APPLICATION AND ADVANCES OF POLYMERS

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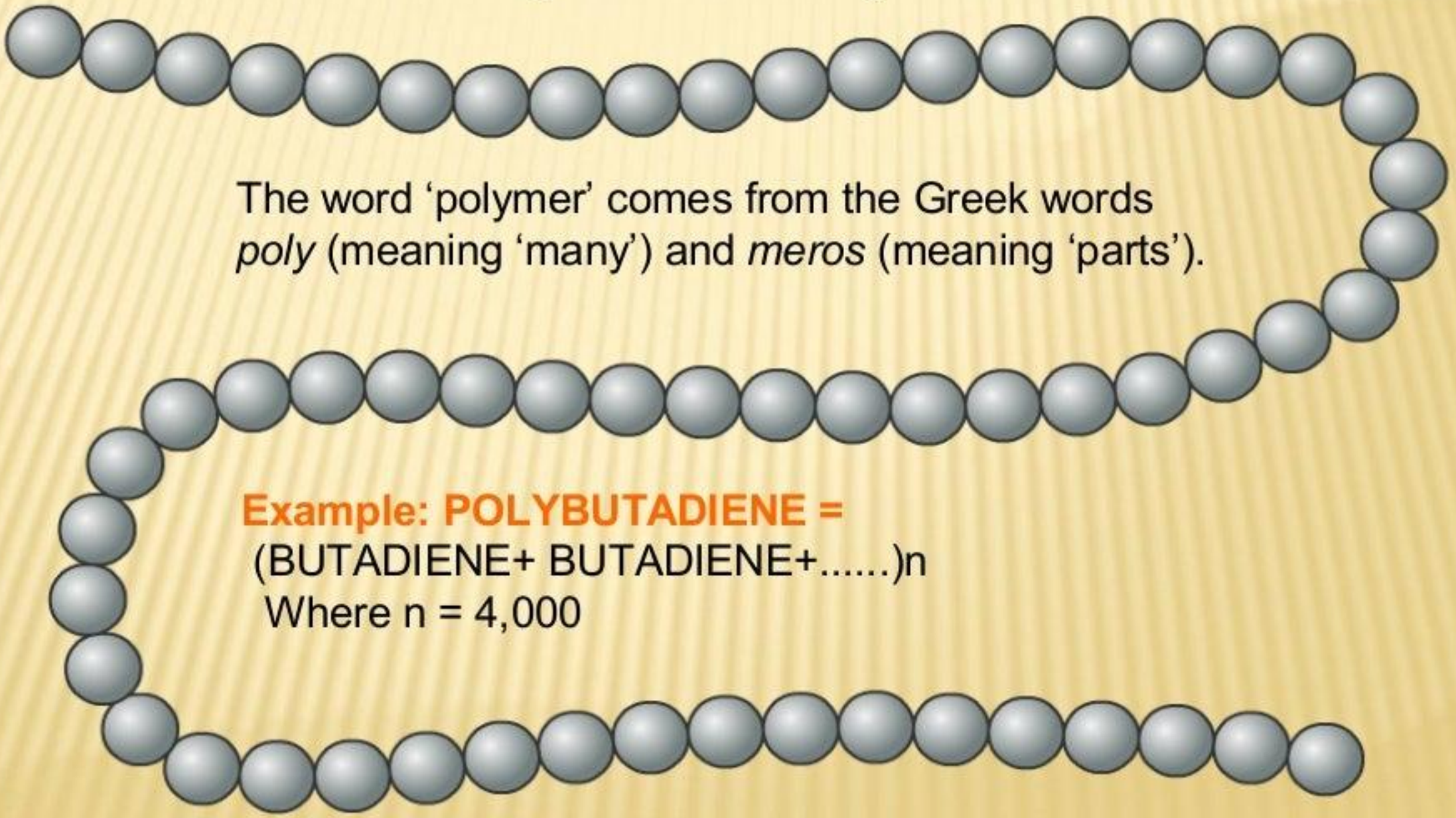
DEFINITION

Polymers are very large molecules made when hundreds of **monomers** join together to form long chains.



The word 'polymer' comes from the Greek words *poly* (meaning 'many') and *meros* (meaning 'parts').

