CAIE Biology A-level

Topic 2: Biological Molecules

Flashcards

Outline the Benedict’s test for reducing sugars

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1. Add an equal volume of Benedict's reagent to the sample to be test.
2. Heat the mixture in a water bath at 100°C for 5 minutes.
3. Positive result: colour change from blue to green to yellow to orange to brick-red. Precipitate forms.

Outline the Benedict's test for non-reducing sugars

Outline the Benedict's test for non-reducing sugars

1. Reducing sugar test, negative result, reagent remains blue.
2. **Hydrolyse** non-reducing sugars (e.g. sucrose) into their monomers by adding an equal volume of HCl.
3. Heat in a boiling water bath for 5 minutes.
4. Neutralise the mixture using sodium hydrogen carbonate solution.
5. Proceed with the Benedict's test as usual.

How can the Benedict's test be made more quantitative?

How can the Benedict's test be made more quantitative?

Either:

Measure the time from immersing solution in water bath till the first colour change is produced

Or:

Create standard solutions of known concentrations, and compare colour change to estimate concentration

Outline the Biuret test for proteins

Outline the Biuret test for proteins

1. Add an equal volume of **sodium hydroxide** to a sample at room temperature.

2. Add a few drops of **dilute copper (II) sulfate solution**. Swirl to mix. (steps 1 & 2 make the Biuret reagent)

3. **Positive result:** colour change from pale blue to purple .
   Negative result: solution remains blue.

Describe how to test for and measure the presence of starch in a sample

Describe how to test for and measure the presence of starch in a sample

1. Add iodine solution.

1. Positive result: colour changes from yellow-brown to blue-black.

Describe the emulsion test for fats and oils

Describe the emulsion test for fats and oils.

- Add ethanol to the sample and shake
- Allow the mixture to settle
- Add an equal volume of water
- Record any observations

Describe the positive result of an emulsion test

Describe the positive result of an emulsion test

White, cloudy emulsion forms.

Define ‘monomer’

Define ‘monomer’

A single subunit that is used to build larger polymers.

Define ‘polymer’

Define 'polymer'

A large molecule comprising of repeating subunits (monomers), often joined by condensation.

Define ‘macromolecule’

Define ‘macromolecule’

A large biological molecule.

Define ‘monosaccharide’, ‘disaccharide’, ‘polysaccharide’

Define 1. monosaccharide, 2. disaccharide, 3. polysaccharide

1. A single unit of carbohydrate
2. 2 units of carbohydrate joined by condensation, held by a glycosidic bond
3. A polymer with monomers of monosaccharides joined together by condensation, held by glycosidic bonds

Draw & describe the structure of α and β glucose

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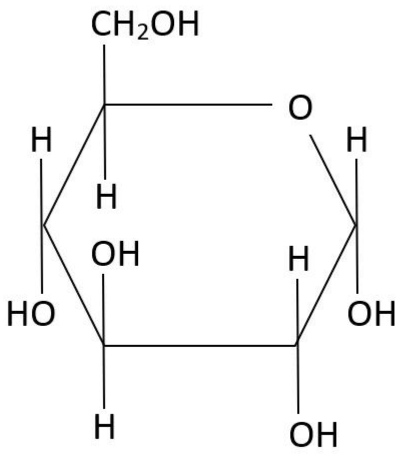
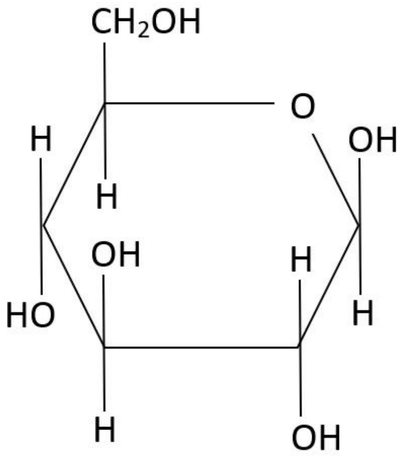


α glucose



□ glucose

Both are hexose monosaccharides (6C) with a ring structure

What is the difference between α and β glucose?

What is the difference between α and β glucose?

The OH group on carbon 1 for alpha glucose is below the plane, while that for beta glucose is above the plane

What happens in condensation reactions- with reference to glycosidic bonds & the type of bond ?

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What happens in condensation reactions- with reference to glycosidic bonds & the type of bond ?

A chemical bond forms between two molecules and a molecule of water is produced. H is removed from one molecule- OH from another.

When this occurs between carbohydrates- it is referred to as a glycosidic bond- this is a type of covalent bond.

What is meant by the terms reducing & non reducing sugars?

What is meant by the terms reducing & non reducing sugars?

