Chapter 11: Polymers

Knowledge organiser

Polymers

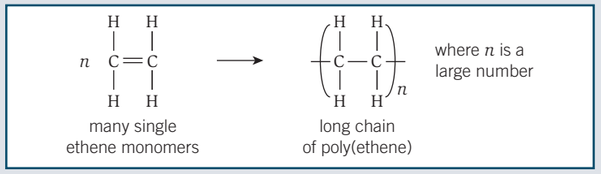
Polymers are very long molecules made up of lots of smaller molecules joined together in a repeating pattern. The smaller molecules are called **monomers**. The process of turning many monomers into a polymer is called polymerisation.

There are two main types of polymerisation.

Type of polymerisation	Monomers	Products of polymerisation
addition polymerisation	molecules with C=C bonds, such as alkenes	just the polymer
condensation polymerisation	diols, dicarboxylic acids, or diamines	polymer and water

Addition polymerisation

Addition polymerisation starts with molecules with a C=C bond (e.g., alkenes) as the monomer. The carbon-carbon double bond breaks in each molecule, and the carbon atoms then link together.



The n refers to a large number of molecules. The rounded brackets and the bonds sticking out of them represent where the next molecule in the chain goes.

The inside of the brackets is known as the **repeating unit** – the section that repeats over and over again many thousands of times in the polymer.

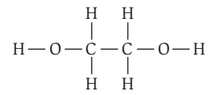
Addition polymers are named after the monomer used to create them.

- An addition polymer made of ethene is called poly(ethene).
- An addition polymer made of propene is called poly(propene).

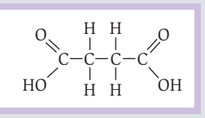
Condensation polymerisation (HT only)

Condensation polymerisation can involve two different monomers, each has *two* functional groups.

Molecule **A** is a diol. It has two –OH groups: one at either end.

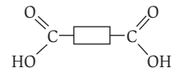


Molecule **B** is a **dicarboxylic acid**. It has a carboxylic acid group at either end.



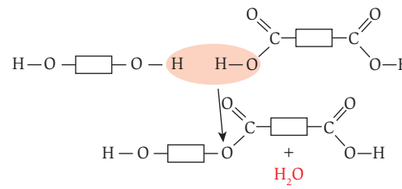
To simplify the diagrams, a rectangle is used to represent  .

Molecule **A**

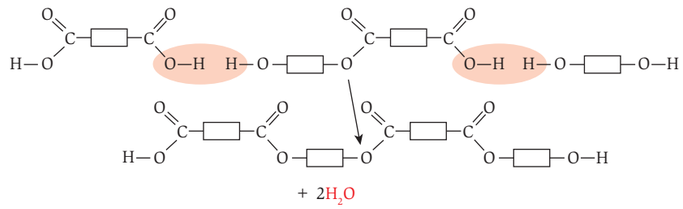


Molecule **B**

When molecule **A** and molecule **B** react together, the –OH group from the carboxylic acid and a hydrogen atom from the –OH group on the alcohol join together to form water.



Another molecule **B** and another molecule **A** can now react with either side of the molecule that has been formed.



You could keep adding more molecules in the pattern ABABABABA. Every time a molecule is added, a water molecule is produced. This type of reaction is called a **condensation reaction**.

If you keep adding molecules, a condensation polymer is produced. This is represented by:

When diols (compounds with two –OH groups) and dicarboxylic acids react together, they form polyesters.

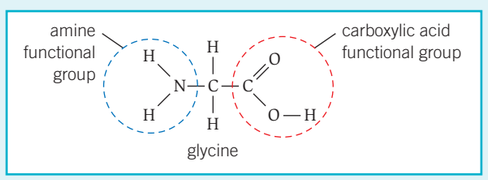
Natural polymers

Amino acids and proteins (HT only)

Condensation reactions can also happen with just one monomer molecule, so long as the molecule has two different functional groups.

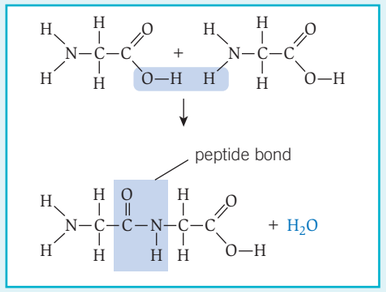
Amino acids have an **amine** functional group and a carboxylic acid functional group. The amine functional group has a nitrogen bonded to a carbon and two hydrogens.

Glycine is the simplest amino acid.



When many molecules of glycine react together they form a **polypeptide**.

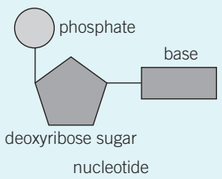
There are many different types of amino acids. They can react together to form many different polypeptides. When lots of polypeptides come together they form something called a **protein**.



DNA

All genetic information is stored in **DNA**. Genetic information contains the instructions for the functioning and development of living organisms.

DNA is made of two long polymers that wind around each other in a double helix. The polymers are made of four different monomers called **nucleotides**.



Starch and cellulose

Starch and cellulose are another two **natural polymers**. Both of these are made from glucose molecules joined together. Whether the resulting polymer is starch or cellulose depends on how the glucose molecules form chains with each other.

Key terms

Make sure you can write a definition for these key terms.

addition polymerisation *amine* *amino acid* *condensation polymerisation* *DNA* *monomer* *natural polymer* *nucleotide* *polymer* *polypeptide* *protein* *repeating unit*

Chapter 11: Polymers

Retrieval questions

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many as you can. Check and repeat.

C11 questions	Answers
1 What are monomers?	small molecules that join together to form a long chain
2 What is a polymer?	a very long molecule made of repeating units
3 What is a repeating unit?	the smallest part of a polymer that repeats itself throughout the chain
4 What is polymerisation?	a reaction that turns multiple monomers into polymers
5 What are the two types of polymerisation?	addition and condensation
6 What kind of monomers are involved in addition polymerisation?	molecules with C=C bonds, such as alkenes
7 What kind of monomers are involved in condensation polymerisation?	monomers with two functional groups
8 What other products are made in condensation polymerisation?	water (normally)
9 What does n represent in an equation showing polymerisation?	a very large number
10 What is a natural polymer?	a polymer that is produced naturally by organisms
11 Give four examples of natural polymers.	polypeptides, starch, cellulose, DNA
12 What are amino acids?	the building blocks for polypeptides and proteins, which have an amine and a carboxylic acid group
13 What is a polypeptide?	a polymer made from many amino acids
14 What is a protein?	a polymer made from amino acids
15 Which monomer makes up starch and cellulose?	glucose
16 What is DNA?	a molecule containing genetic information
17 Which monomers are DNA made of?	nucleotides
18 How is DNA arranged?	double helix

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