

Energy & Respiration

A-Level Biology ■ Topic 12

A-Level Biology



Energy & Respiration

What we will cover

- 1 ATP – the energy currency
- 2 Substrates & RQ
- 3 The four stages
- 4 Glycolysis
- 5 Krebs & oxidative phosphorylation
- 6 Anaerobic respiration



muscles need energy

1 ATP and substrates

Energy & Respiration
└ ATP and substrates

ATP – the energy currency

ATP 三磷酸腺苷 stores energy in its terminal phosphate bond. Hydrolysis to ADP + P_i releases it; respiration (and photosynthesis) rebuilds ATP.

ATP is a short-term, mobile energy currency – not a store. Cells make it as they need it.

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└ ATP and substrates

Substrates and RQ

Respiratory quotient 呼吸商 $RQ = \text{CO}_2 \text{ produced} / \text{O}_2 \text{ used}$. Carbohydrate ≈ 1.0 ; lipid ≈ 0.7 ; protein ≈ 0.9 . An RQ above 1 suggests anaerobic respiration as well.

2 Aerobic respiration

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Aerobic respiration

The four stages

- glycolysis** 糖酵解 – in the **cytoplasm** 细胞质
- link reaction** 连接反应 & **Krebs cycle** 克雷布斯循环 – the **matrix** 基质
- oxidative phosphorylation** 氧化磷酸化 – the inner membrane

Reduced NAD & FAD carry hydrogen to the membrane.

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Glycolysis

Glucose 葡萄糖 (6C) is split into two **pyruvate** 丙酮酸 (3C).

It spends 2 ATP but makes 4 – a net 2 ATP (plus reduced NAD) – and needs **no oxygen**.

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Krebs cycle

The link reaction makes **acetyl CoA** 乙酰辅酶 A, which joins the cycle. Each turn:

- decarboxylation** 脱羧 – releases CO₂
- dehydrogenation** 脱氢 – reduces NAD & FAD

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Oxidative phosphorylation

Makes **most** of the ATP:

- electrons pass the **electron transport chain** 电子传递链, pumping protons
- protons flow back through **ATP synthase** ATP 合酶 (chemiosmosis 化学渗透)
- oxygen** 氧气 is the final electron acceptor → water

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Anaerobic respiration

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Anaerobic respiration

Anaerobic respiration

Without oxygen, only glycolysis runs. **Fermentation** 发酵 regenerates NAD:

- mammals → **lactate** 乳酸
- yeast 酵母 → **ethanol** 乙醇 + CO₂

Far less ATP than aerobic respiration.

4 Recap

Worked example – respiratory quotient

Find the RQ for aerobic respiration of glucose: $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$.

- $\text{RQ} = \frac{\text{CO}_2 \text{ produced}}{\text{O}_2 \text{ used}}$
- $= \frac{6}{6} = 1.0$
- Lipids are less oxidised, so they need more oxygen $\Rightarrow \text{RQ} \approx 0.7$.
- An RQ above 1.0 means some anaerobic respiration is also happening.

RQ identifies the substrate: carbohydrate 1.0, protein ≈ 0.9 , lipid ≈ 0.7 . Above 1.0 $\Rightarrow$ extra CO_2 from anaerobic respiration.

Topic 12 – key takeaways

1 ATP

the cell's energy currency; $\text{ADP} + \text{P}_i$

2 Glycolysis

glucose to pyruvate; net 2 ATP, no O_2

3 Krebs cycle

decarboxylation & dehydrogenation

4 Chemiosmosis

ATP synthase makes most ATP; O_2 accepts e^-

Check yourself

- 1 Where in the cell does glycolysis happen?
- 2 What is the net ATP gain from glycolysis?
- 3 What is the final electron acceptor?
- 4 What does yeast make in anaerobic respiration?

A ribose P P P

Answers 1. the cytoplasm 2. 2 ATP 3. oxygen 4. ethanol and CO_2