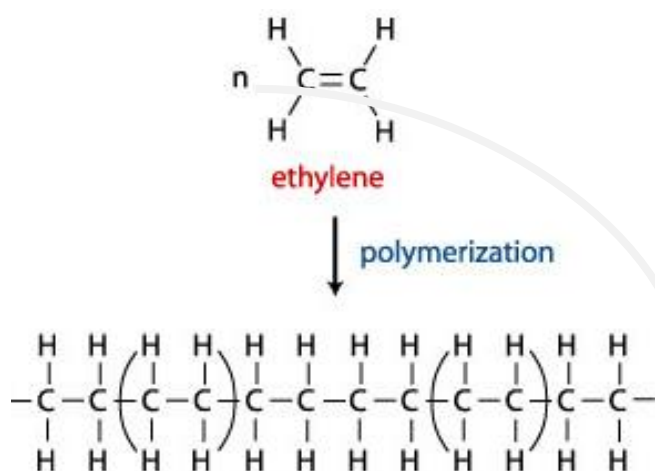


# Polymers

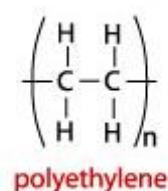
## POLYMERS :

**Definition:** They are substances whose molecules have high molar masses and are composed of a large number of repeating units called monomers.

## Representation of a polymer:



or simply



$n$  tells us that the monomer repeats itself  $n$  times  
&  
the lines cutting the bracket on either side are called as the continuation bonds and tells us that the structure repeats itself at each end.

# Types of polymerisation

## Addition Polymerisation

## Condensation Polymerisation

Poly(tetrafluoroethene)  
or PTFE OR TEFLON

PVC  
Poly(vinylchloride)  
Poly(chloroethene)

Poly(ethene)  
Poly(propene)

Nylon

Poly(ester)

Protein  
s

## Difference between addition polymerisation and condensation polymerisation:

	<b>Addition Polymerisation</b>	<b>Condensation Polymerisation</b>
1.	Addition polymerisation is the joining together of two or more simple molecules, called <u>Monomers</u> , to form a single new compound of the same empirical formula, called a polymer .	It is a process in which the monomer molecules of different compounds combine to form a new compound with the loss of some simple molecules, like water, or HCl.
2.	<b>Examples: Polythene, Polypropylene and Polystyrene are formed through this method of polymerisation</b>	<b>Examples: Polyesters proteins and nylon are formed through this method of polymerisation.</b>

## Condensation polymerisation

It is a process in which a polymer is formed from 2 different kinds of monomers with the elimination of a small molecule such as water or hydrogen chloride.

**Note:**

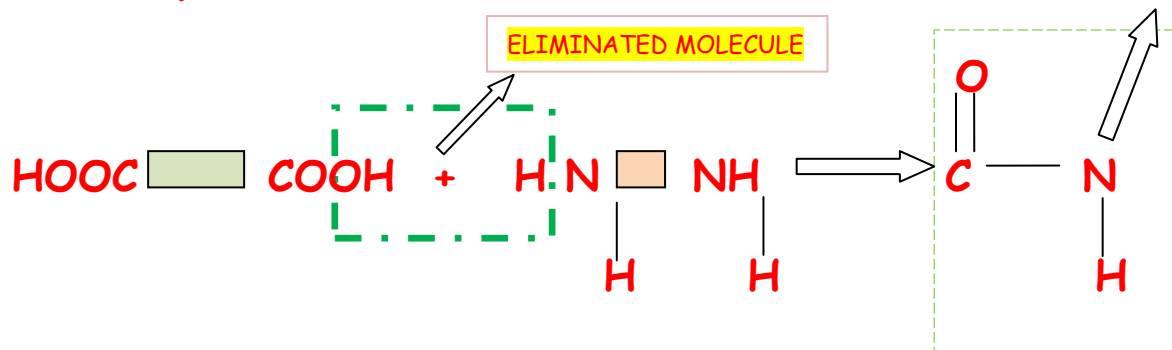
- a)** The monomers for condensation polymerization have two main characteristics:  
Instead of double bonds, these monomers have functional groups (like alcohol, amine, or carboxylic acid groups).
- b)** Each monomer has at least two reactive sites, which usually means two functional groups.

**Proteins, nylons and polyesters are formed by condensation polymerisation**

**(Note: Proteins and nylons are formed by amide linkages & polyesters are formed by ester linkages.)**

## Amide linkage :

Dicarboxylic acid + Diamine  $\longrightarrow$  Amide linkage



MANY SUCH AMIDE LINKAGES FORM A MACROMOLECULE WHICH IS A POLYAMIDE.

Polyamides are polymers where the repeating units are held together by amide links.

