

# Seed Respiration

**Biology**



Science

Grade 10-12

Biology Lab

Individual or teams of 2

## DESCRIPTION

Plants generate Oxygen, which is essential for humans to survive. However, plants also consume Oxygen during respiration. It is actually possible to measure the amount of Oxygen used by plants with a device called a respirometer. Germinating seeds will be used to demonstrate Plant Respiration.

## LEARNING OUTCOMES

Students will:

- examine oxygen consumption by seeds
- understand the importance of respiration to life on Earth

## READINESS ACTIVITIES

Students should:

- review the life cycle of a plant, especially during germination
- examine respiration in other organisms, such as humans

## MATERIALS

- large test tube
- metric ruler
- germinating seeds of any kind (1g)
- one-hole stopper
- limewater
- pipette
- wad of cotton
- marking crayon
- liquid detergent
- balance
- paper towels
- spatula
- scotch tape
- support stand and clamp
- rigid polyethylene tubing or hollow glass tubing, 20 cm long and bent at right angle

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## Introduction

Plants are known for their ability to convert Carbon dioxide into Oxygen. However, all **aerobic** organisms take in Oxygen and give off Carbon dioxide as long as they are alive. This is true for plants as well as animals. During **germination**, seeds use sugars and other molecules as a substrate for **respiration**.

## Germination

Germination of a seed begins with water uptake by the seed. This process is called **imbibition**. The uptake of water by a seed is an essential step in order for the seed to germinate. The total amount of water taken up is about 2-3 times the weight of the seed. Whether or not a viable seed will germinate depends on a number of factors. The chemical environment of the seed must be right. Water must be available, Oxygen has to be present since the seed must respire and no dangerous chemicals should be present. The physical environment must also be favourable. The temperature must be suitable as well as the light quality and quantity. A person may wonder why seeds are often buried underground. The reason is that this helps guarantee the seeds receive the correct amount of light for germination. Full sunlight can often prevent a seed from germinating. The extent to which germination has progressed can be determined by measuring water uptake or respiration.

## Oxygen Consumption

If you place a living organism in a closed system, it is possible to measure its consumption of Oxygen. In this exercise, a respirometer will be used to measure oxygen consumption. The instrument contains limewater and germinating seeds. As the seeds consume oxygen, carbon dioxide is excreted. The carbon dioxide is then absorbed by the limewater, creating a slight vacuum in the respirometer. This vacuum will draw a drop of liquid detergent in the glass tubing inward. This movement will be measured in millimeters using a metric ruler taped to the glass tubing. This will give an idea of how much oxygen the germinating seeds consume.

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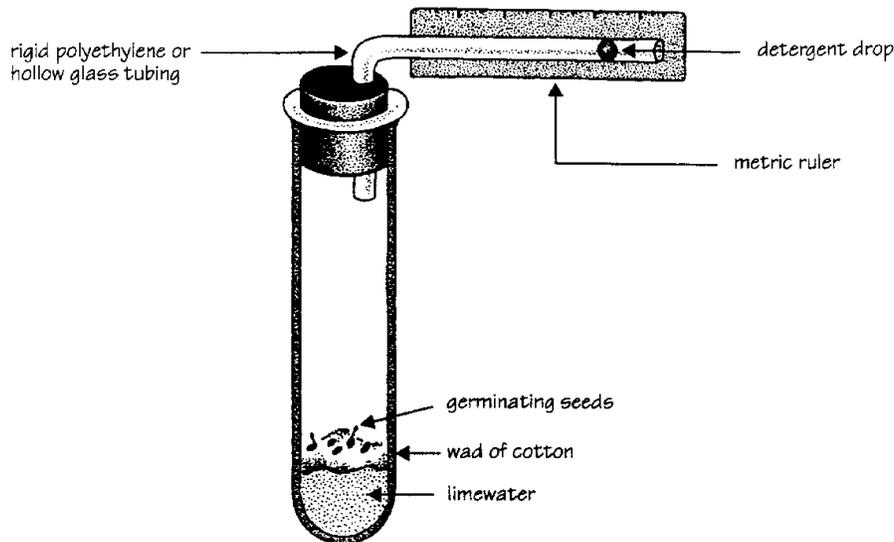


Figure 1.  
The device that will be used to measure the oxygen consumption of the germinating seeds: a respirometer.

## Procedure

1. Prior to the lab, obtain some small plant seeds. Try and use a different variety than your classmates. The seeds need to be germinating for the experiment. You can do this by spreading them on wet paper towel a day or two before the lab.
2. Begin by inserting the short end of the tube into the hole of the stopper. BE VERY CAREFUL if you are using GLASS. It could break easily. The long end of the tube should be sticking out at a right angle as in the diagram.
3. Draw a line 0.5 cm above the bottom of the test tube with the marking crayon. Add limewater to the tube up to this mark.
4. Moisten a small wad of loose cotton and place it on top of the limewater. Now place the gram of germinating seeds on top of the moistened cotton.

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5. Tape the metric ruler to the tubing as shown in the diagram. Add a drop of detergent to the tubing with the pipette. The drop should be near the end of the tubing.
  6. Insert the stopper and tubing into the test tube. Do it carefully. The air in the tube may cause the detergent drop to spill out as you press down. Keep pushing until an airtight seal is formed. Keep this setup in an airtight position. This is best done by a support stand and clamps, but if none are available, use two stacks of books.
  7. Wait five minutes before taking an initial reading. This will allow any  $\text{CO}_2$  that was in the respirometer when it was assembled to be absorbed. Take the initial reading wherever the drop of detergent is with respect to the metric ruler. Always take the measurement from the same part of the detergent drop. Record the initial reading in data table.
  8. Take readings every minute for 15 minutes and record them in the data table.

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Table 1. Measurement of Carbon dioxide production by germinating seeds over a 15 minute time interval.

**Data Table**

Minute	Movement (mm)	Minute	Movement (mm)
initial		8	
1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15	

## Questions

1. Compare the respiration rate of your seeds with those of your classmates. Is there any relationship with the size of the seed itself?
2. Is there any relationship between temperature and the respiration rate of germinating seeds?

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## Glossary of Terms

<b>aerobic</b>	organisms which require oxygen to sustain life
<b>imbibition</b>	the initial step in germination where water is taken up by a seed
<b>germination</b>	occurs when a seed sprouts or starts to grow
<b>respiration</b>	a process in which living cells take in oxygen and give off carbon dioxide

## Notes

- It would be much safer if plastic tubing could be used as opposed to glass. If only glass available, it might be a good idea if the instructor bends the glass, and inserts it into the stopper for the students.
- limewater is a saturated solution of calcium hydroxide. Calcium hydroxide can also be used, but it can irritate the skin, so gloves should be worn when handling it. Just fill the test tube up to the 0.5 cm mark with the powder. Add just enough water to make a paste.
- It is important to watch the placing of the drop of liquid detergent. It must be close to the opening, but if it is too close it will fall out when the stopper is put on the tube. Try and find an approximate distance that fits both conditions.
- Try and use some variables in the experiment. Some respirometers could be put at different temperatures, contain different moisture contents, and contain different seeds. The health of the seeds could also vary, by exposing them to different conditions during germination.

## References

- Bewley, J.D., and M. Black. 1985. *Seeds: Physiology of Development and Germination*. Plenum Press, New York.
- Cooper, E.L. 1997. *Agriscience: Fundamentals & Applications*. Delmar Publishers, Albany, New York.
- Walch, J.W. 1994. *Low-Cost Biology Investigations*.