Macromolecules

Polymerisation:

Polymerisation is the joining of small molecules (monomers), into chains of a very large molecule (polymer). The monomers can be as atoms, simple molecules of ethen as in poly(ethene), or as in complex molecules such as in proteins and polyamides, or esters.

Monomer:

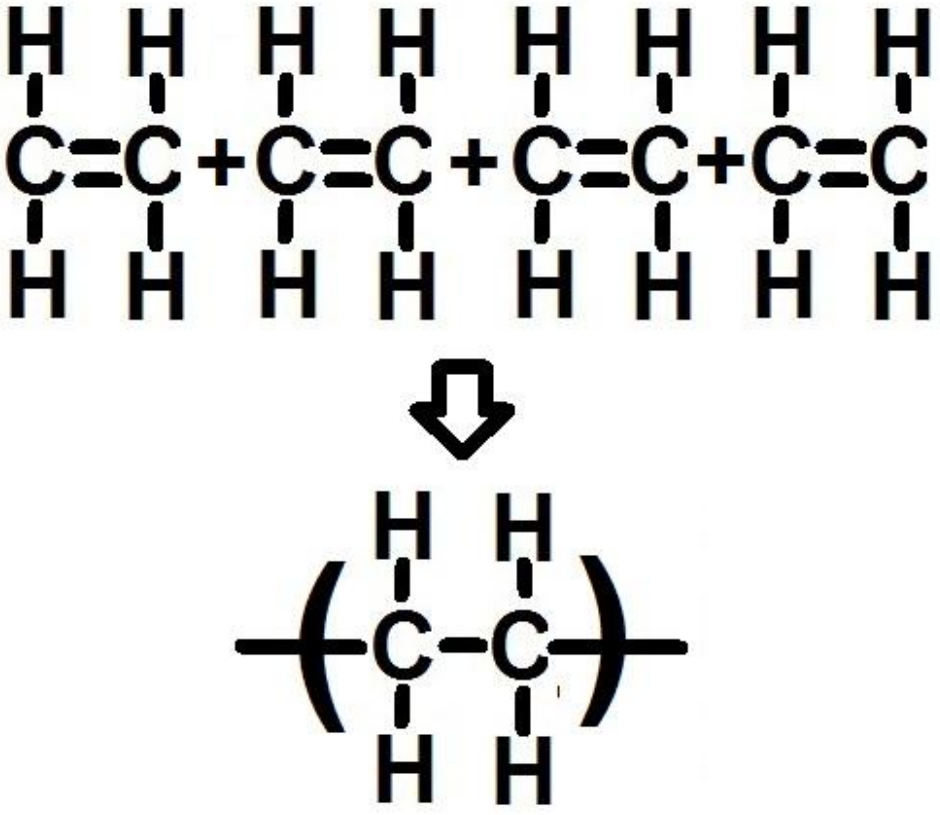
Small molecules that join together to form one large polymer molecules.

Polymer:

A very large molecule made up small repeating units called monomer molecules.

Addition polymerisation:

The chemical reaction in which monomers join together to form a large polymer. This reaction needs a catalyst, high temperature and pressure.



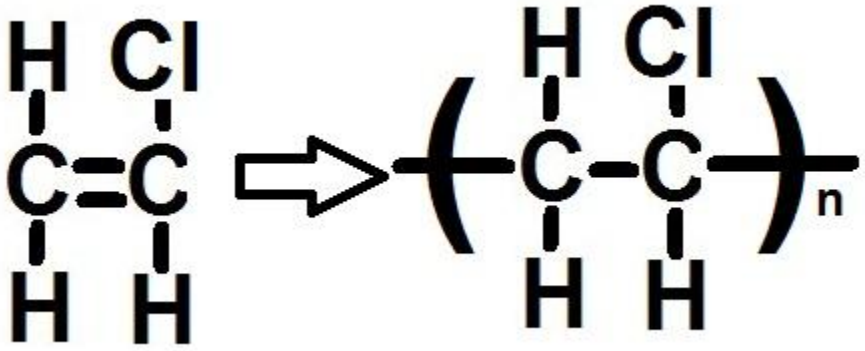
Alkenes can take part in addition polymerisation and the C=C double bond changes into a single bond. Alkene molecules can form a long chain polymer.

