KNOWLEDGE

Chemistry Topic 11 Polymers (triple)

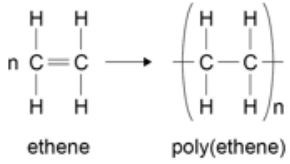
ORGANISER

Section 1: Key terms

Polymer	**Very large covalently bonded** molecules with **many repeating units** (poly means many).
Monomer	**Small reactive molecules** which join together to make a polymer (mono means one).
Plastics	Made of very large covalently bonded molecules called polymers
Addition polymerisation	The reaction between **alkene monomers** to form a polymer
Condensation polymerisation	Usually involves a **small molecule released** in the reaction (like **water or HCl**), as the polymer forms.
Monosaccharide	Simple **carbohydrates** made from **one sugar unit** e.g. glucose.
Polysaccharide	A polymer made from monosaccharide monomers e.g. starch or cellulose).
Protein	Polymers of **amino acids**
DNA	**D**eoxyribo**n**ucleic **a**cid is made up from monomers called **nucleotides**
Nucleotides	**Monomers** used to make DNA. There are four different types that can react to form DNA polymers.

Section 2: Addition polymerisation

One of the most important ways that chemicals from crude oil are used is to make polymers. Alkenes can be used to make polymers such as poly(ethene) and poly(propene) by addition polymerisation.



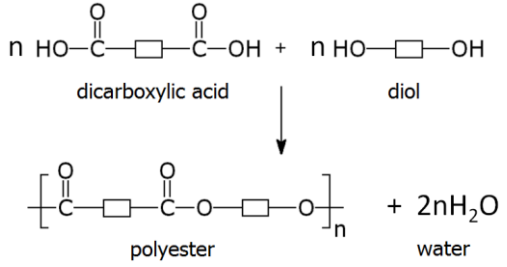
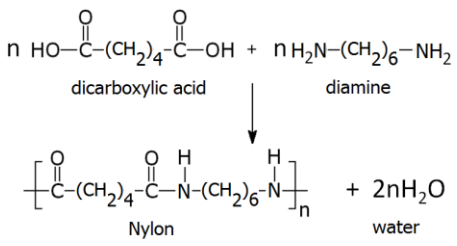
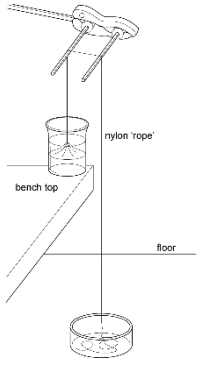
In addition polymers the repeating unit has the **same atoms as the monomer** because when the C=C bond "**opens up**" in polymerisation, **no other molecule** is formed in the reaction.

Uses	**Polyethene** is very useful as it is strong, transparent and easily shaped. Used to make drinks bottles, washing up bowls, dustbins and cling film. **Polypropene** forms a very strong tough plastic. Used to make carpets, milk crates and ropes.

Section 3: Condensation polymerisation (HT)

As well as addition polymerisation (which requires monomers with a C=C), chemists can also make polymers from another type of reaction called **condensation polymerisation**.

Condensation polymerisation involves monomers with **two functional groups**. When these types of monomers join together, they usually lose small molecules such as water or HCl, and so the reactions are called condensation reactions. Two products are usually formed.

Examples	Polyester (used to make clothing) and nylon (used to make rope and stockings).
Forming a polyester	Requires an **diol (dialcohol)** monomer and a **dicarboxylic acid** monomer. 
Forming nylon	Requires a **diamine** monomer and a **dicarboxylic** acid monomer.   Nylon thread can be made using the apparatus shown in the diagram

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Section 4: Natural polymers

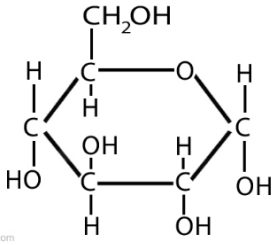
Naturally occurring polymers are found in all living things (e.g. polymers that make up starch, cellulose, proteins and DNA. They are formed during **condensation polymerisation** reactions.

Section 4a: Making polysaccharides from sugars

Simple carbohydrates (monosaccharides) are compounds containing carbon, hydrogen and oxygen e.g. glucose $C_6H_{12}O_6$

Monosaccharides can bond together to make polymers (polysaccharides). **Starch and cellulose are polysaccharides** made from **glucose** monomers. Plants use the starch they make from glucose as energy stores.

Glucose monomers → Starch polymer + water

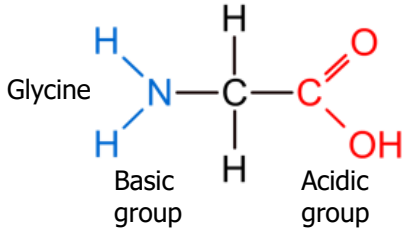


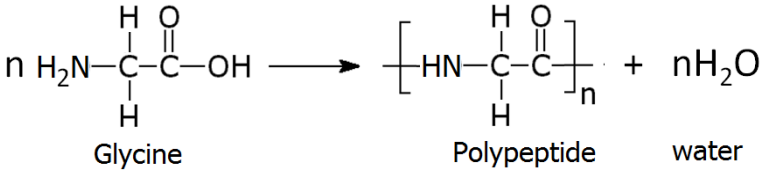
Glucose

Section 4b: Making polypeptides and proteins from amino acids. (HT)

The monomers of proteins are called **amino acids**. Amino acids have **two functional groups**, one basic (the amine group – NH_2) and one acidic (carboxylic acid group -COOH). The simplest amino acid is glycine.

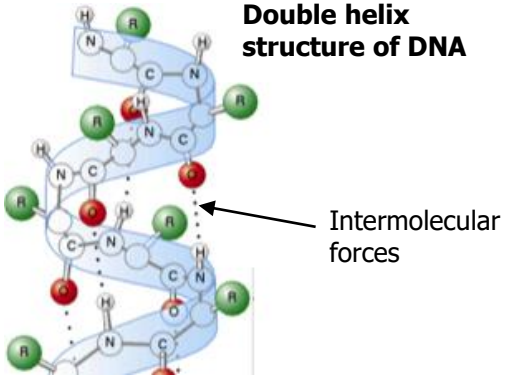
Many more glycine monomers can link together form a polypeptide molecule. There are about 20 amino acids that join together in a variety of sequences that make up more than 1000 proteins in your body.





Section 5: DNA

DNA (**d**eoxyribo**n**ucleic **a**cid) is a natural polymer **essential for life** because it enables living things to develop and function. It is made up from monomers called **nucleotides**. DNA's structure contains a **genetic code** that determines the different **amino acid sequences** of every protein in living organisms and viruses.

Nucleotide	Based on the sugar **deoxyribose**, bonded to a phosphate group and a base.
How is DNA made	By the condensation polymerisation of repeating units of nucleotide monomers. DNA is a **polynucleotide**.
Structure of DNA	Most DNA molecules are **two polymer chains**, made from **four different nucleotide** monomers, in the form of a **double helix**. The two polymer strands run in opposite directions to each other and are held in place by the **intermolecular forces** down the length of each polymer strand. **Double helix structure of DNA**  There are **four different nucleotide** monomers that can react to form DNA polymers.