CAIE Biology A-level

Topic 3: Enzymes

Flashcards

What type of protein is an enzyme?

What type of protein is an enzyme?

Usually globular and water-soluble.

Has tertiary structure with hydrophilic R groups on the outside and hydrophobic R groups on the inside.

How does an enzyme lower the activation energy?

How does an enzyme lower the activation energy?

By holding the substrate molecules close together, or placing a physical strain on the bonds so that they are weaker and are broken more easily.

Where can enzymes act?

Where can enzymes act?

They can be intracellular or extracellular.

Describe the induced fit model of enzymes

Describe the induced fit model of enzymes

The substrate interacts with the R groups of amino acids at the active site of the enzyme

The shape of the active site changes to create a better fit or stronger binding to the substrate.

Describe the lock and key hypothesis

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The substrate is complementary in shape to the enzyme's active site and binds to it.

State two ways to investigate the progress of enzymatic reactions

State two ways to investigate the progress of enzymatic reactions

You could:

Analyse the amount of product of the reaction is present (e.g. in the H_2O_2 reaction with catalase, O_2 gas is produced).

Or:

Analyse a colour change indicating the removal of substrate or presence of products (e.g. starch + amylase→ maltose - in the presence of iodine would produce an obvious colour change).

State an additional way we can monitor an enzymatic reaction by use of colorimetry (using the starch - amylase reaction as an example)*

*Only applies to 22-24 syllabus.

State an additional way we can monitor an enzymatic reaction by use of colorimetry (using the starch- amylase reaction as an example)*

Use a colorimeter to build a calibration curve (measure absorbance of known concentrations of starch in the presence of iodine solution at equal increments of concentration). Measure samples of your reaction solution at equal time intervals and use your calibration curve to estimate concentration of starch. This allows you to measure the progress of the reaction.

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State the 5 factors affecting enzymatic reactions you **must** know about

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- Temperature
- Enzyme concentration
- Substrate concentration
- Inhibitor concentration
- pH - using a buffer solution

Describe the effect of temperature on enzyme activity

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As temperature increases, the rate of activity increases as enzyme and substrate molecules gain kinetic energy, so the number of successful collisions to form enzyme-substrate (ES) complexes increase.

It reaches a maximum at the optimum temperature.

Beyond that temperature, enzymes become denatured and fewer ES complexes are formed, so the activity decreases.

Describe the effect of pH on enzyme activity

Describe the effect of pH on enzyme activity

Enzyme activity is highest at the optimum pH. As pH increases or decreases from its optimum, it will lead to a partial or permanent denaturation of the enzyme so the activity decreases.

State the function & importance of a buffer solution in enzymatic reactions

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Buffer solutions - maintain pH by minimising changes to pH in a system.

Important as the products of a reaction may affect a system's pH, which in turn can affect reaction rates.

Describe the effect of substrate concentration on enzyme activity

Describe the effect of substrate concentration on enzyme activity

When substrate concentration increases, enzyme activity increases as substrate concentration is limiting. More substrate results in more enzyme-substrate complexes formed, so the activity increases.

Beyond a certain substrate concentration, enzyme activity plateaus because enzyme concentration is limiting. All enzyme active sites are occupied. Vmax is reached.

Describe the mode of action of a competitive inhibitor

Describe the mode of action of a competitive inhibitor

A molecule that is similar in shape to the substrate, so is also complementary to the active site and binds to it, blocking ES complex formation.

Increasing substrate concentration decreases the effect of inhibition, and inhibition is reversible.

Describe the mode of action of a non-competitive inhibitor

Describe the mode of action of a non-competitive inhibitor

Binds to an allosteric site of the enzyme and disrupts the tertiary structure of the enzyme, changing the shape of the active site so ES complexes cannot be formed.

Increasing substrate concentration has no effect on the degree of inhibition.

What are irreversible inhibitors?

What are irreversible inhibitors?

Permanently prevent formation of ES complexes. Once they have bound to all enzymes, the reaction will stop.

Heavy metal ions e.g. mercury, silver cause disulphide bonds in tertiary structure to break.

Bind to enzymes by strong (covalent) bonds e.g. cyanide binds to cytochrome c.

What are reversible inhibitors?

What are reversible inhibitors?

- May be competitive or non-competitive. Bind to enzyme temporarily e.g. by H-bonds or a few ionic bonds.
- ES complexes can form after the inhibitor is released.

State what the Michaelis-Menten equation is used for, and state its formula (including units and meaning of formulae terms).

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Michaelis-Menten equation can be used to calculate the **maximum rate of reaction (Vmax)** by relating the **velocity of enzyme reactions (V)** to **concentration of a substrate [S].**

Vmax represents the maximum rate of reaction achieved by the system at maximum substrate concentration.

Km (½ Vmax) can be used to tell us the affinity of an enzyme to its substrate - as the lower the concentration of substrate required to achieve ½ Vmax indicates a greater affinity.

$$Vo = \frac{V_{max}[S]}{Km + [S]}$$

V0 = Initial velocity (moles/times)
[S] = substrate concentration (molar)
V_{max}= maximum velocity
K_m = substrate concentration at half V_{max}

Describe how an enzyme can be immobilised

Describe how an enzyme can be immobilised

They are **immobilised by attaching them to an insoluble, inert material e.g. calcium alginate.**

This forms a gel capsule around them thus holding them in place during the reaction.

State the advantages of immobilising enzymes

State the advantages of immobilising enzymes

Immobilising enables enzymes to be easily separated from the products and thus **reused**. This also means the product remains enzyme free.

Immobilised enzymes are encapsulated and therefore not fully exposed to denaturing conditions. This makes them more able to withstand changes to pH & temperature in solution.

How do reactions of free enzymes differ to those of immobilised enzymes?

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Immobilisation allows for increased resistance of enzymes to denaturing conditions. This means that, even if solution conditions change (pH, temperature), reactions will proceed to a larger range than if free enzymes were involved.