Uses of some polymers:

1) Poly (ethene):

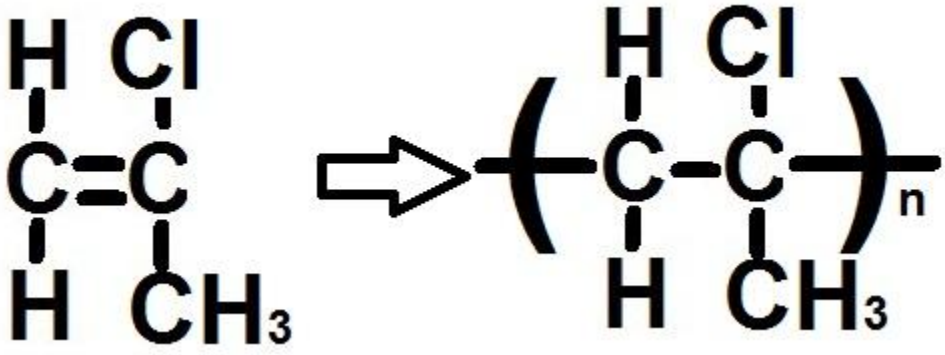
It is used to make balls, buckets, plastic bags and electric insulators.

2) Poly Vinyl Chloride:



Used as an electric insulator for cables and for making pipes and guttering.

3) Poly (propene):



Used to make plastic sheets and electrical insulators.

4) Tetrafluoroethene:

Used to make non-stick pans and acid repellent containers in chemical plants.

Plastics and pollution:

Polymers are non-biodegradable, which means that they do not decay. They are a major source of pollution and fill up all available waste sites. Advantage of recycling is no visual pollution from plastics. Burning them is not a solution to their disposal since poisonous gases are formed.

The best long term solution would be to recycle polymer waste.

Condensation polymerisation:

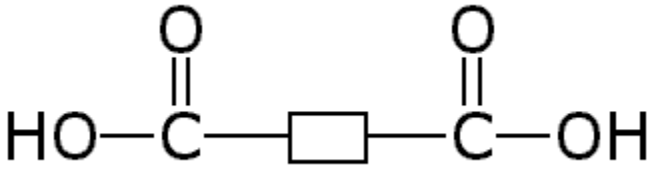
A reaction in which 2 products, the polymer and a small molecule, such as water or HCl, which is eliminated when the monomer units link together.

1) Synthetic macromolecules:

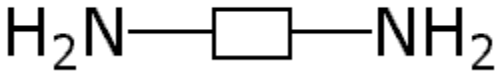
a) Polyamides, e.g. nylon:

Monomers are:

