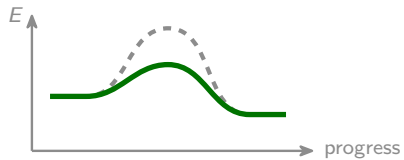


Cellular Energetics

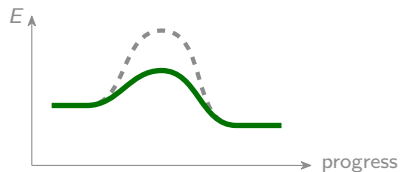
AP Biology ■ Unit 3

AP Biology



What we will cover

- 1 Enzymes as catalysts
- 2 Enzyme conditions and inhibitors
- 3 ATP and energy coupling
- 4 Photosynthesis
- 5 Cellular respiration



1

Enzymes

Enzymes as biological catalysts

Enzymes 酶 speed reactions by lowering the activation energy – without being used up.

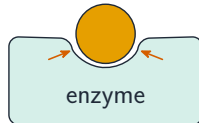
- the **substrate** 底物 binds the **active site** 活性位点
- **induced fit** 诱导契合模型: the site reshapes to grip it
- each enzyme is **specific** 专一的 to one reaction

lock-and-key



active site is a fixed shape

induced fit



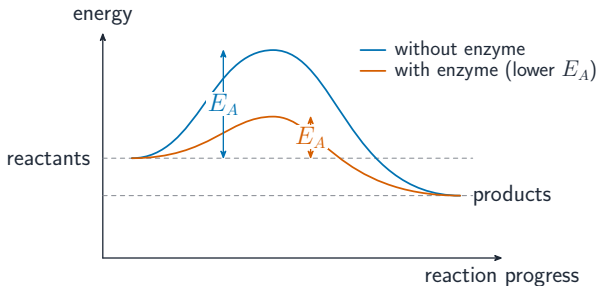
active site moulds to fit the substrate

An enzyme lowers the activation energy

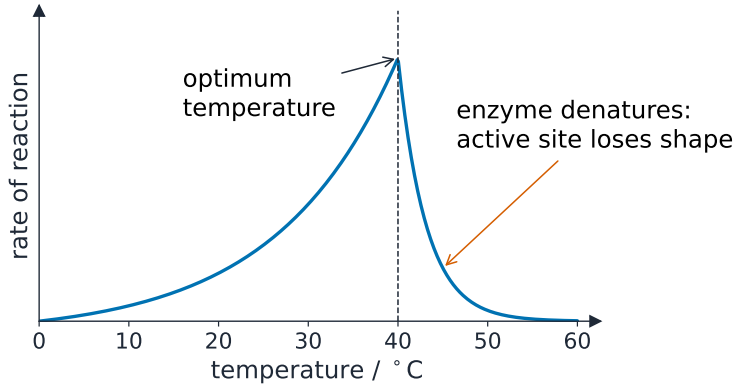
activation energy the energy needed to **start** a reaction

The enzyme gives a lower-energy path; reactants and products, and ΔG , are **unchanged**.

Lower $E_A \Rightarrow$ more collisions succeed $\Rightarrow$ **faster** reaction.



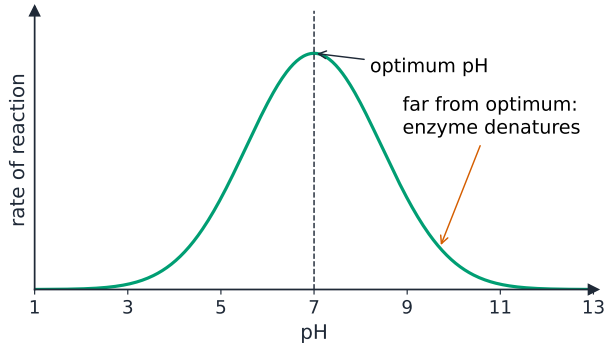
Temperature: rate rises to an optimum, then falls



rate of an enzyme reaction against temperature

Below the **optimum** 最适: more kinetic energy, more successful collisions. Past it, the protein **denatures** 变性: the active site **loses its shape** and the rate falls.

pH: each enzyme has an optimum pH

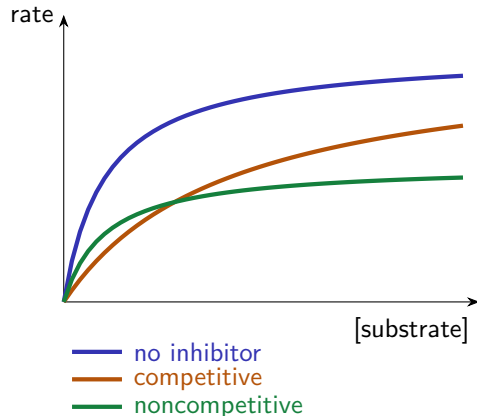


Away from the optimum, H^+ or OH^- ions disrupt ionic and hydrogen bonds, so the active site changes shape. Pepsin (stomach) works best near pH 2; most enzymes near pH 7.

