

Respiration

Revision notes · How respiration releases energy from glucose to make ATP, aerobic and anaerobic respiration, and the seed practical.

For Pearson Edexcel International GCSE Biology 4BI1 and Science (Double Award) 4SD0. **Biology only** is not in the Double Award and is only examined on Paper 2.

Respiration Spec 2.34-2.39

Respiration and ATP Spec 2.34, 2.35

Respiration is the process that releases energy from food molecules such as glucose. It happens in every living cell, all the time. It is a chemical reaction in cells, so it is not the same as breathing.

Cells cannot use the energy in glucose directly. Instead, the energy released when glucose is broken down is used to make a molecule called **ATP** (adenosine triphosphate).

1. Glucose is broken down in respiration and energy is released.
2. This energy is used to join a phosphate group onto ADP (adenosine diphosphate), making ATP.
3. ATP moves to the part of the cell where energy is needed.
4. ATP is broken down back to ADP and phosphate, and this releases energy for the cell to use.
5. ADP and phosphate are then used again in respiration to make more ATP.

So ATP is the energy carrier of the cell. ATP **provides energy for cells** to carry out the processes of life.

- Muscle contraction, so that movement is possible.
- Active transport, which moves substances against a concentration gradient.
- Making large molecules from small ones, such as proteins from amino acids.
- Cell division and growth.
- Sending nerve impulses.

ATP	The molecule that provides energy for cells. It is made during respiration.
Respiration	The chemical process in cells that releases energy from food, such as glucose, and uses it to make ATP.

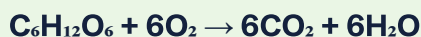
*Common mistake: Do not say that respiration 'makes energy'. Energy cannot be made. Say that respiration **releases** energy from glucose to make ATP, and ATP provides energy for cells.*

Aerobic and anaerobic respiration equations Spec 2.37, 2.38

Aerobic respiration

Aerobic respiration uses oxygen to break down glucose. It releases a large amount of energy to make ATP. You need to know both the word equation and the balanced symbol equation.

glucose + oxygen → carbon dioxide + water



Anaerobic respiration

Anaerobic respiration happens without oxygen. The products depend on the type of organism. You need to know the word equations only.

Anaerobic respiration in animals and in plants

Organism	Word equation
Animals (for example muscle cells during hard exercise)	glucose → lactic acid
Plants (and yeast)	glucose → ethanol + carbon dioxide

Exam tip: Learn the symbol equation as $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$. To check it is balanced, count the atoms on each side: 6 carbon, 12 hydrogen and 18 oxygen.

*Common mistake: Animals make **lactic acid**, and plants make **ethanol and carbon dioxide**. Mixing these up is a very common way to lose marks.*

Comparing aerobic and anaerobic respiration Spec 2.36

Aerobic and anaerobic respiration compared

	Aerobic respiration	Anaerobic respiration
Oxygen needed?	Yes	No
Glucose breakdown	Complete breakdown	Incomplete breakdown
Energy released	A large amount per glucose molecule	Much less per glucose molecule
Products in animals	Carbon dioxide and water	Lactic acid
Products in plants and yeast	Carbon dioxide and water	Ethanol and carbon dioxide
When it happens	Whenever enough oxygen is available	When oxygen is not available, for example in muscles during vigorous exercise

Aerobic respiration releases much more energy because glucose is **completely** broken down. Anaerobic respiration releases less energy because glucose is only **partly** broken down. Both types release energy from glucose to make ATP.

*Exam tip: A comparison needs both sides in the same sentence, for example: **aerobic respiration releases more energy per glucose than anaerobic respiration.***

Practical: carbon dioxide and heat from respiring seeds Spec 2.39

Respiring organisms release carbon dioxide and heat. You can show both with germinating seeds, which respire quickly as they grow. A second set of seeds that have been boiled (and so are dead) acts as the **control**.

Heat released

1. Soak some seeds, such as peas, so that they start to germinate. Boil a second batch to kill them, then let them cool to room temperature.
2. Rinse both batches in a weak disinfectant solution. This kills microorganisms that would also respire.

- Put the living seeds in one **vacuum flask** (which reduces heat loss) and the boiled seeds in another. Put a thermometer in each flask and plug the top with cotton wool.
- Use the same mass of seeds in each flask and start both at the same temperature.
- Record the temperature of each flask at the start and then at regular intervals, for example every day for several days.