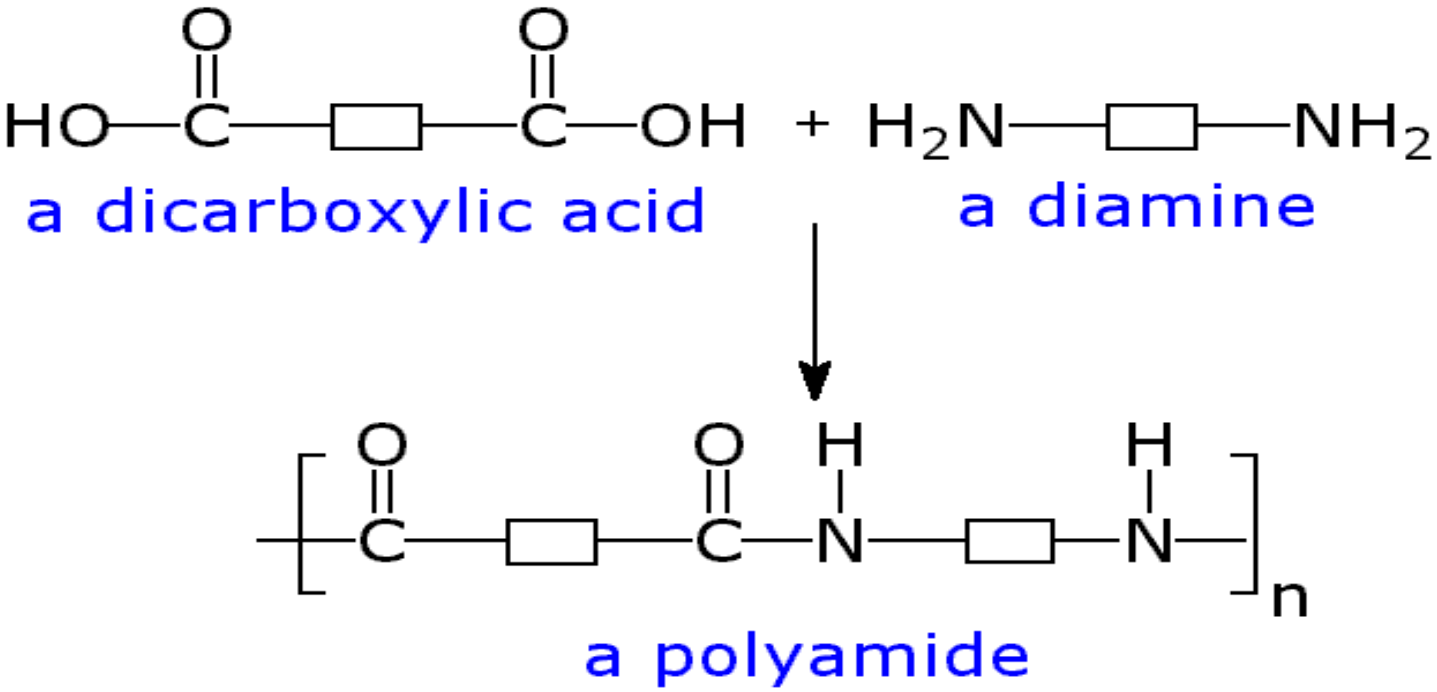
- Dicarboxylic acid



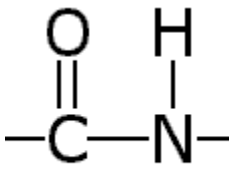
- Diamine



The reaction:



$_{2n}H_2O$ is eliminated when this reaction occurs.



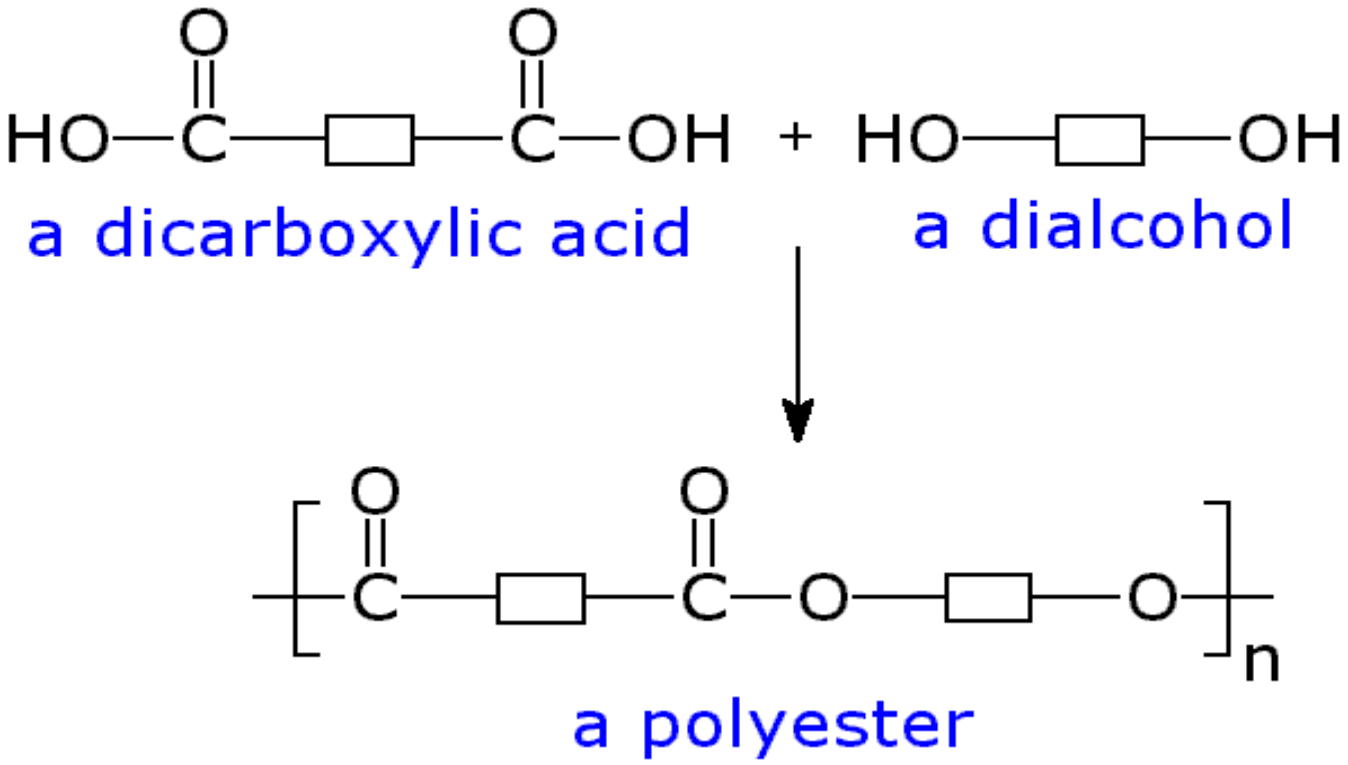
The nylon above contains the amide linkage. This is why the polymer is called a polyamide.