An amide *group* has the formula -CONH<sub>2</sub>. An amide *link* has the structure as shown above

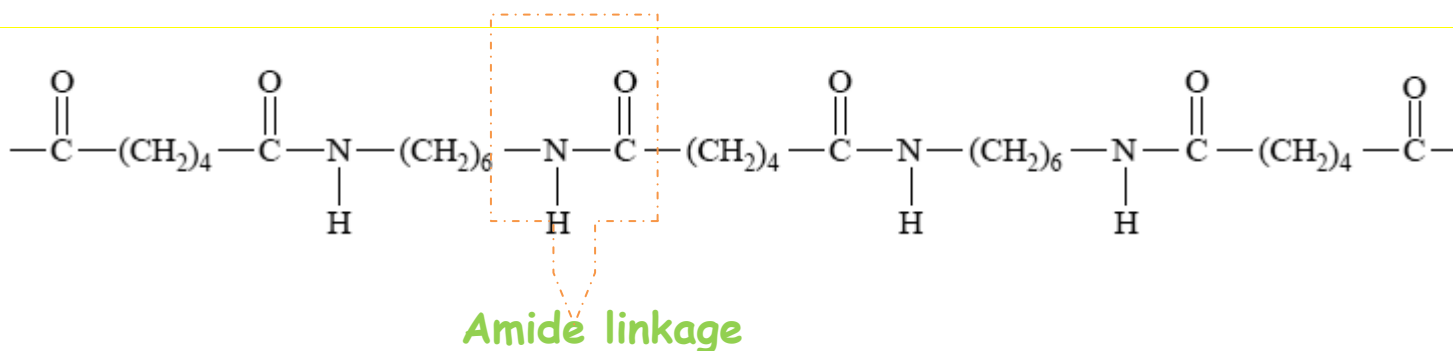
## EXAMPLES OF POLYAMIDES

Proteins and nylons are examples of polyamides

**Nylon:** Nylon is an artificial polyamide made by humans. In nylon, the repeating units contain chains of carbon atoms. There are various different types of nylon depending on the nature of those chains.

a) Nylon is made from two monomers each of which contain 2 monomers.

One of the monomers is a dicarboxylic acid and the other monomer is a diamine. When these two compounds polymerise, the amine and acid groups combine, each time with the loss of a molecule of water. This is known as **condensation polymerisation**.

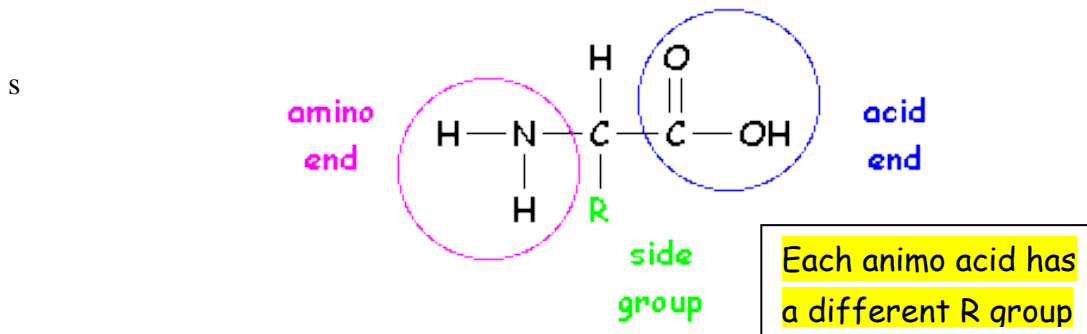


Hence, Nylon is a polyamide made by condensation reaction with the loss of a water molecule

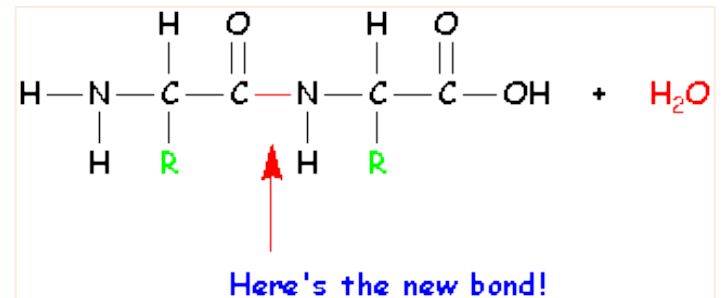
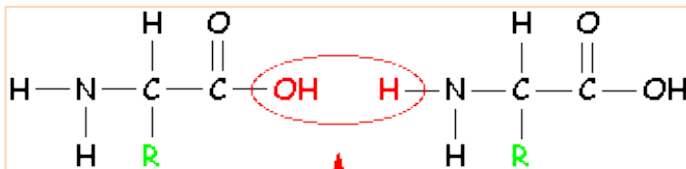
## Proteins:

Proteins are natural polyamides made from amino acids by condensation reactions. This means they are made by animals, plants, bugs, fungi, and other living things - including humans.

Each monomer is an amino acid. The general structure of an amino acid is as shown below.