Substrate and inhibitors

More substrate speeds the reaction until every enzyme is **saturated** 饱和的.

inhibitor	how it acts
competitive	blocks the active site; more substrate overcomes it
noncompetitive	binds elsewhere, reshapes the site
feedback	the end product shuts off step 1

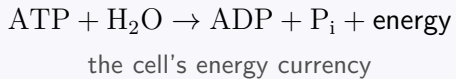


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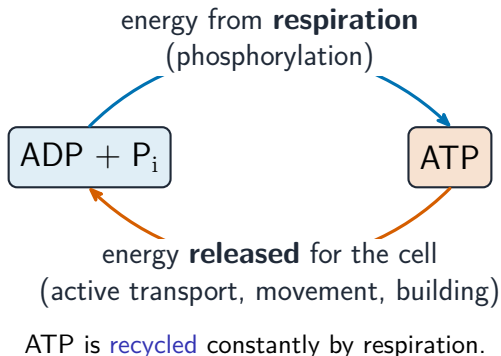
ATP

ATP and energy coupling

Exergonic 放能反应 reactions release
free energy 自由能;
endergonic 吸能反应 ones absorb it.



A **coupled reaction** 偶联反应 uses
ATP breakdown to power an **uphill**
step.

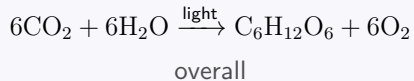


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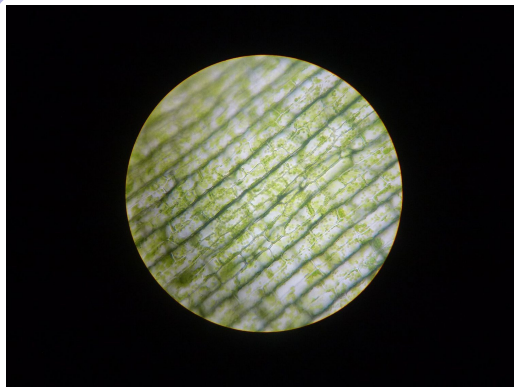
Photosynthesis

Photosynthesis

In the **chloroplast** 叶绿体, light energy becomes sugar:

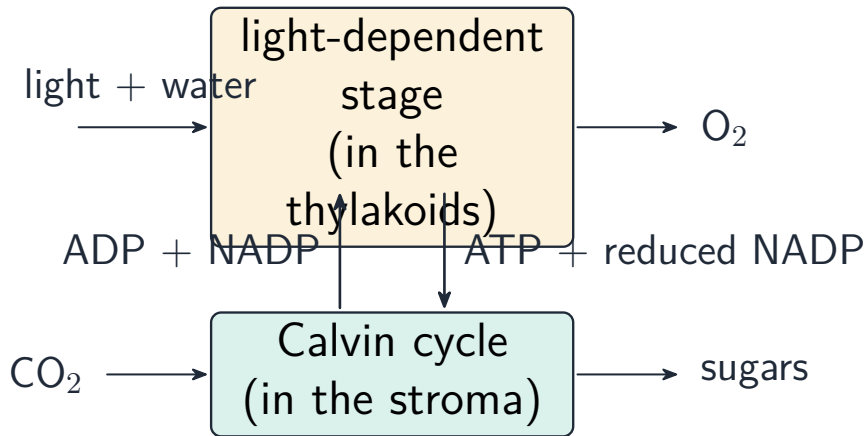


- **light reactions** – thylakoid: split H_2O , make O_2
- **Calvin cycle** – stroma: fix CO_2 into sugar



Chloroplasts capture light and fix carbon

Two stages linked by ATP and NADPH



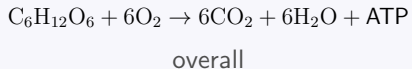
The two stages of photosynthesis are linked by ATP and NADPH

