

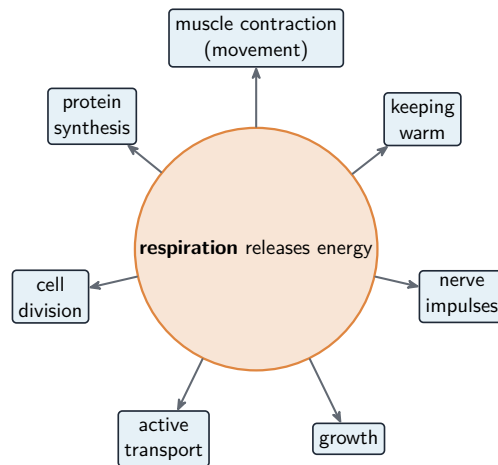
Respiration

IGCSE Biology

Respiration and energy

Respiration 呼吸作用 is the release of **energy** 能量 from food, and it happens in every living cell, all the time. (It is **not** the same as breathing.) Cells use this energy for many jobs:

- **muscle** 肌肉 contraction (movement).
- **protein synthesis** 蛋白质合成 (building proteins).
- cell **division** 分裂 (making new cells).
- **active transport** 主动运输.
- growth.
- the passage of **nerve impulses** 神经冲动.
- keeping a constant body **temperature** 温度.



Cells use the energy from respiration for many different jobs

You can investigate respiration in **yeast** 酵母: warmer yeast respire faster (up to its best temperature), giving off bubbles of **carbon dioxide** 二氧化碳.

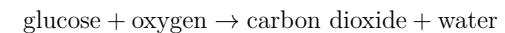
Aerobic respiration



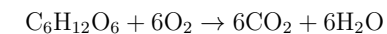
Aerobic respiration releases energy steadily for sustained exercise.

Aerobic respiration 有氧呼吸 uses **oxygen** 氧气 to break down **nutrient molecules** 营养物质 (mainly **glucose** 葡萄糖) and release energy.

Word equation:



(Supplement) Balanced chemical equation:



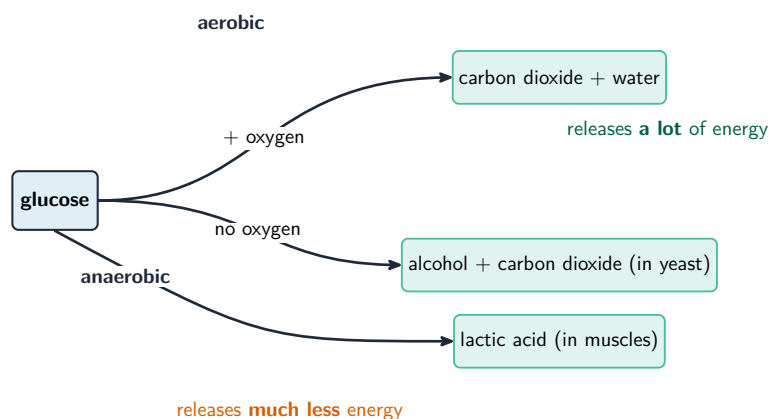
Aerobic respiration releases a **lot** of energy from each glucose molecule.

Anaerobic respiration



A hard sprint relies on anaerobic respiration, building up lactic acid.

Anaerobic respiration 无氧呼吸 breaks down glucose to release energy **without** oxygen. It releases **much less** energy from each glucose molecule than aerobic respiration, because the glucose is not fully broken down.



Aerobic respiration needs oxygen and gives a lot of energy; anaerobic gives much less

In yeast

glucose $\rightarrow$ alcohol + carbon dioxide

The **alcohol** 酒精 made by yeast is used to make bread rise and to brew drinks.

In muscles (Supplement)

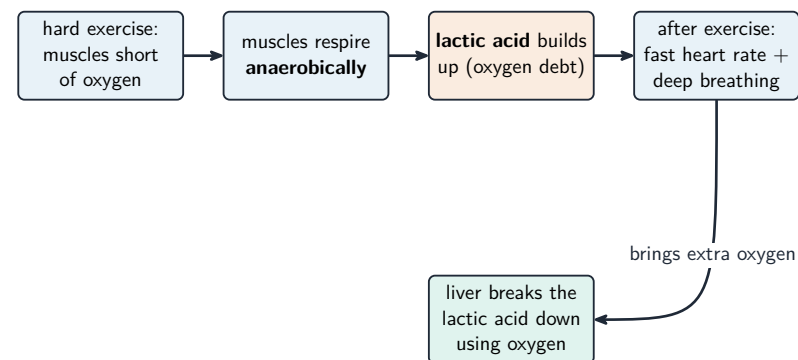
During hard exercise your muscles cannot get enough oxygen, so they respire anaerobically:

glucose $\rightarrow$ lactic acid

The **lactic acid** 乳酸 builds up in the muscles and the blood. This creates an **oxygen debt** 氧债 — the extra oxygen the body will need later to break that lactic acid down.

After you stop exercising, the oxygen debt is repaid:

- your **heart rate** 心率 stays high, carrying the lactic acid in the blood from the muscles to the **liver** 肝脏.
- you keep breathing deeply and quickly, taking in extra oxygen.
- the liver uses this oxygen to break the lactic acid down by aerobic respiration.



Lactic acid from anaerobic respiration is broken down later, using extra oxygen

Worked example. A runner sprints hard for 20 seconds, then breathes deeply for several minutes after stopping. Explain why. During the sprint the muscles cannot get oxygen fast enough, so they respire **anaerobically** and lactic acid builds up, creating an **oxygen debt**. The deep breathing afterwards takes in the extra oxygen the liver needs to break that lactic acid down by aerobic respiration, while a high heart rate

carries the acid from the muscles to the liver. The breathing repays a debt built up **during** the sprint - it is not simply “because the muscles are still working”.

Exam tips

- Respiration releases energy in **all** living cells, all the time — it is not breathing.
- Aerobic: glucose + oxygen → carbon dioxide + water, and it gives **a lot** of energy. Learn the balanced equation too.
- Anaerobic (no oxygen) gives **much less** energy. In yeast: glucose → alcohol + carbon dioxide. In muscles: glucose → lactic acid.
- Lactic acid causes an **oxygen debt**, repaid by a fast heart rate and deep breathing, with the liver breaking the lactic acid down.