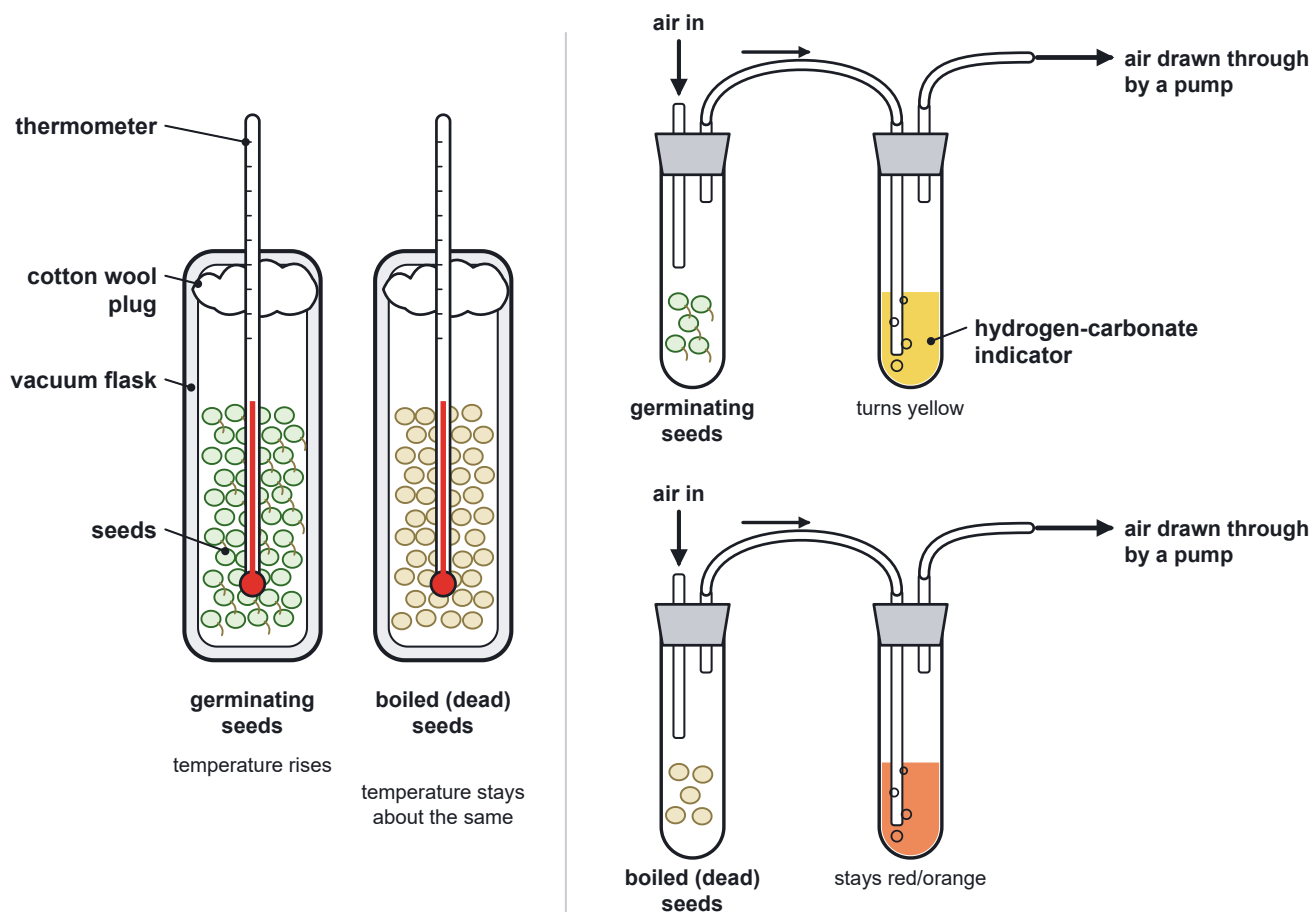
Carbon dioxide released

- Set up a tube of germinating seeds and a tube of boiled seeds, each connected to a tube of hydrogen-carbonate indicator (or limewater). Alternatively, hold the seeds on gauze above the indicator in a sealed tube.
- If the tubes are connected, draw air through each set of apparatus with a pump or syringe, so that any carbon dioxide released by the seeds bubbles through the indicator.
- Record the colour of the indicator after a set time.

Variables in the investigation	
Type of variable	Example
Independent variable	Living seeds or boiled seeds
Dependent variable	Temperature of the flask, or the colour of the indicator
Control variables	Mass of seeds, starting temperature, volume of indicator, volume of air drawn through, time

Expected results		
Test	Living seeds	Boiled seeds
Temperature	Rises, because respiration releases heat	Stays about the same
Hydrogen-carbonate indicator	Changes from red/orange to yellow (carbon dioxide released)	Stays red/orange
Limewater	Turns cloudy	Stays clear

Practical: Wash your hands after handling seeds and disinfectant, and wear eye protection. Limewater is an irritant. The boiled seeds are the control because they show that the changes are caused by living seeds, not by the apparatus.



Key red/orange: normal carbon dioxide level yellow: high carbon dioxide level

Germinating seeds release **heat** (the temperature rises) and **carbon dioxide** (the indicator turns **yellow**). Boiled seeds are the control.

Quick check

1. What is the name of the molecule that provides energy for cells?
2. State the word equation for aerobic respiration.
3. What is made in anaerobic respiration in animals?
4. What is made in anaerobic respiration in plants?
5. Why are boiled seeds used as a control in the respiring seeds practical?

Quick check answers

Respiration

1. ATP (adenosine triphosphate).
2. glucose + oxygen → carbon dioxide + water.
3. Lactic acid.
4. Ethanol and carbon dioxide.
5. They are dead, so they show that any changes are caused by living seeds respiring.