It is used to make clothes and other materials.

b) Polyesters e.g. Terylene:

It is a man made fibre that contains the ester linkage. They are formed when a dicarboxylic acid and a dialcohol combine together by condensation polymerisation.

$_{2n}H_2O$ is eliminated when this reaction occurs.



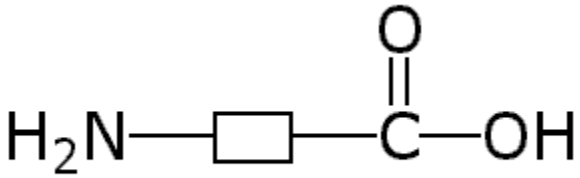
Ester linkage is formed as molecules are held together by the ester group and so it is called polyester.

Terylene is used to make clothes.

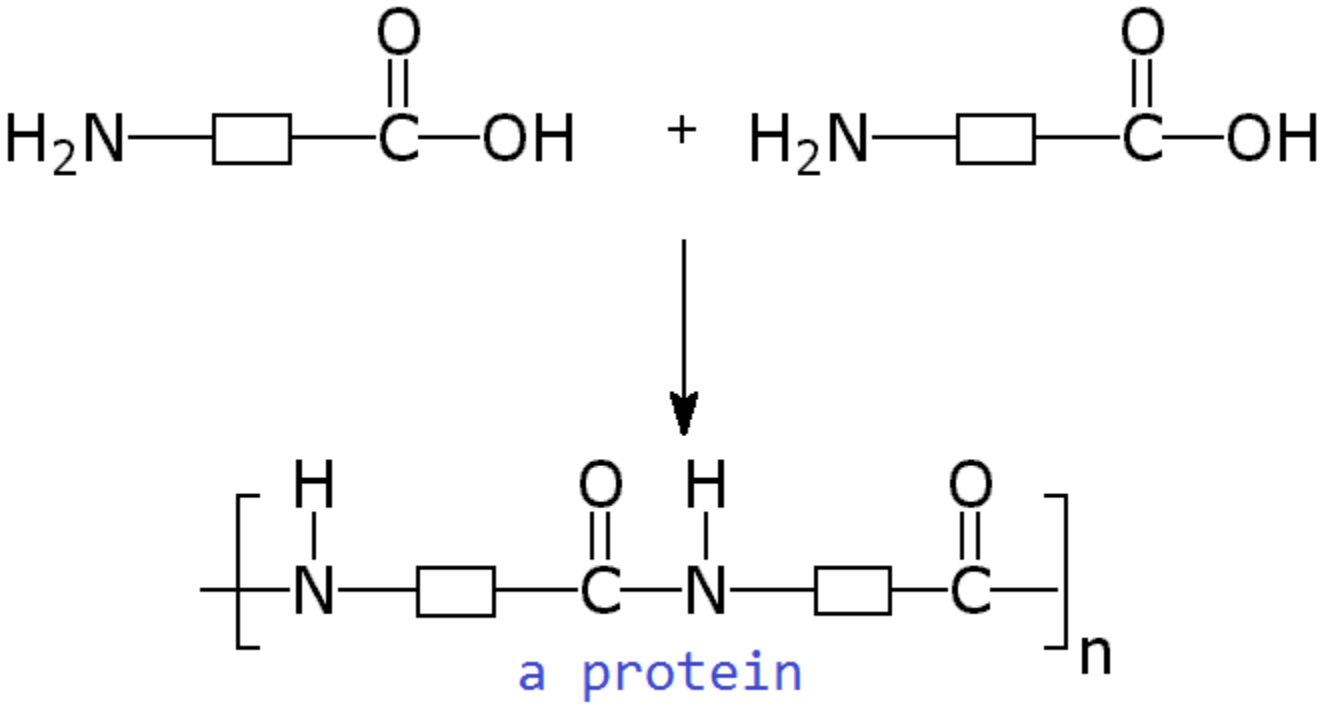
2) Natural macromolecules:

