 40°C (check with the thermometer) to Beaker 1 until it is about two-thirds full. Record the color of the contents under the heading “Beaker 1” in the data table on the next page.
5. Cover with transparent wrap and leave in a warm place.



Preparing Beaker 1

6. Pour 10 ml of glucose solution into Beaker 2 and add 5 g of dried yeast.
7. Add warm water at about 40°C (check with the thermometer) to Beaker 2 until it is about two-thirds full and then add 5 drops of methylene blue using the eyedropper (see diagram 2 below). Stir the solution with the teaspoon and record the color of the contents under “Beaker 2” in the data table.
8. Cover with transparent wrap and leave in a warm place.
9. Every day for the next five days, look at both beakers. Record the colors of the solutions in both beakers in the data table.



Preparing Beaker 2

Data table		
	Beaker 1: glucose solution	**Beaker 2: glucose solution + yeast**
Color at start		
Color after 1 day		
Color after 2 days		
Color after 3 days		
Color after 4 days		
Color after 5 days		

Analysis

1. Did the color of the solutions in the two beakers change color during the experiment?
2. Describe how the color changed over the five days. Was it a gradual or a rapid change?
3. Explain what was happening.
4. Why was Beaker 1 (without yeast) included in the experiment?
5. Why do living organisms in water take oxygen from the water around them?
6. Why does water that is polluted with sewage have a low oxygen content?
7. What can be done to prevent eutrophication of a waterway or lake?

Want to know more?

Our Findings

Eutrophication – Using Up Oxygen In Water

1. Beaker 1 should have remained blue and Beaker 2 should have gone colorless.
2. Expect the blue color to become lighter over the days, showing that the water is becoming depleted in oxygen. However, the change may occur when the beaker could not be observed, so the change from blue to colorless may appear to change suddenly.
3. The yeast in Beaker 2 is alive and respiring; the process of respiration uses up oxygen in the water so the indicator (methylene blue) becomes colorless.
4. Beaker 1 was included as a control to test whether simply leaving glucose solution and methylene blue together would lead to a color change.
5. Living organisms take oxygen from the water around them in order to respire and thus release the energy necessary for life from the glucose (a substance with a high energy content).
6. Bacteria in the water feeding on the sewage use oxygen from the water to respire in the same way as the yeast.
7. Digestion of sewage by microorganisms in aerated water at publicly owned treatment works leads to the release of water free from sewage. Slurry at farms can be stored in watertight containers, and either collected and treated, or spread gradually on fields over a wide area. Reducing the use of nitrate fertilizers, for instance, by encouraging organic farming would also help. Further study could be made by visiting a local lake or waterway to look for evidence of eutrophication.

Special Safety Note To Experimenters

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, copy, and remain mindful of the General Safety Precautions that follow this note. 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, even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following basic safety guidelines the entire time you are performing the 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. We made this choice 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 to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each experiment you are preparing to perform, and that you will remember them. Except in rare instances, these precautions will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not 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 cutting a piece of wood. 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, wait to perform it until you find out for sure that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks 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
—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
— Be careful not to slip or fall into the water when working near rivers and streams, and do not enter water that is deeper than your rubber boots.
— Do not enter fast-moving water, floodwater, or rivers/streams where the water level is higher than normal

USING EQUIPMENT WITH CARE:

—Set up apparatus far from the edge of the desk
—Use knives and other sharp or pointed instruments with caution
—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 (do not use 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

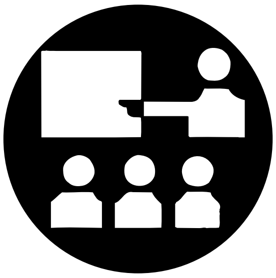
HEATING SUBSTANCES:

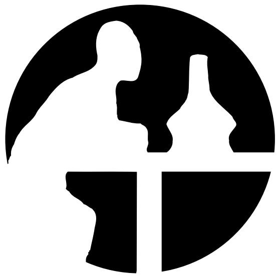
—Wear safety glasses, apron, and gloves when boiling water
—Keep your face away from test tubes and beakers
—Use test tubes, beakers, and other glassware made of Pyrex™ glass
—Never leave apparatus unattended
—Use safety tongs and heat-resistant gloves
— If your laboratory does not have heat-proof workbenches, 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

Settings And Warning Signs

Settings and hazard warning signs are used throughout the experiments to indicate where they should take place and where particular care should be taken with the materials

SCHOOL LAB





HOME

TOXIC

SPLASH

WARNING

IRRITANT

NAKED FLAMES

HOT LIQUIDS

CORROSIVE

CUT / STAB HAZARD