A-LEVEL BIOLOGY • EXERCISE SHEET

12.2 Respiration

Name: _____ Class: _____ Date: _____ **Total: 17 marks**

Objective

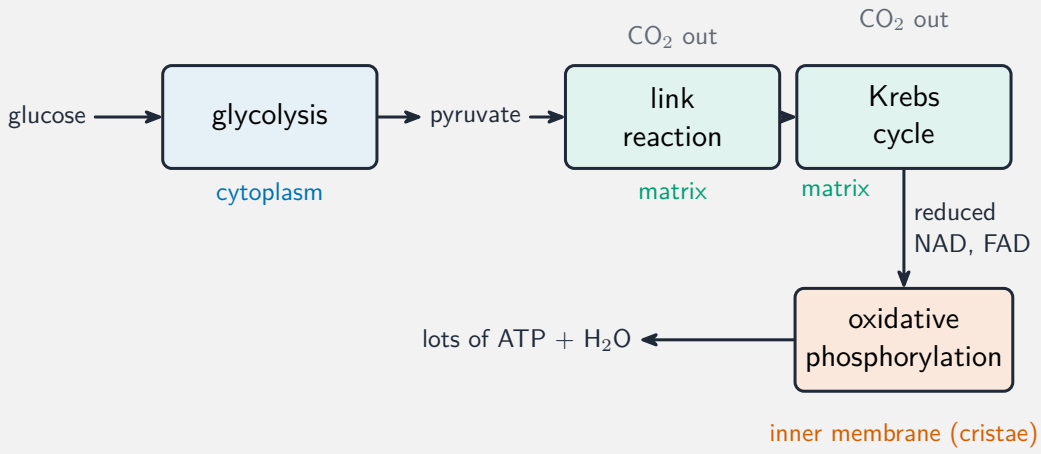
Build the skills to answer exam questions on **respiration** —the four stages of **aerobic** 有氧 respiration, the role of NAD and FAD, **oxidative phosphorylation** 氧化磷酸化, and **anaerobic** 无氧 respiration.

You must be able to:

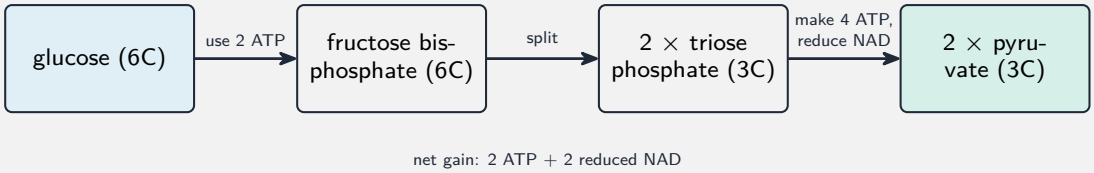
- state where glycolysis, the link reaction, the Krebs cycle and oxidative phosphorylation occur
- outline each stage, including decarboxylation, dehydrogenation and chemiosmosis
- relate mitochondrial structure to function and describe anaerobic respiration

1 Worked examples

The four stages and where they happen

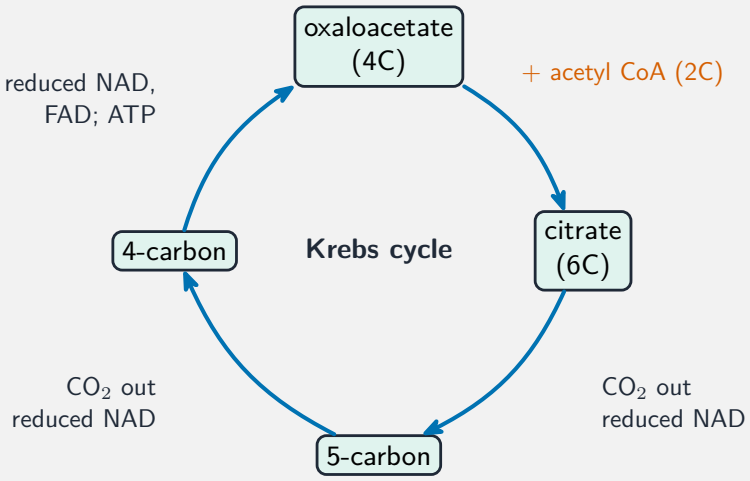


The four stages; reduced NAD and FAD carry hydrogen to the inner membrane where most ATP is made



Glycolysis (cytoplasm) spends 2 ATP but makes 4 → net gain 2 ATP + reduced NAD; needs no oxygen

