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TOPIC 11.6: MACROMOLECULES

random| plasmid

Chromosomes and plasmids are both DNA molecules. Chromosomes are large, circular DNA molecules that contain the genetic information of a cell. Plasmids are small, circular DNA molecules that can replicate independently of the chromosome. They are often used in genetic engineering to introduce new genes into a cell.

The process of inserting a gene into a plasmid is called transformation. This involves taking a plasmid and a gene from one cell and inserting them into another cell. The gene is then expressed in the new cell, producing the desired protein.

For cells, DNA is organized into long, thin, thread-like structures called chromosomes. These chromosomes are made up of DNA molecules that are tightly packed together. The DNA molecules are made up of a sugar-phosphate backbone and a nitrogenous base pair.

One model of a more complex carbohydrate that includes A, G, C, and T bases, although it is not a DNA molecule, is called a nucleotide. The nucleotide is the basic unit of DNA. It is made up of a sugar, a phosphate group, and a nitrogenous base. The sugar and phosphate group are connected by a phosphodiester bond, and the nitrogenous base is connected to the sugar by a glycosidic bond.

The first published reports of a DNA X-ray diffraction pattern were based on the work of Rosalind Franklin and Maurice Wilkins. They showed that DNA has a helical structure. This was later confirmed by James Watson and Francis Crick, who proposed the double helix model of DNA.

Although the B-DNA form is the most common, there are other forms of DNA. These include the A-DNA form, which is a compact, right-handed helix, and the Z-DNA form, which is a left-handed helix.

In addition to B-DNA, the A-DNA form is a major form of DNA. It is a compact, right-handed helix that is often found in the major groove of the DNA molecule. The A-DNA form is characterized by its compact structure and its ability to form a major groove.

THE ABOUT

CHAPTER ANALYSIS



MASTERY

- Key component of Organic Chemistry
- Commonly tested, especially Section A & B



EXAM

- Know how the **difference** between '**Addition Polymerisation**' & '**Condensation Polymerisation**'
- Know your **ester linkage** & **amide linkage**



WEIGHTAGE

- **Heavy** overall weightage
- Entire Organic Chemistry portion accounts for **15-20%** of each year's Chemistry paper

KEY CONCEPT

MACROMOLECULES

POLYMERISATION

ADDITION POLYMERISATION

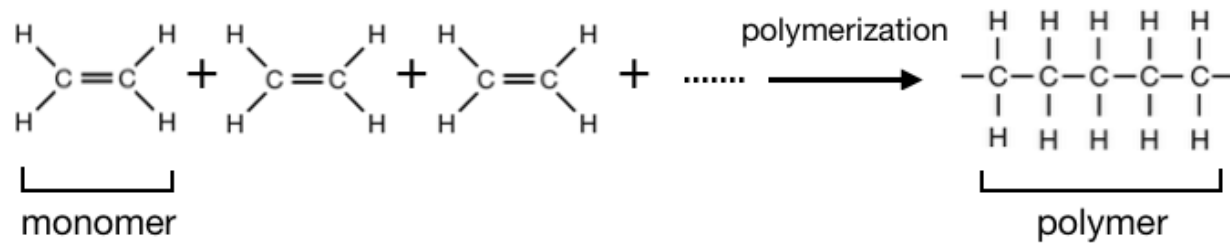
CONDENSATION POLYMERISATION



MACROMOLECULES

A macromolecule is a large molecule that is formed from many smaller molecules.

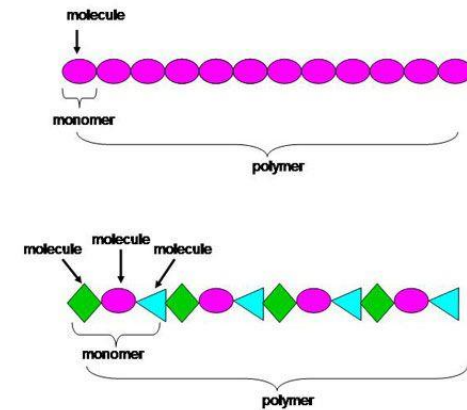
Different macromolecules usually contains different smaller units and linkages.



