WJEC (Wales) Biology A-level

Unit 1.4 - Enzymes

Flashcards

Define metabolism

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The sum of all the enzyme controlled chemical reactions taking place in a cell.

State the two main types of reactions that make up metabolism.

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Anabolic and **catabolic** reactions.

What is anabolism?

What is anabolism?

A set of metabolic pathways that **synthesise** complex molecules from smaller, simpler molecules.

What is catabolism?

What is catabolism?

A set of metabolic pathways that **breakdown** complex molecules into smaller, simpler molecules.

What is an enzyme?

What is an enzyme?

- A biological catalyst used to speed up the rate of intracellular and extracellular biochemical reactions
- Not used up or permanently altered

What is an intracellular enzyme?

What is an intracellular enzyme?

An enzyme that acts within cells, e.g. catalase.

What is an extracellular enzyme?

What is an extracellular enzyme?

An enzyme that is secreted by cells and functions outside of cells, e.g. amylase.

What is the active site of an enzyme?

What is the active site of an enzyme?

A region on an enzyme that is complementary to the shape of a specific substrate. The substrate binds and the reaction takes place.

Why is an active site described as ‘specific’?

Why is an active site described as ‘specific’?

- The 3D structure of each enzyme (including the active site) is unique due to the presence of different side chains and branches
- Only **specific** substrates complementary to the active site can bind

Define activation energy

Define activation energy

The **minimum** amount of energy required for a reaction to take place.

What is catalysis?

What is catalysis?

- An increase in the rate of a chemical reaction using a catalyst (such as an enzyme)
- The catalyst lowers the activation energy of the reaction

Describe the ‘lock and key’ model.

Describe the ‘lock and key’ model.

1. Substrate(s) and the active site of the enzyme come into contact
2. Substrate(s) binds, **enzyme-substrate complex** forms
3. Reaction takes place, product(s) formed in an **enzyme-product complex**
4. Product(s) released from the active site. The active site is now free to bind to another substrate

What is the induced-fit hypothesis?

What is the induced-fit hypothesis?

A model of enzyme action which states that once a specific substrate binds to the active site, the enzyme undergoes subtle **conformational changes**. This puts a strain on the substrate, **lowering** the **activation energy** for the reaction.

What factors affect the rate of an enzyme-controlled reaction?

What factors affect the rate of an enzyme-controlled reaction?

- Temperature
- pH
- Substrate concentration
- Enzyme concentration

How does temperature affect the rate of enzyme-controlled reactions?

How does temperature affect the rate of enzyme-controlled reactions?

- As temperature increases molecules have more KE
- Molecules moves faster and collide more frequently
- More enzyme-substrate complexes form
- Rate of reaction increases
- Rate peaks at the optimum temperature

Explain how increasing temperature above the optimum affects the rate of an enzyme-controlled reaction

Explain how increasing temperature above the optimum affects the rate of an enzyme-controlled reaction

- Temperature increases above the optimum
- Increased vibrations break hydrogen and ionic bonds in tertiary structure
- Active site changes shape, enzyme is denatured
- No more enzyme-substrate complexes can form
- Rate of reaction decreases

Draw a graph to show the effect of increasing temperature on the rate of an enzyme-catalysed reaction.

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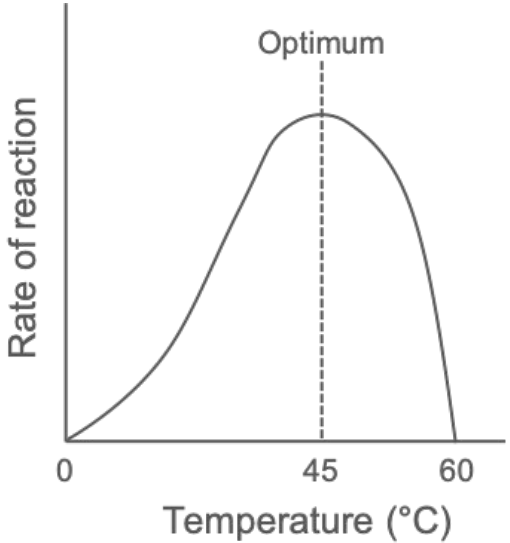

How does pH affect the rate of enzyme-controlled reactions?

How does pH affect the rate of enzyme-controlled reactions?

- Enzymes have an optimum pH
- pH shifts from the optimum
- Hydrogen and ionic bonds in the tertiary structure are altered
- Interaction of polar and charged R-groups changes
- Active site changes shape, enzyme is denatured
- Rate of reaction decreases

Draw a graph to show the effect of increasing pH on the rate of an enzyme-catalysed reaction.

