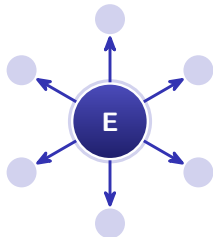


Respiration

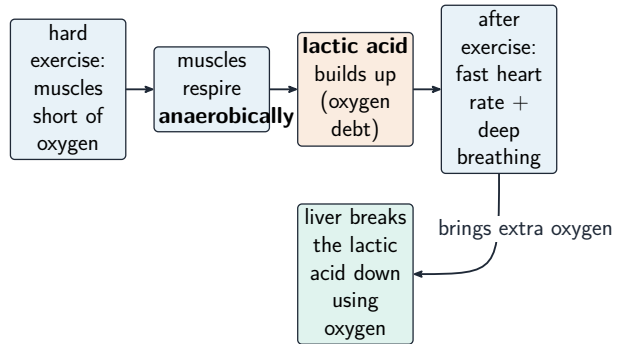
IGCSE Biology ■ Topic 12

IGCSE Biology



What we will cover

- 1 Respiration & energy
- 2 Aerobic respiration
- 3 Anaerobic respiration
- 4 Oxygen debt

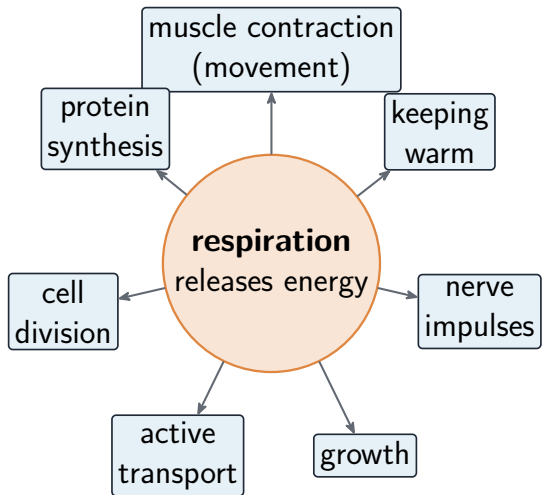


oxygen debt

1

Energy

Respiration and energy



- **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.

What the energy is spent on

Building	Making large molecules from small ones – proteins from amino acids, starch from glucose.
Moving	Muscle contraction, and active transport 主动运输 against a concentration gradient.
Signalling	The passage of nerve impulses 神经冲动 along every neurone, all day.
Staying warm	Keeping a constant body temperature 体温 in mammals and birds.

Aerobic respiration 有氧呼吸 uses oxygen to break down **nutrient molecules** 营养物质 – mainly glucose – and release that energy.

2

Aerobic and anaerobic

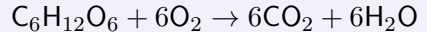
Aerobic respiration



Aerobic respiration releases energy steadily for sustained exercise.

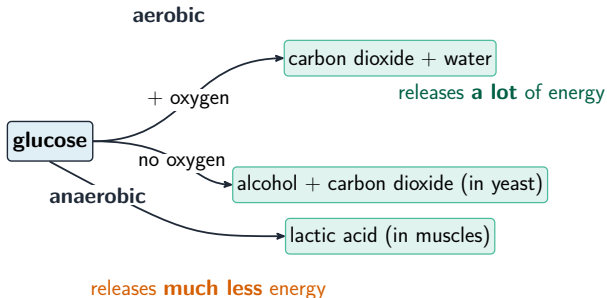
Word equation:

glucose + oxygen → carbon dioxide + water



Aerobic respiration releases far more energy per glucose molecule than anaerobic respiration.

Anaerobic respiration



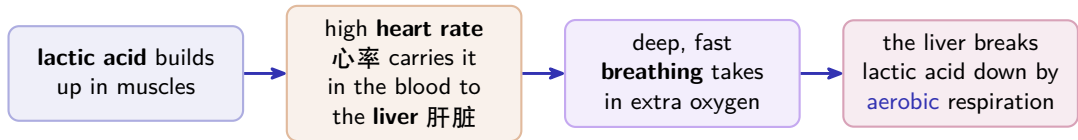
Anaerobic respiration 无氧呼吸 works **without** oxygen, giving **much less** energy.