4

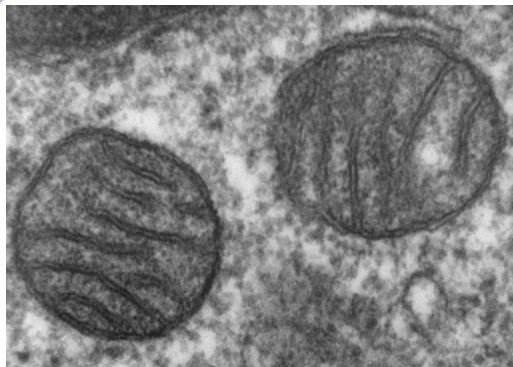
Respiration

Cellular respiration

In the **mitochondrion** 线粒体, glucose is broken down to make ATP:



- glycolysis → Krebs → oxidative phosphorylation
- aerobic: about 30–32 ATP per glucose
- **Chemiosmosis** 化学渗透: H^+ flows back through ATP synthase



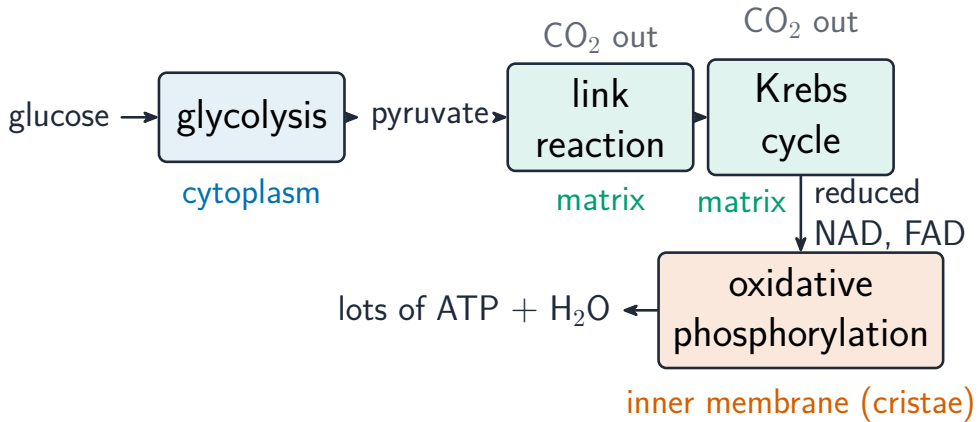
50 nm

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Mitochondria oxidise fuel to make ATP

Where each stage of respiration happens



The stages of aerobic respiration and where in the cell they happen

The stages of cellular respiration

stage	where	what happens
glycolysis	cytoplasm	glucose $\rightarrow$ 2 pyruvate; net 2 ATP, NADH
Krebs cycle 克雷布斯循环	matrix	carbon leaves as CO_2 ; NADH, FADH_2 loaded
electron transport chain 电子传递链	inner membrane	electrons pump H^+ across the membrane
chemiosmosis	inner membrane	H^+ flows back through ATP synthase: most of the ATP
without oxygen	cytoplasm	fermentation regenerates NAD^+ ; glycolysis only

Oxygen is the final electron acceptor (it becomes water): without it the chain stops.

Exam tips

- An **enzyme lowers the activation energy** and is not used up; its **active site** is specific to one substrate (lock and key).
- Rate rises with temperature only up to the **optimum** – beyond it the enzyme **denatures** and the rate falls (unlike an ordinary reaction).
- Know the $\text{ATP} \leftrightarrow \text{ADP}$ cycle: breaking a phosphate **releases** energy to power the cell.
- Write the overall equations: photosynthesis **stores** energy (builds glucose); respiration **releases** it (breaks glucose down) – they are opposites.
- Match each stage to its location and whether it needs oxygen.

5

Recap

Unit 3 – key takeaways

1

Enzymes

lower activation energy; specific active site; denature

2

ATP

$\text{ATP} \rightarrow \text{ADP} + \text{P}_i$; couples to uphill steps

3

Photosynthesis

light reactions + Calvin cycle
build glucose

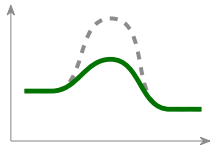
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Respiration

glycolysis, Krebs, oxidative phosphorylation

Check yourself

- 1 How does an enzyme speed up a reaction?
- 2 What molecule carries energy for the cell?
- 3 Which organelle carries out photosynthesis?
- 4 Aerobic respiration yields how many ATP vs fermentation?



Answers 1. it lowers the activation energy 2. ATP 3. the chloroplast 4. ~30 vs 2