OCR (B) Biology A-level

2.1.3 - Proteins and enzymes

Flashcards

What is the general structure of an amino acid?

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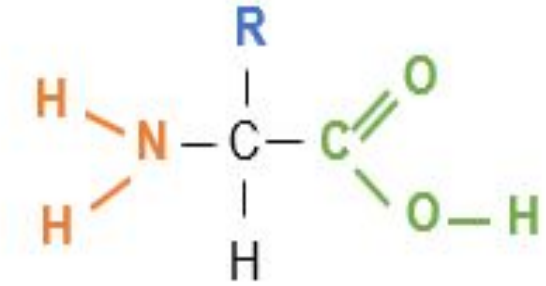


-COOH - carboxyl/carboxylic acid group

-R - variable side group, consists of carbon chain & may include other functional groups e.g. benzene ring or -OH (alcohol)

-NH_2 - amine/amino group

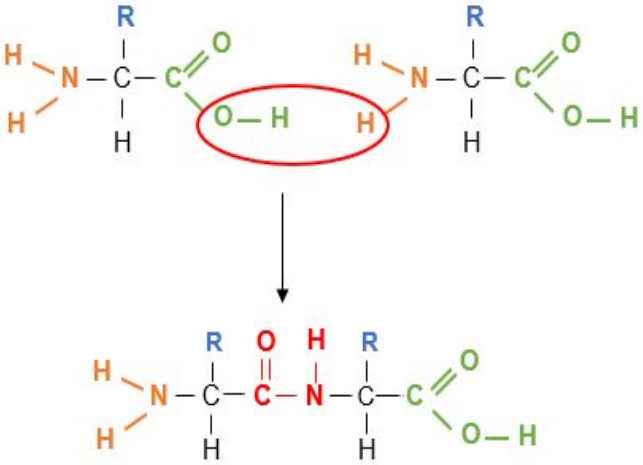
How do dipeptides and polypeptides form?

How do dipeptides and polypeptides form?

condensation reaction forms peptide bond (-CONH-) & eliminates a molecule of water

dipeptide: 2 amino acids join

polypeptide: 3 or more amino acids join together



Outline how chromatography could be used to identify the amino acids in a mixture.

Outline how chromatography could be used to identify the amino acids in a mixture.

1. Use capillary tube to spot mixture onto pencil origin line & place chromatography paper in solvent.
2. Allow solvent to run until it almost reach end of paper.
3. Amino acids move different distances based on relative attraction to paper & solubility in solvent.
4. Use revealing agent or UV light to observe spots.
5. Calculate R_f values & match to database.

What is an R_f value and how is it calculated?

What is an R_f value and how is it calculated?

Retardation factor (R_f) is a ratio that indicates relative solubility in mobile phase vs attraction to stationary phase.

Rf value = distance moved by solute (origin to centre of spot) ÷ distance moved by solvent (origin to solvent front)

What is the primary structure of a protein?

What is the primary structure of a protein?

Sequence, number & type of amino acids in the polypeptide, determined by sequence of codons on mRNA

What is the secondary structure of a protein?

What is the secondary structure of a protein?

Formed when the primary structure coils or folds. Hydrogen bonds form between O δ- attached to –C=O & H δ+ attached to –NH.

Describe the 2 types of secondary protein structure.

Describe the 2 types of secondary protein structure.

α-helix:

- All N-H bonds on same side of protein chain
- Tubular shape
- H-bonds parallel to helical axis

β-pleated sheet:

- N-H & C=O groups alternate between sides
- Polypeptide chain folds back on itself in parallel sheets

Define ‘tertiary structure’ of a protein. Describe the bonds present.

Define ‘tertiary structure’ of a protein. Describe the bonds present.

3D structure formed by further folding

- **disulfide bridges**: strong covalent S-S bonds between molecules of the amino acid **cysteine**
- **ionic bonds**: relatively strong bonds between charged R groups (pH changes cause these bonds to break)
- **hydrogen bonds**: numerous & easily broken

Define ‘quaternary structure’ of a protein.

Define ‘quaternary structure’ of a protein.

- Two or more polypeptide chains
- May involve addition of prosthetic groups e.g. metal ions or phosphate groups

Describe the molecular structure and function of globular proteins.