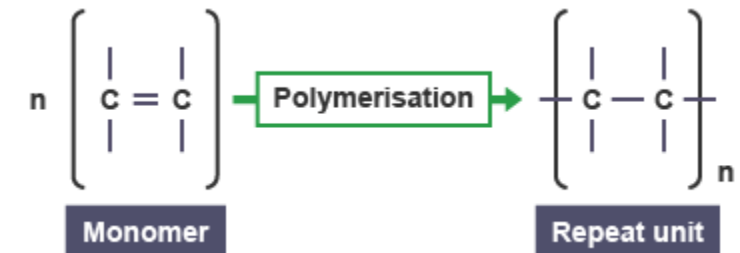
POLYMERISATION

When polymerisation occurs, small molecules known as **monomers** are linked together to form a **long-chain macromolecule known as a polymer**.

Polymerisation is defined as the process where **small molecules (monomers) chemically combined together to form one large chainlike molecule (polymer)**.



The **repeating unit** of a polymer is the smallest portion of the polymer, that when repeated multiple times, would form the entire polymer.



ADDITION POLYMERISATION

ADDITION POLYMERISATION

Addition polymerisation is the process where **small molecules (monomers)** are **linked together to form a polymer** without any other by-products.

APPLICATION

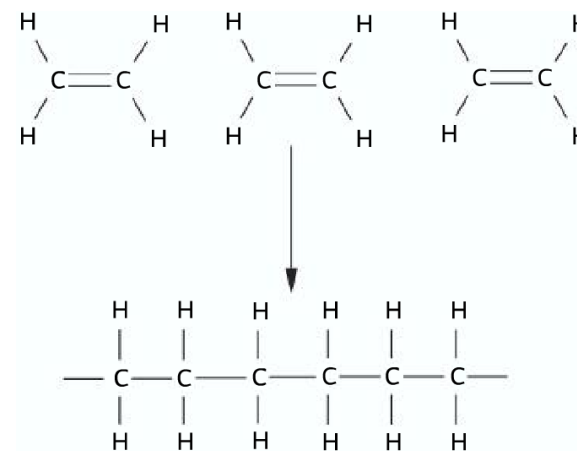
Poly(ethene) is the most **widely used plastic** because of its resistance to many different chemicals, and that it is not soluble in water at room temperature.

It is present in plastic products such as plastic bags, plastic bottles and used as water pipes.

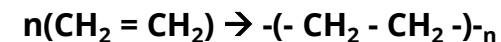
POLY(ETHENE)

Poly(ethene) is an example of a polymer that is formed using addition polymerisation of ethene monomers.

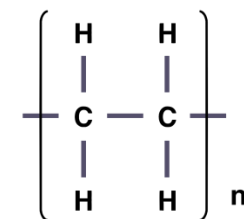
During addition polymerisation, the **C=C double bond is broken**.



The equation for the addition polymerisation of ethene monomers to form poly(ethene) is:



The **repeating unit** of poly(ethene) is:

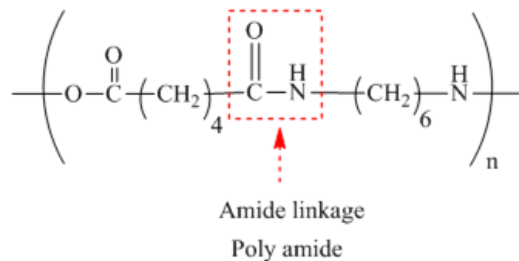


CONDENSATION POLYMERISATION

CONDENSATION POLYMERISATION

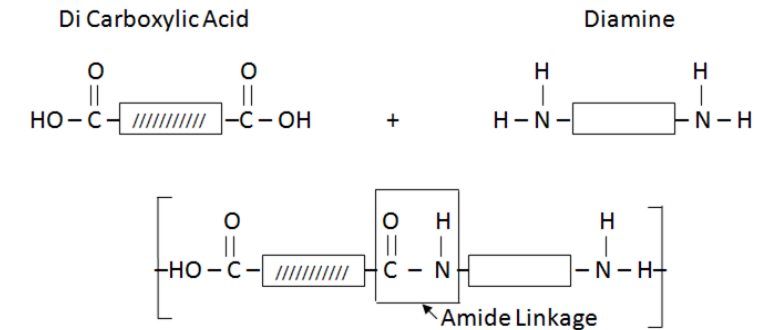
Condensation polymerisation is the process where **two different monomers are chemically combined to form a polymer**. The process produces by-products such as water.