These could be proteins, fats or carbohydrates.

- Proteins
  These have the amide linkage like nylon, as they are also polyamides.
  They are made up of amino acids.



  There are about 20 different amino acids in a protein.
  The reaction:

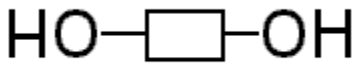


This reaction also eliminates $_{2n}H_2O$.

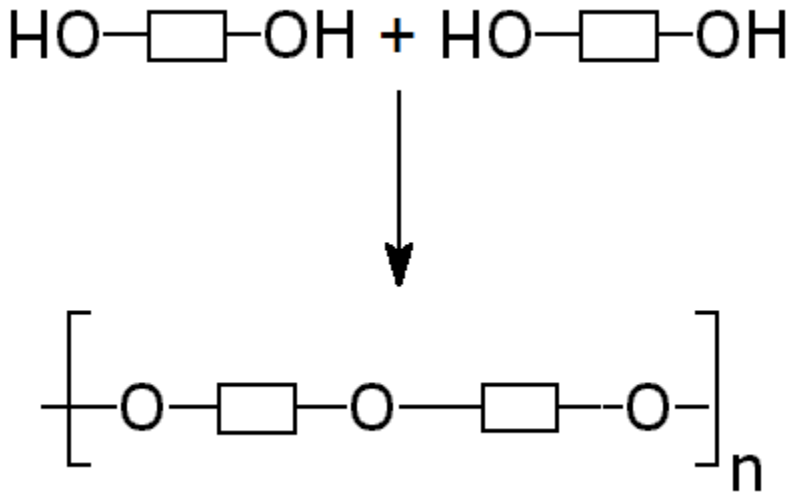
Proteins can also be hydrolysed back into amino acids by heating them with dilute hydrochloric acid.
The products of the hydrolysis of proteins (amino acids) and carbohydrates can be separated and identified by chromatography.
The chromatogram needs to be sprayed with a locating agent so that they can become visible and be compared to other pure samples of the monomer.

- Carbohydrates
  They contain the elements carbon, hydrogen and oxygen. The ratio of hydrogen to oxygen is 2:1 as in water, hence it is a hydrate.

  Glucose and starch are both carbohydrates.
  Glucose when polymerised produce starch.



They can be joined along a chain to form starch which is a polymer and is obtained by condensation polymerisation.