Describe the molecular structure and function of globular proteins.

- spherical & compact
- hydrophilic R groups face outwards & hydrophobic R groups face inwards = usually water-soluble
- involved in metabolic processes e.g. enzymes such as amylase, insulin (2 polypeptide chains linked by 2 disulfide bonds), haemoglobin

Describe the structure of haemoglobin.

Describe the structure of haemoglobin.

- globular conjugated protein with prosthetic group
- 2 α-chains, 2 β-chains, 4 prosthetic haem groups
- water-soluble so dissolves in plasma
- Fe^{2+} haem group forms coordinate bond with O_2
- tertiary structure changes so it is easier for subsequent O_2 molecules to bind (cooperative binding)

What are enzymes?

What are enzymes?

Proteins that act as **biological catalysts** for intra & extracellular reactions.

Specific tertiary structure determines shape of **active site**, which is complementary to a **specific substrate**.

Formation of **enzyme-substrate complexes** (**ESCs**) lowers **activation energy** of metabolic reactions.

Name 5 factors that affect the rate of enzyme-controlled reactions.

Name 5 factors that affect the rate of enzyme-controlled reactions.

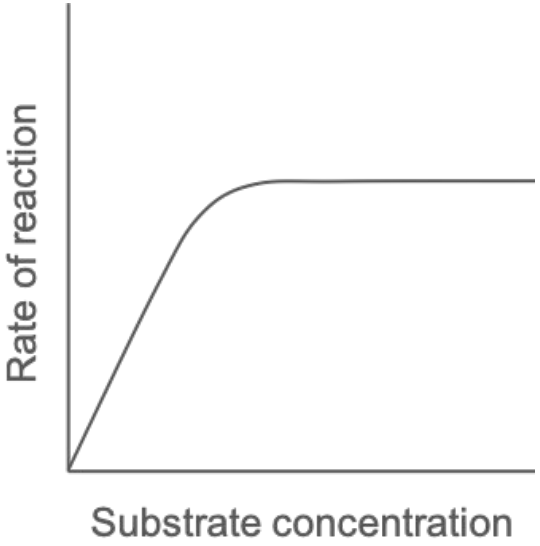
- enzyme concentration
- substrate concentration
- concentration of inhibitors
- pH
- temperature

How does substrate concentration affect rate of reaction?

How does substrate concentration affect rate of reaction?

Given that enzyme concentration is fixed, rate increases proportionally to substrate concentration.

Rate levels off when maximum number of ESCs form at any given time.

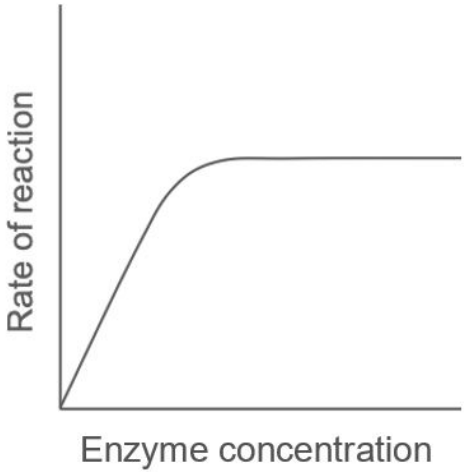


How does enzyme concentration affect rate of reaction?

How does enzyme concentration affect rate of reaction?

Given that substrate is in excess, rate increases proportionally to enzyme concentration

Rate levels off when maximum numbe of ESCs form at any given time.

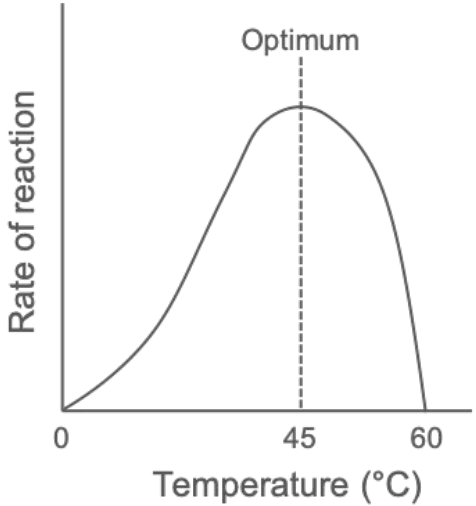


How does temperature affect the rate of enzyme-controlled reactions?