The repeat unit of nylon contains the **-CONH- amide linkage**. The polymer is made up of monomers linked by the amide linkages, hence it's called **polyamide**.

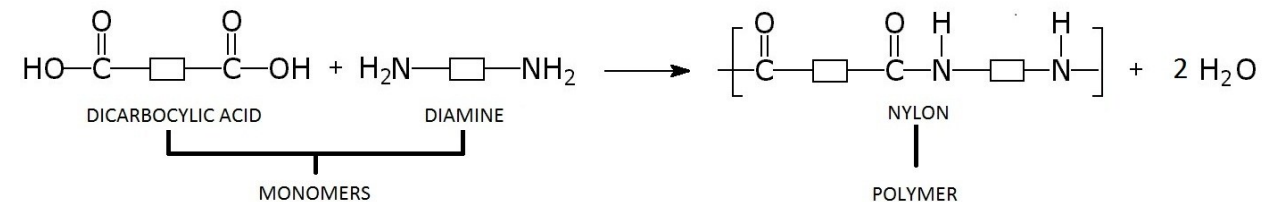


NYLON

Nylon is a synthetic polymer formed through condensation polymerisation of **dicarboxylic acid and diamine**, one containing the carboxylic acid functional group and the other containing the amine functional group.



During the condensation reaction process, **water molecules are formed as by-products and removed**:



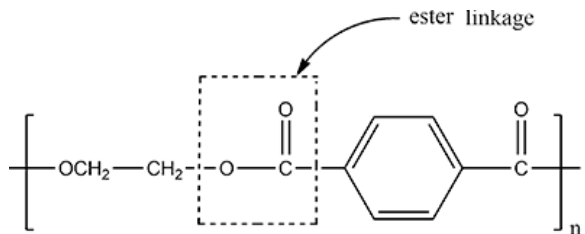
Nylon is **light, strong, and has high stretchable**. Hence, this man-made fibre is used to make **clothing, fishing lines, parachutes and sleeping bags**.

CONDENSATION POLYMERISATION

CONDENSATION POLYMERISATION

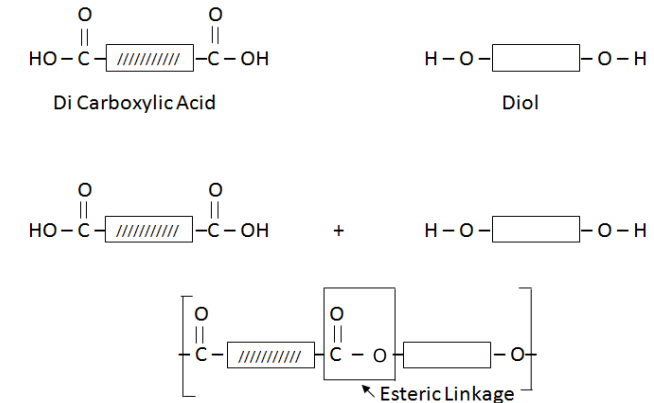
Condensation polymerisation is the process where **two different monomers are chemically combined to form a polymer**. The process produces by-products such as water.

The repeat unit of terylene contains the **-CONH- ester linkage**. The polymer is made up of monomers linked by the ester linkages, hence it's called **polyester**.



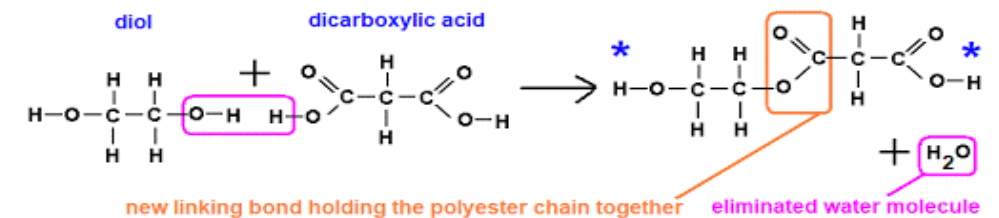
TERYLENE

Terylene is a polymer formed through condensation polymerisation of **dicarboxylic acid and diol**, one containing the carboxylic acid functional group and the other containing the alcohol functional group.