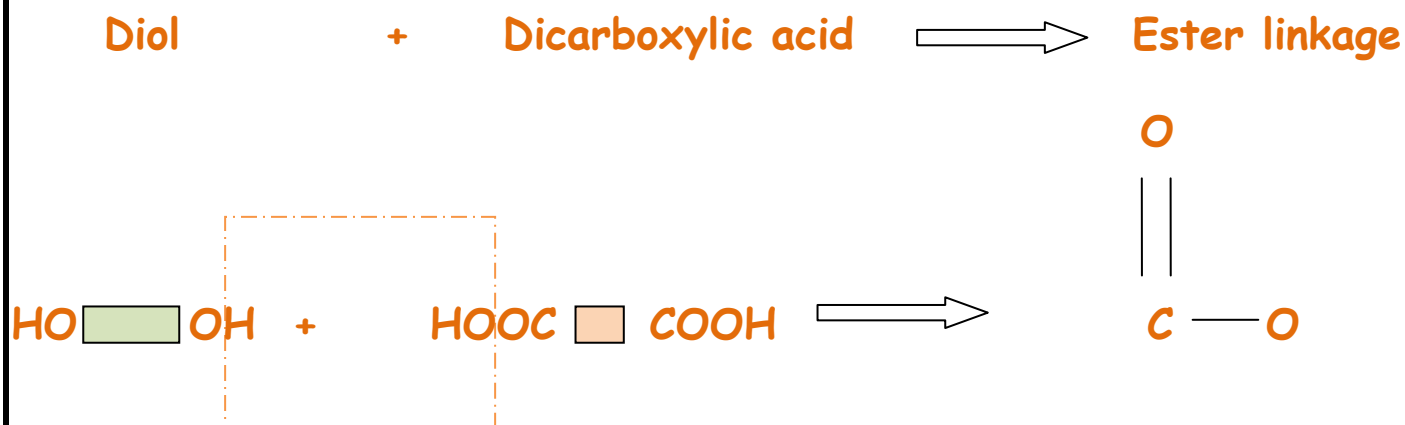
When 2 amino acids react together, an amide linkage is formed with the loss of a water molecule and a new molecule with an amide linkage is formed. as shown below.



Many such amino acids form a polyamide as shown below

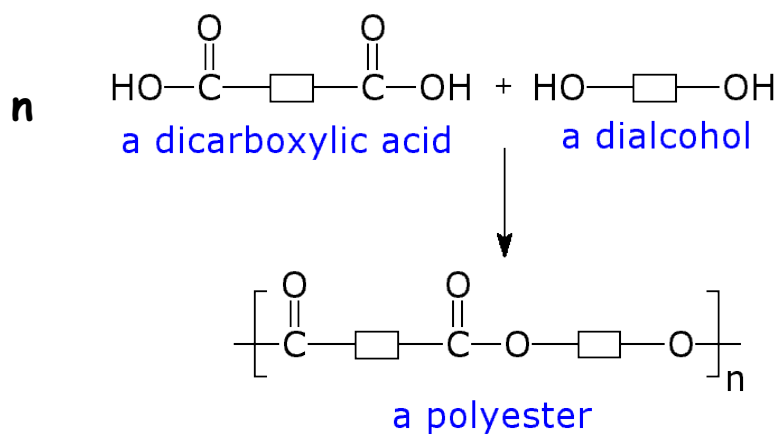
## Poly(ester):

Polyesters are polymers formed by condensation polymerisation, consisting of ester linkages.



MANY SUCH DIOLS AND DICARBOXYLIC ACIDS FORM A MACROMOLECULE CALLED AS A POLYESTER AS SHOWN BELOW.

Terylene is a polyester and has a structural formula as shown below.





## Addition polymerisation

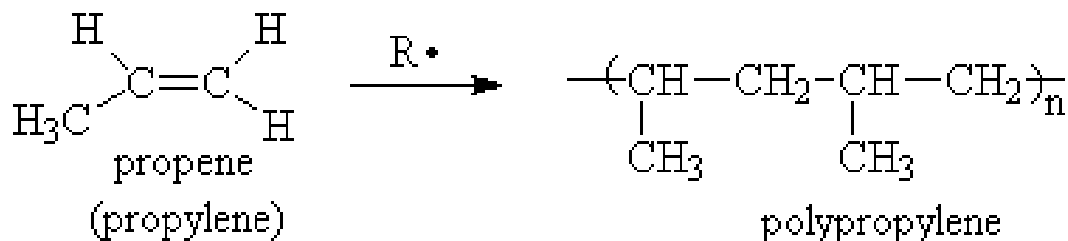
It is a process in which a single product called a polymer is formed from 2 or more unsaturated monomers .

### Note:

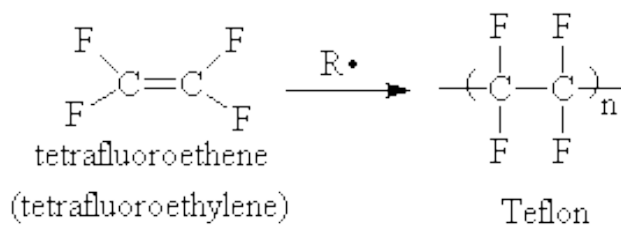
- a) Addition polymerisation is the joining together of two or more simple molecules, called Monomers, to form a new compound of the same empirical formula, called a polymer
- b) The addition polymerisation process can only occur when the monomer molecule is unsaturated (i.e. contain double bonds or triple bonds). Thus, addition polymerisation is characteristic of ethene and the other ethenes. The polymers formed by addition polymerisation are thermoplastics.

## Examples of addition polymers

### Formation of polypropene:



### Formation of teflon:



### Poly(vinylchloride):