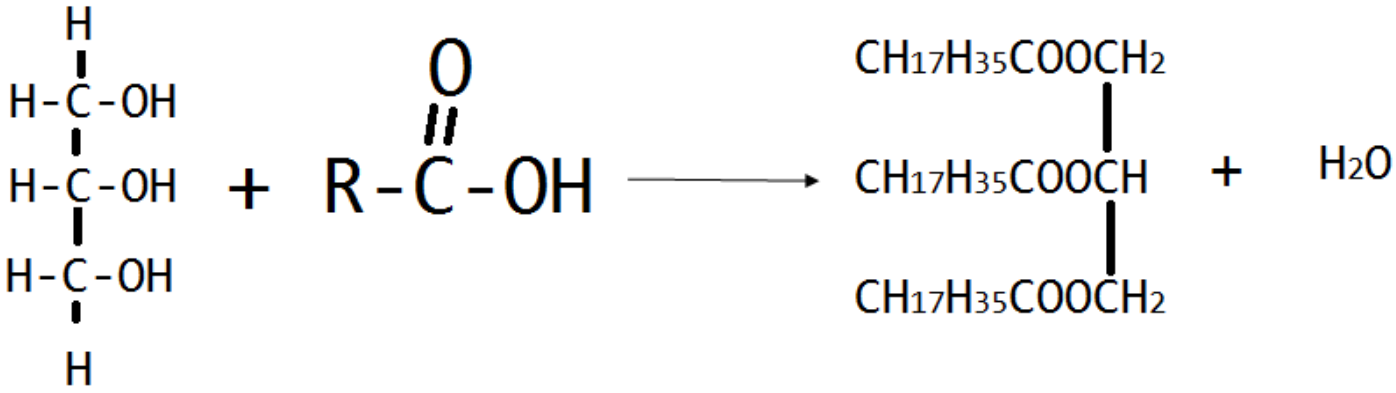


This reaction also eliminates $_{2n}H_2O$.
When complex carbohydrates are heated with dilute HCl, they are hydrolysed back into simple sugars.

Starch + $HCl_{(aq)}$ = Sugar (Glucose)

- Fats

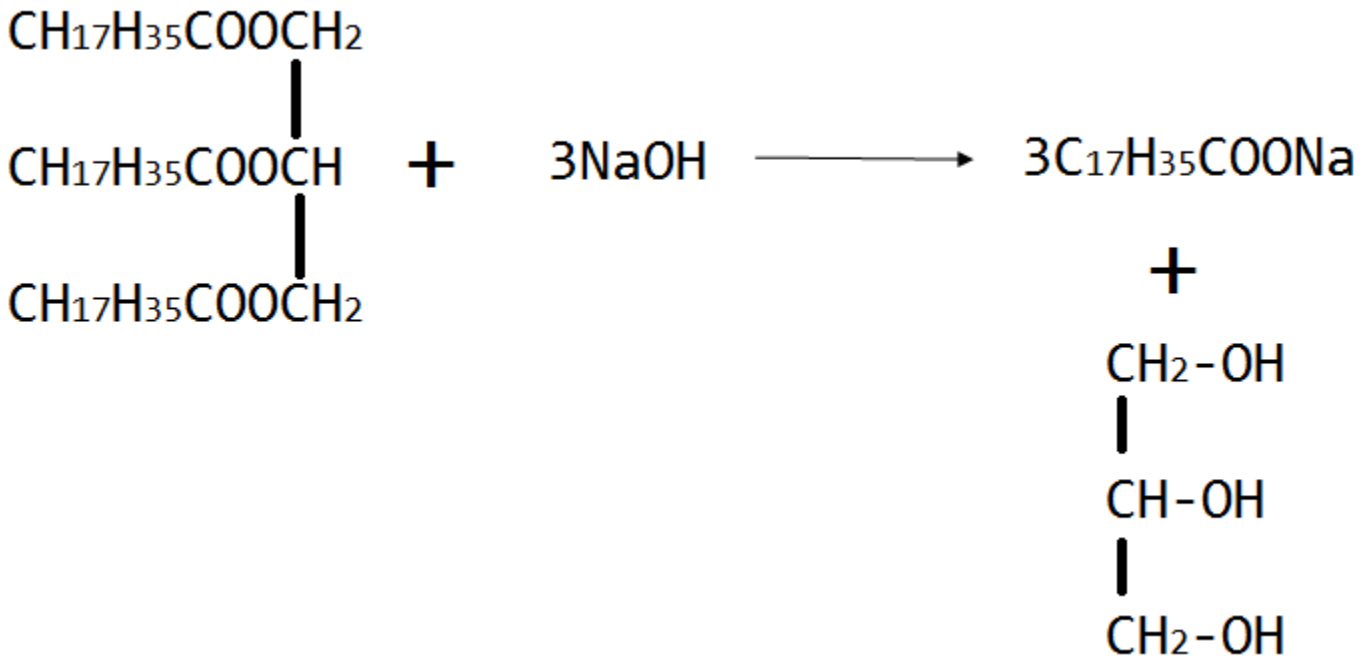
  Both animal and plant fats and oils are esters. A fat is glycerol stearate.



Glycerol + Carboxylic acid = Fats + Water

Fats can also be hydrolysed by heating them with NaOH.

Fat + Sodium Hydroxide = Sodium salt of organic acid + glycerol



Glycerol stearate + NaOH = sodium Stearate + glycerol

This process is called saponification.