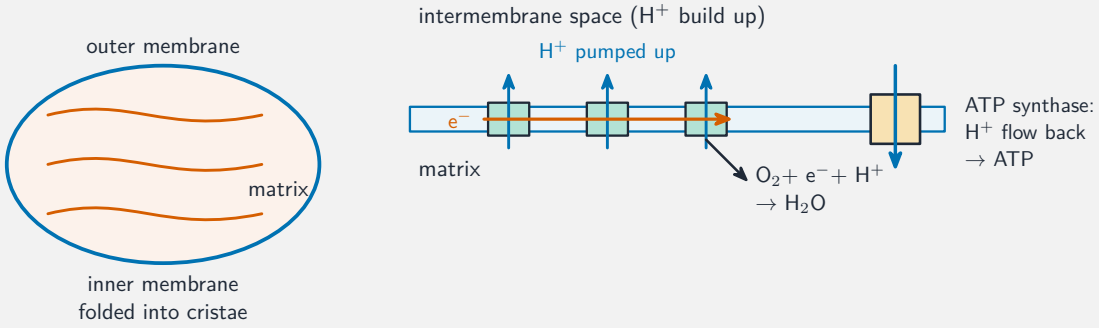
The link reaction and Krebs cycle



Each turn: decarboxylation releases CO_2; dehydrogenation reduces NAD and FAD

Link reaction (matrix): pyruvate (3C) loses CO_2 → acetyl (2C), carried by **coenzyme A** 辅酶 A; NAD is reduced. **Krebs cycle** (matrix): acetyl (2C) + oxaloacetate (4C) → citrate (6C), converted back with **decarboxylation** and **dehydrogenation**.

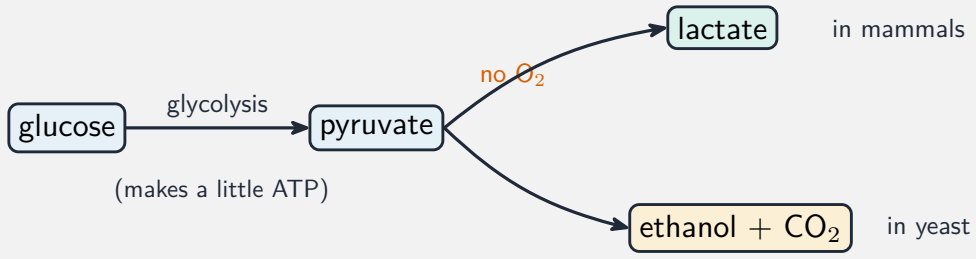
Oxidative phosphorylation



Electrons pump H^+ into the intermembrane space; they flow back through ATP synthase to make ATP (chemiosmosis)

Energetic electrons pass along the **electron transport chain** 电子传递链; the energy pumps protons across the inner membrane; protons flow back through **ATP synthase** to make ATP; **oxygen** is the final electron acceptor, forming water. **Cristae** 嵴 give a large surface for this.

Anaerobic respiration



this regenerates NAD so glycolysis can keep running (far less ATP than aerobic)

Without oxygen, pyruvate becomes lactate (mammals) or ethanol (yeast), regenerating NAD for glycolysis

2 Practice

2.1 State where in a eukaryotic cell each stage occurs: glycolysis; Krebs cycle; oxidative phosphorylation. [3]

2.2 State the net number of ATP molecules made directly in glycolysis. [1]

3 Exam-style questions

3.1 In which stage does oxygen act as the final electron acceptor? [1]

- **A** glycolysis
- **B** the link reaction
- **C** the Krebs cycle
- **D** oxidative phosphorylation

3.2 What is produced when pyruvate undergoes lactate fermentation in a muscle? [1]

- **A** ethanol and carbon dioxide
- **B** lactate
- **C** acetyl coenzyme A
- **D** citrate

3.3 (a) Describe what happens in the link reaction. [3]

(b) Explain how the folding of the inner mitochondrial membrane into cristae helps respiration. [2]

3.4 (a) Explain how ATP is made during oxidative phosphorylation, with reference to protons and ATP synthase. [4]

(b) Explain why anaerobic respiration releases far less energy than aerobic respiration. [2]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **12.2 Respiration** past-paper sheet in the Library, or try these in **Practice mode**:

- 9700/42 N25 —Q1 (respiration stages)
- 9700/44 N25 —Q9 (respiration, calculation)

- 9700/41 J25 —Q2 (oxidative phosphorylation)

Solutions

2.1 glycolysis —cytoplasm; Krebs cycle —mitochondrial matrix; oxidative phosphorylation —inner mitochondrial membrane.

2.2 2 (a net gain of 2 ATP).

3.1 D. In oxidative phosphorylation oxygen is the final electron acceptor.

3.2 B. In mammals, anaerobic respiration converts pyruvate to lactate.

3.3 pyruvate enters the mitochondrial matrix; it loses a CO (decarboxylation) and is oxidised to a 2C acetyl group, reducing NAD; the acetyl group joins coenzyme A to form acetyl coenzyme A.
(b) cristae give a large surface area for more electron carriers and ATP synthase, so more ATP is made.

3.4 (a) energetic electrons pass along the electron transport chain, releasing energy; this pumps protons across the inner membrane into the intermembrane space; the protons flow back into the matrix through ATP synthase; this flow provides energy to make ATP (chemiosmosis).
(b) anaerobic respiration uses only glycolysis, without the link reaction, Krebs cycle and oxidative phosphorylation that release most of the ATP.