

Cellular Respiration

Real World Energy
Backgrounder
Grade Level: 9-12



Aerobics Class

Almost all organisms on Planet Earth need oxygen to live. This includes most plants. Organisms that need oxygen to survive are called **aerobes**. Their oxygen comes from the atmosphere, or from the water in which they live.

What exactly is **respiration**? Simply put, it means “to breathe.” Cellular respiration in plants is a process in which glucose molecules are taken apart and the chemical energy is harvested from them. **Aerobic Respiration** is just respiration that uses oxygen as well as glucose. As you know, glucose is the universal food molecule used by all organisms on the planet. During respiration, the chemical energy stored in glucose is harvested and made available to the cell for its many life processes.

These life processes include:

- **Movement:** Many cells have fibres that enable them to move. Muscle cells are packed with specialized fibres that allow them to shorten themselves dramatically.
- **Making proteins:** Many cells can make proteins, which are used for building or energy.
- **Cell growth:** Cells often start small and grow to their full size over a period of hours or days. This takes energy.
- **Transporting substances:** Cells can pass chemicals and particles through their membranes. This is how they take in glucose, water, and other substances they need, and how they remove wastes such as carbon dioxide.

- **Reproduction:** Many cells multiply themselves, usually by splitting to form two “daughter cells.” The process is complex and uses up some of the glucose stored inside the cell.

The basic ingredients of aerobic respiration are glucose and oxygen. In a complex series of steps, the glucose molecule is taken completely apart. The chemical energy that was stored in the glucose molecule is stripped and passed on to other substances in the cell. What is left behind gets reassembled as carbon dioxide and water and is sent out as waste.

Carbon dioxide can become toxic if it builds up inside the cell, so it is usually removed quickly. Single-celled organisms simply release it to their environment. More complex creatures such as insects, fish, and mammals have lungs or gills to help them get rid of their carbon dioxide. Those same organs also help to bring oxygen to the cells where cellular respiration is taking place.

Aerobic respiration produces heat. Anyone who has done heavy exercise knows about the heat produced during cellular respiration. During exercise, muscles burn up large amounts of glucose and, in the process, generate lots of heat. This explains the sweating, flushed face, and the need for cold drinks!

Green Thumb: Green Energy from Anaerobic Respiration

Anaerobic respiration can be a source of clean, renewable energy! All you need is animal manure, water, and a large enclosed container. Anaerobic bacteria begin to digest the manure and release methane as their main waste product. Fortunately for us, methane still contains large amounts of useable energy. Methane from animal manure or other kinds of organic matter is called **biogas**. It is exactly the same thing as natural gas, such as that used in most furnaces in Canada. Biogas is considered renewable energy because the animals producing the manure are feeding on a renewable food supply, grass, which easily grows back each season.

Getting Glucose

All living things must have a steady supply of glucose. For animals, glucose comes from the food they eat. The process of digestion releases glucose from foods that contain sugars and starch. Glucose can also be made from proteins and fats, the other major components in the food of animals

For plants, getting glucose is simple: they just wait for the sun to shine. Because most plants have chlorophyll and chloroplasts, they can make their own glucose on the spot.

Cellular Respiration without Oxygen

Some organisms can extract energy from glucose without oxygen. This is called **anaerobic respiration**. The organisms that use this process are called anaerobes. There are several forms of anaerobic respiration, each of which produces different by-products. These organisms are almost always very primitive single-celled bacteria.

Instead of carbon dioxide, the by-products are substances such as methane (also called natural gas), vinegar, or hydrogen gas. In each of these cases, much of the chemical energy in glucose is lost in the by-products. Anaerobes almost always live in environments where oxygen is absent, but where there is lots of glucose or cellulose around. One such environment is the large intestine of most large

mammals, including humans. As you can imagine, this explains a lot!

Practical Uses of Cellular Respiration in Industry

Beer and wine are made with the help of aerobic yeasts. They ferment sugars from fruit or grain to produce carbon dioxide and alcohol.

Aerobic respiration is put to very practical use by almost every large town and city in Canada. Most towns and cities treat their sewage at large plants located on the outskirts of town. Much of the work of breaking down the sewage is done by aerobic bacteria. The sewage is pumped into large shallow tanks which are kept well stirred and aerated. The bacteria thrive in this environment and digest all the waste they can.

Composting is similar to sewage treatment, except that the waste materials are solid, not liquid. In a compost heap, waste materials such as kitchen scraps become food for bacteria. The bacteria digest most of the plant matter in the heap, producing carbon dioxide, water vapour, and heat. The compost heap must be turned and mixed occasionally to ensure the bacteria have oxygen.

Cellular respiration is also important in food production. Here are a few examples:

Food	Respiration Process	By-product
Yogurt	Anaerobic	Vinegar
Wine, Beer	Aerobic	Alcohol, carbon dioxide
Bread	Aerobic	Carbon dioxide
Sauerkraut	Anaerobic	Vinegar

Green Thumb: Waste Management in Nature

Planet Earth owes a lot to aerobic respiration! Imagine a forest where nothing rotted. Each fall, a new layer of dead leaves would be added so that, in just a few decades the whole forest would disappear under a mass of fallen leaves! Fortunately for the trees (and us), there are billions of organisms that start working on dead leaves even before they hit the ground. Bacteria, fungi, and other consumers eat away at the fallen plant material, reducing it to fine particles and soil within just a few weeks.

Key Points to Remember

- Cellular respiration is the process by which cells extract useable chemical energy from glucose, with or without oxygen.
- All life on the planet gets its energy through cellular respiration.
- Cellular respiration in the presence of oxygen is called aerobic respiration and is by far the most efficient way to get energy from glucose.
- The end-products of aerobic respiration are carbon dioxide, water, and heat.
- Anaerobic respiration is a form of cellular respiration that does not require oxygen.
- Organisms get their glucose from their food, except in the case of plants, which make their own glucose from carbon dioxide, water, and sunlight.