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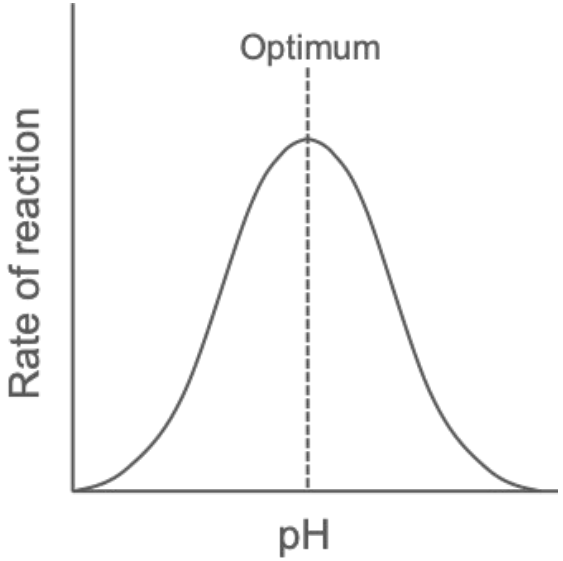


What is a buffer?

What is a buffer?

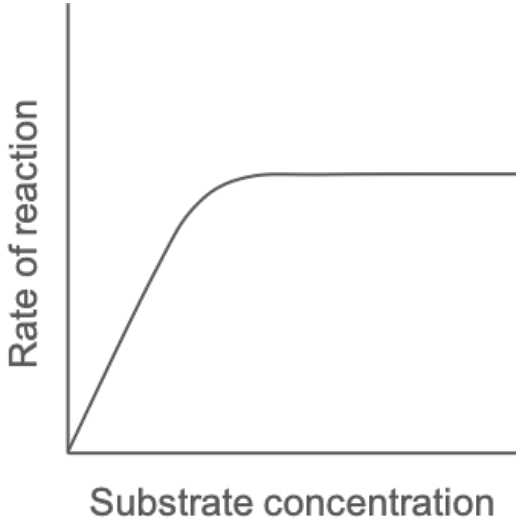
A molecule that maintains a constant pH in a solution when small amounts of acid (H+) or base(OH-) are added.

How does substrate concentration affect the rate of an enzyme-controlled reaction?

How does substrate concentration affect the rate of an enzyme-controlled reaction?

If enzyme concentration is fixed, the rate of reaction increases proportionally to the substrate concentration.

Once all active sites become full, the rate of reaction becomes constant - graph plateaus (enzyme concentration is a limiting factor)

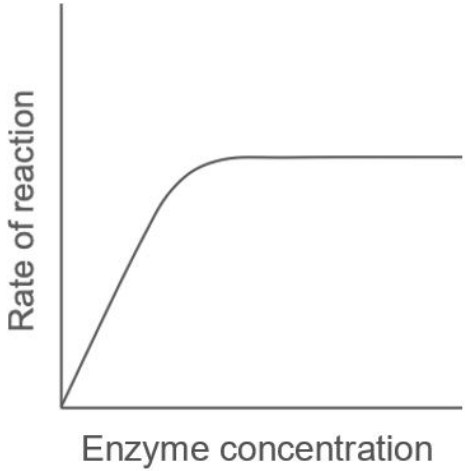


How does enzyme concentration affect the rate of an enzyme-controlled reaction?

How does enzyme concentration affect the rate of an enzyme-controlled reaction?

If substrate concentration is fixed, the rate of reaction increases proportionally to the enzyme concentration.

When all of the substrates occupy active sites, the rate of reaction remains constant - graph plateaus (substrate concentration is a limiting factor)



What is a competitive inhibitor?

What is a competitive inhibitor?

A molecule which binds to the active site of an enzyme, blocking it and preventing the substrate from binding.

Is competitive inhibition temporary or permanent?

Is competitive inhibition temporary or permanent?

Competitive inhibition is generally temporary. However, in some cases (e.g. aspirin) it may be permanent.

How does increasing substrate concentration affect competitive inhibition?

How does increasing substrate concentration affect competitive inhibition?

- Increase in substrate concentration
- More substrate than inhibitor
- Rate of reaction increases

What is a non-competitive inhibitor?

What is a non-competitive inhibitor?

- An inhibitor which binds to a different part of an enzyme, the **allosteric site**
- The tertiary structure of the enzyme (including the active site) changes shape
- The active site is no longer complementary to the substrate. The substrate cannot bind and the enzyme is inhibited

Is non-competitive inhibition temporary or permanent?

Is non-competitive inhibition temporary or permanent?

Permanent

How does increasing substrate concentration affect non-competitive inhibition?

How does increasing substrate concentration affect non-competitive inhibition?

Increasing the substrate concentration will not overcome the effect of the non-competitive inhibitor.

What are immobilised enzymes?

What are immobilised enzymes?

Enzymes which are attached to an inert, insoluble material over which the substrate passes and the reaction takes place.

Give an example of an application of immobilised enzymes.

Give an example of an application of immobilised enzymes.

Biosensors

Why are immobilised enzymes important in industrial processes?

Why are immobilised enzymes important in industrial processes?

- Enables enzymes to be **reused**
- Improves enzyme **stability** in variable/extreme temperatures and pH
- Increases the **efficiency** of reactions