Reducing sugar- is able to reduce other sugars to form di or polysaccharides due to free groups which can be condensed. All monosaccharides are reducing sugars.

Non reducing- Do not possess a condensable free group ∴ cannot reduce other sugars

State whether the following are reducing or non reducing sugars- glucose, fructose, maltose, sucrose

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Reducing:

Glucose, Fructose, Maltose

Non reducing:

Sucrose

State how sucrose is formed via the formation of a glycosidic bond

State how sucrose is formed via the formation of a glycosidic bond.

α glucose + □ fructose form sucrose via the omission of H_2O (condensation reaction) forming a glycosidic bond between them

How are glycosidic bonds broken? What is this known as?

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How are glycosidic bonds broken? What is this known as?

Water is used to break the glycosidic bond. This is known as a **hydrolysis** reaction- consider the meaning behind the term “**hydrolysis**”.

Link- we added HCl to test for non-reducing sugars to hydrolyse their poly- or di-saccharides.

Describe the structures of amylose & amylopectin

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Describe the structures of amylose & amylopectin

- Amylose: 1,4-glycosidic bonds, unbranched helical
- Amylopectin: 1-4 & 1,6-glycosidic bonds, branched

How do the structures of amylose & amylopectin relate to their function?

How do the structures of amylose & amylopectin relate to their function?

Amylose & amylopectin (starch) act as a storage polymer of α-glucose in plant cells:

- insoluble = no osmotic effect on cells
- large = does not diffuse out of cells

Amylose:

- 1,4 glycosidic bonds
- Unbranched helix= compact

Amylopectin:

- 1,4 & 1,6 glycosidic bonds
- branched = many terminal ends for rapid hydrolysis into glucose

Describe the structure and functions of glycogen

Describe the structure and functions of glycogen

Main storage polymer of α-glucose in animal cells (but also found in plant cells):

- 1,4 & 1,6 glycosidic bonds.
- Branched (more so than amylopectin) = many terminal ends for hydrolysis.
- Insoluble = no osmotic effect & does not diffuse out of cells.
- Compact.

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Describe the structure and functions of cellulose

Describe the structure and functions of cellulose

Polymer of β-glucose (polysaccharide) gives rigidity to plant cell walls (prevents bursting under turgor pressure, holds stem up).

- 1,4 glycosidic bonds.
- Straight-chain, unbranched molecule.
- Alternate glucose molecules are rotated 180°.
- H-bond crosslinks between parallel strands form microfibrils = high tensile strength.

What is the difference between saturated and unsaturated fats?

What is the difference between saturated and unsaturated fats?

- Saturated fats have no C=C bonds, and are solid at room temperature due to strong intermolecular forces.
- Unsaturated fats have one or more C=C bonds, and are liquid at room temperature due to weak intermolecular forces.

Describe the structure of a triglyceride, with reference to how it is formed

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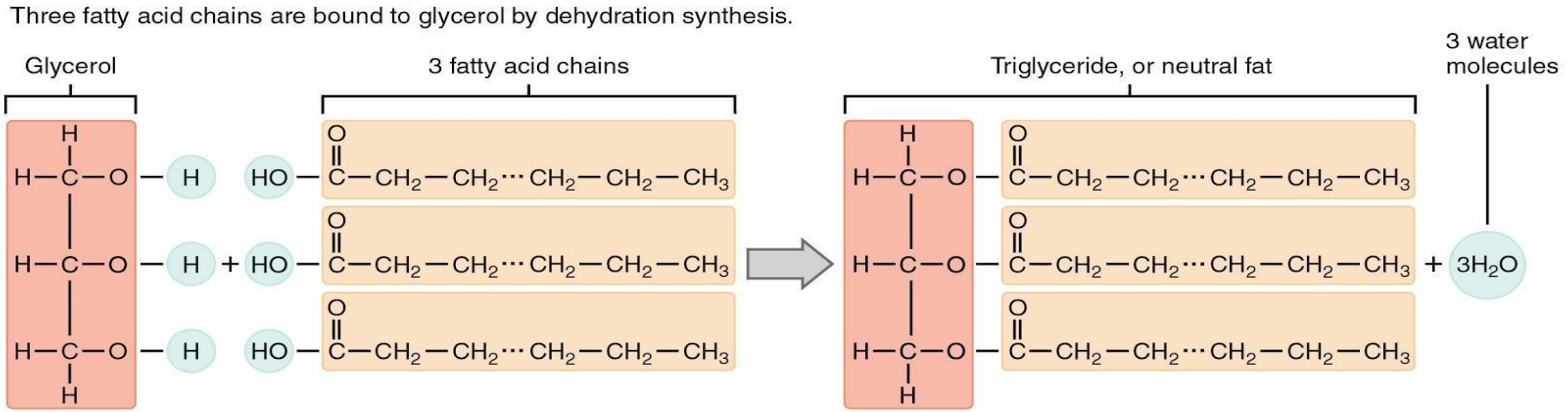
One molecule of glycerol forms ester bonds with three fatty acids- these can be saturated or unsaturated- via condensation reactions.