- yeast: glucose → **alcohol** 酒精 + CO₂
- muscle: glucose → **lactic acid** 乳酸

Both yeast products are used: the CO₂ makes **bread** rise, and the alcohol is what **brewing** is for.

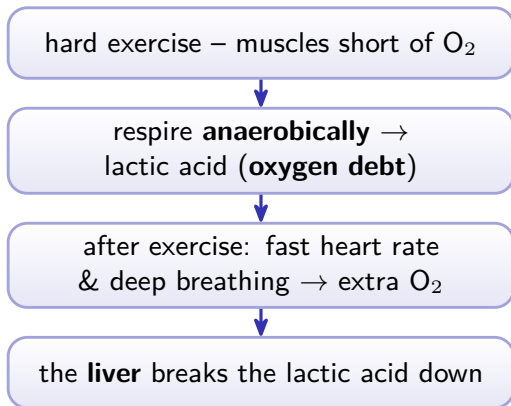
In muscles (Supplement)

Hard exercise: muscles **cannot get enough oxygen**, so they respire **anaerobically**.



Oxygen debt the extra oxygen needed **after** exercise to remove the lactic acid.

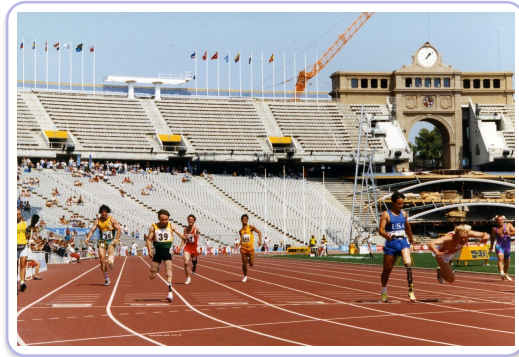
Oxygen debt



Lactic acid builds up – the **oxygen debt** 氧债.

After exercise: a fast heart rate & deep breathing bring extra O₂, so the **liver** 肝脏 breaks the lactic acid down.

A sprint and lactic acid



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

Exam tips

- Respiration releases energy in **all** living cells, all the time – it is not breathing.
- Aerobic: glucose + oxygen $\rightarrow$ 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 $\rightarrow$ alcohol + carbon dioxide. In muscles: glucose $\rightarrow$ 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.

3

Recap

Worked example – aerobic or anaerobic?

A sprinter's muscles ache after a 200 m race. Explain what happened.

- Sprinting needs energy **faster** than the blood can deliver oxygen.
- So muscles also respire **anaerobically** 无氧地: glucose → **lactic acid** (+ a little energy).
- Lactic acid **builds up** in the muscle, causing the ache and fatigue.
- Afterwards you keep panting to repay the **oxygen debt** and break the lactic acid down.

Aerobic: glucose + oxygen → CO_2 + water, **lots** of energy. Anaerobic in muscle: glucose → lactic acid, **little** energy, no oxygen needed.

Topic 12 – key takeaways

1

Respiration

releases energy in all cells, all the time

2

Aerobic

glucose + O₂ → CO₂ + water;
lots of energy

3

Anaerobic

no O₂; alcohol (yeast) or lactic acid

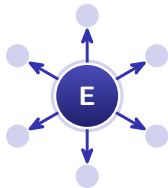
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Oxygen debt

repaid; liver breaks down lactic acid

Check yourself

- 1 Where in the body does respiration happen?
- 2 What are the products of aerobic respiration?
- 3 What does anaerobic respiration make in muscles?
- 4 Which organ breaks down lactic acid?



Answers 1. in every living cell 2. carbon dioxide & water 3. lactic acid 4. the liver