During the condensation reaction process, **water molecules are formed as by-products and removed**:

How the link bond is formed in making a polyester by the elimination of water

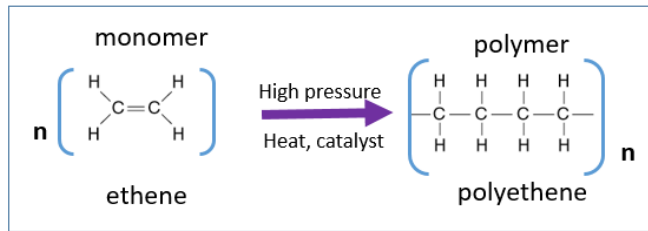


Man-made fibres like terylene lasts longer, would not decompose, and has the ability to maintain their shape under humid conditions.

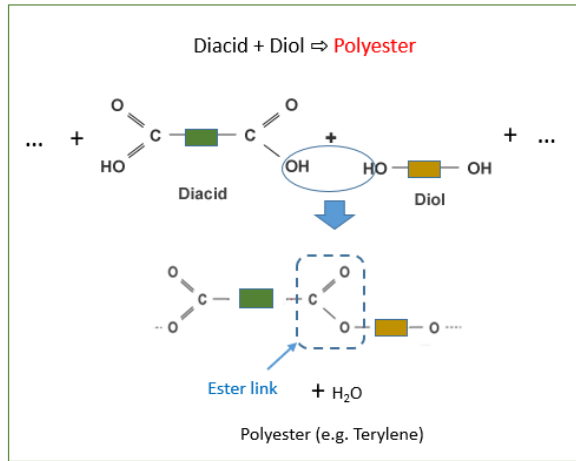
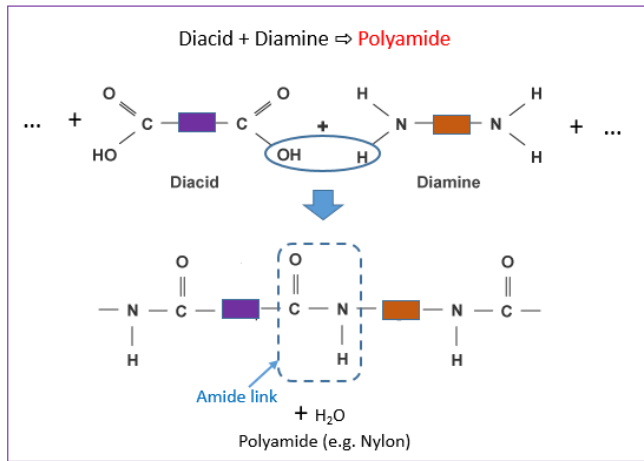
Some uses of terylene are also used to make sails of boats and clothes.

SUMMARY

Addition Polymerisation



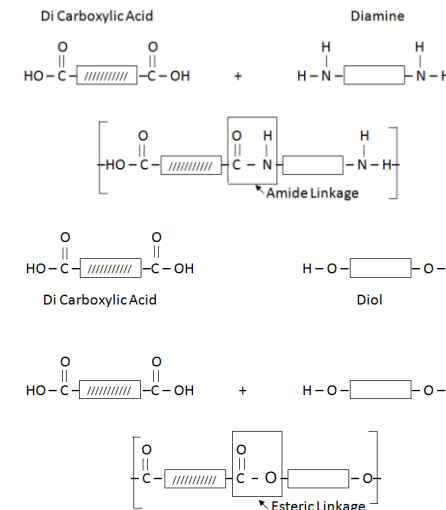
Condensation Polymerisation



Addition polymerisation	Condensation polymerisation
Monomers must contain a double bond (e.g. alkenes)	Monomers must have two functional groups at the two ends
No by-products is produced	By-products like water are produced
Example: polyethene	Example: nylon & terylene