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

Rate increases as kinetic energy increases & peaks at optimum temperature.

Above optimum, ionic & H-bonds in tertiary structure break. Active site no longer complementary to substrate (denaturation).



How can the rate of reaction be investigated?

How can the rate of reaction be investigated?

Measure the amount of reactant or product as the reaction proceeds e.g. use colorimetry for concentration or gas syringe for volume of gas.

Plot a graph. For initial rate, calculate the gradient of the tangent at t = 0 (change in concentration of product or reactant ÷ time).

How does blood clotting occur?

How does blood clotting occur?

1. Collagen fibres in damaged blood vessels exposed
2. Activated platelets (with help of Ca^{2+}) stick together & form plug
3. White blood cells collect at site of damage
4. Tissue below endothelium secretes enzyme thromboplastin
5. Thromboplastin causes prothrombin to change to its active form, thrombin
6. Thrombin (with help of Ca^{2+}) hydrolyses soluble fibrinogen into insoluble fibrin
7. Fibrin fibres form a mesh that traps blood cells.

Describe the first aid procedure to prevent excessive blood loss.

Describe the first aid procedure to prevent excessive blood loss.

Check for embedded object. Do not remove any object present.

Apply direct pressure to open wounds to stem blood flow.

Apply external clotting agents.

Give 2 examples to show how enzymes can be used in diagnosis.

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Lactate dehydrogenase (LDH) catalyses conversion of lactate to pyruvate after anaerobic respiration. High levels of LDH can indicate tissue damage.

Amylase hydrolyses starch to maltose. High blood amylase levels can indicate pancreatic disease.

Name 3 enzymes or inhibitors that can act as anticoagulants.

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- streptokinase (enzyme from bacteria)
- aspirin (synthetic derivative of a naturally-occurring inhibitor)
- warfarin (synthetic inhibitor)

How can the enzyme streptokinase be used in medical treatment?

How can the enzyme streptokinase be used in medical treatment?

Converts plasminogen into its active form, the protease enzyme plasmin. Plasmin hydrolyses the fibrin mesh that forms blood clots.

Can be administered intravenously as an anticoagulant e.g. to treat thrombosis.

How does aspirin work?

How does aspirin work?

Permanent competitive inhibitor binds covalently to COX-1 & COX-2 enzymes. Prevents production of prostaglandins (pain signallers). Can relieve pain.

Prevents platelets from sticking together to form a plug, so reduces blood clotting. Can reduce risk of heart attack or stroke.

How does warfarin work?

How does warfarin work?

Inhibits epoxide reductase, leading to a reduction in vitamin K and vitamin K hydroquinone.

Glutamyl carboxyl inhibited, preventing the production of prothrombin.

Prevents blood from clotting.

What are blood groups? Outline the different blood groups.

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Classification based on surface antigens on red blood cells & presence of certain antigens in the plasma.

- **group A** : A antigens, anti-B antibodies
- **group B**: B antigens, anti-A antibodies
- **group O**: no antigens, both anti-A & anti-B antibodies
- **group AB**: both A & B antigens, no antibodies

If RhD antigen is also present, blood group is RhD+. If not, blood group is RhD-.

Outline the types and uses of stored blood products.

Outline the types and uses of stored blood products.

- **Whole blood**: for severe bleeding
- **Leucodepleted blood** (few white blood cells): for immunodeficient patients
- **Packed red cells** (high haemoglobin, little plasma): for anaemia
- **Platelets**: for thrombocytopenia (low platelet count)
- **Clotting factors**: for haemophilia
- **Plasma**: to replace coagulation factors

Outline the issues surrounding the use of stored blood products.

Outline the issues surrounding the use of stored blood products.

- Blood groups of donor & recipient must be compatible to prevent rejection by the immune system.
- Side effects for donors e.g. dizziness.
- Requires informed consent. Some religious objection.
- Can transmit infections e.g. HIV.
- Separating blood components means one donation can treat several patients.

How is blood for medical treatments collected for storage?

How is blood for medical treatments collected for storage?

Blood donation. Apheresis may be used to separate blood components.