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Relate the structure of triglycerides to their functions

Relate the structure of triglycerides to their functions

- High energy-to-mass ratio - **energy storage**.
- Insoluble hydrocarbon chain - no effect on water potential of cells, used for **waterproofing.**
- Slow conductor of heat - **thermal insulation.**
- Less dense than water - **buoyancy** of aquatic animals.
- Protects organs- high melting point- very stable molecule resistant to large amounts of force

Describe the structure and function of phospholipids

Describe the structure and function of phospholipids

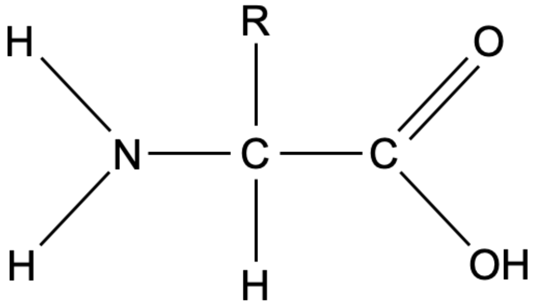
Polar molecule: **glycerol** backbone attached to **2 hydrophobic fatty acid** tails and **1 hydrophilic polar phosphate** head.

- Forms phospholipid **bilayer** in water - component of membranes- the hydrophobic the tails allow for control of movement of water soluble molecules in and out of cells

Describe the common structure of an amino acid

Describe is the common structure of an amino acid

- Amine group ($-NH_2$)
- Variable side chain (R)
- Carboxyl group (-COOH)
- H atom



How are peptide bonds formed?

How are peptide bonds formed?

The OH is lost from the carboxyl group, and an H from the amine group (condensation), forming a peptide bond (-CONH-).

Describe and name the process by which peptide bonds are broken

Describe and name the process by which peptide bonds are broken

H_2O is split to H + OH, OH returns to the carboxyl group, H to the amine- this is a **hydrolysis** reaction.

What is the primary structure of a protein?

What is the primary structure of a protein?

A sequence of amino acids in a polypeptide, held by peptide bonds.

What is secondary structure?

What is secondary structure?

The regular folding of a polypeptide into alpha helices and beta pleated sheets, held by hydrogen bonds

What is tertiary structure?

What is tertiary structure?

The further coiling of a protein into its functional 3D shape. Held by hydrogen, ionic, and disulphide bonds, and hydrophobic interactions

What is quaternary structure?

What is quaternary structure?

The folding of 2 or more polypeptides into a 3D shape, which may include prosthetic (non-protein) groups. Held by hydrogen, ionic, and disulphide bonds, and hydrophobic interactions.

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).

State the main differences between globular and fibrous proteins

State the main differences between globular and fibrous proteins

Globular proteins are soluble & involved in physiological processes e.g. haemoglobin.

Fibrous proteins are insoluble & have a structural role e.g. collagen.

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State the features of a globular protein, with reference to haemoglobin

State the features of a globular protein, with reference to haemoglobin.

- Spherical & compact.
- Hydrophilic R groups face outwards & hydrophobic R groups face inwards = usually water-soluble.
- Involved primarily in physiological roles e.g. metabolic processes e.g. enzymes such as amylase, insulin (2 polypeptide chains linked by 2 disulfide bonds), haemoglobin.
- Compact nature means haemoglobin can transport more oxygen per unit of blood.

Describe the structure of collagen

Describe the structure of collagen

Fibrous protein: insoluble, long strands with high tensile strength.

Made up of 3 polypeptide chains coiled to form a triple helix.

Every third amino acid is glycine (the smallest amino acid).

Collagen molecules lie parallel to form collagen strands, held by staggered covalent cross bridges between lysine residues.

How does hydrogen bonding occur in water?

How does hydrogen bonding occur in water?

The δ+ hydrogen on one water molecule is attracted to the lone pair of the δ- oxygen on another water molecule.

What are the properties of water due to hydrogen bonding?

What are the properties of water due to hydrogen bonding?

High surface tension .

Acts as a solvent for water soluble molecules so can act as a transport medium.

High specific heat capacity.

High latent heat of vaporisation.

Higher boiling point than expected (liquid at room temperature).

Ice is less dense than liquid water.