POLYMER

**Condensation
Polymerisation**
(elimination of water)



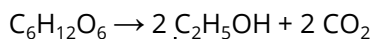
LONG CHAIN ALKANE

H₂ gas
(For Haber process)

Catalytic Cracking
(Al₂O₃ & SiO₂, 600 °C)

**Addition
Polymerisation**
(High temp & pressure)

SUGAR



Fermentation
(37°C, yeast & no O₂)

Hydration
(300 °C & 60 atm, Phosphoric(V) acid)

Oxidation
(acidified aqueous potassium
manganate(VII) / exposed to air)

ALKANE

C - C

Hydrogenation
(200 °C & nickel)

ALKENE

C = C

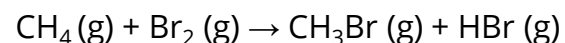
ALCOHOL

-OH

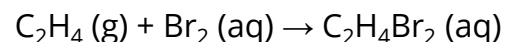
CARBOXYLIC ACID

-COOH

Substitution
(UV light)



Bromination
(Test for C=C bonds)

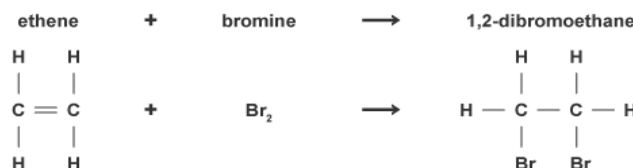


Esterification
(warm, sulfuric acid)

ESTER + H₂O
-COO-

Prefix

Meth- 1
Eth- 2
Prop- 3
But- 4
Pent- 5
Hex- 6
Hep- 7
Oct- 8
Non- 9
Dec- 10



ALL ORGANIC COMPOUNDS
Complete Combustion

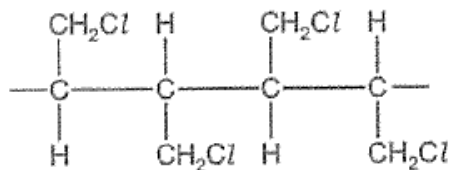


Incomplete Combustion



Try it yourself! (TYS Question)

12. The diagram shows the partial structure of a polymer.



Which statement about this polymer is correct?

(N2019/P1/Q40)

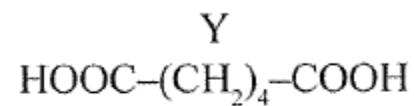
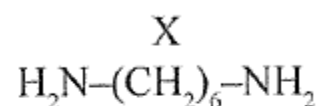
- A It could be made by addition polymerisation of
- $$\begin{array}{ccc}
 \text{CH}_2\text{Cl} & & \text{CH}_2\text{Cl} \\
 & \diagdown & / \\
 & \text{C} = \text{C} \\
 & / & \diagdown \\
 \text{H} & & \text{H}
 \end{array}$$
- B It could be made by condensation polymerisation of
- $$\begin{array}{ccc}
 \text{CH}_2\text{Cl} & & \text{H} \\
 & \diagdown & / \\
 & \text{C} = \text{C} \\
 & / & \diagdown \\
 \text{H} & & \text{CH}_2\text{Cl}
 \end{array}$$
- C Its monomer has the empirical formula $\text{C}_4\text{H}_6\text{Cl}_2$.
- D Its monomer could be made by the reaction of an alkane with chlorine. ()

Answer:

12. **A**
This polymer is made from addition polymerisation.

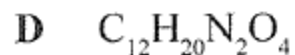
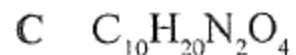
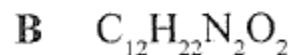
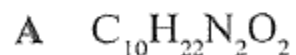
Try it yourself! (TYS Question)

13. Two compounds, X and Y, react together to form the polymer nylon.



What is the formula of the partial structure which repeats within the polymer?

(N2020/P1/Q40)



()

Answer:

13. **B**

X and Y will react to produce H_2O as a side product. Hence, the formula of the partial structure can be derived by adding the C atoms in X and Y together (since the number of C atoms remains unchanged) and removing 2 H atoms and 2 OH atoms for the formation of the side product.

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