Example: POLYBUTADIENE =
(BUTADIENE+ BUTADIENE+.....)n
Where n = 4,000

INTRODUCTION

- Polymers are complex and giant molecules usually with carbons building the backbone, different from low molecular weight compounds.
- The small individual repeating units/moleules are known as monomers(means single part).
- Imagine that a monomer can be represented by the letter **A**. Then a polymer made of that monomer would have the structure:

-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A

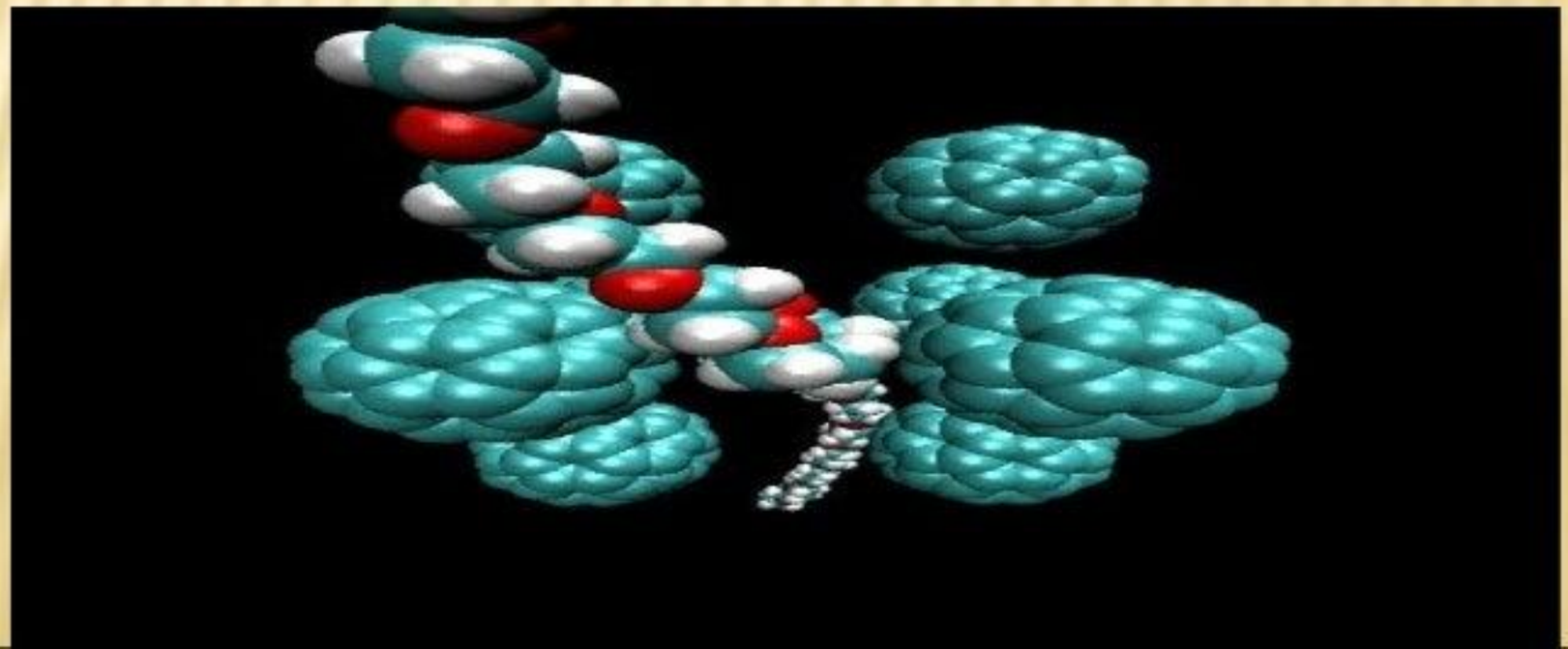
- This kind of polymer is known as **HOMOPOLYMER.**

CONT.....

- In another kind of polymer, two different monomers might be involved.
- If the letters A and B represent those monomers, then the polymer could be represented as:

-A-B-A-B-A-B-A-B-A-B-A-B-A-B-A-B-A-B-A-B-A- B-A-B-A

- A polymer with two different monomers is known as a **COPOLYMER / HOMOPOLYMER.**

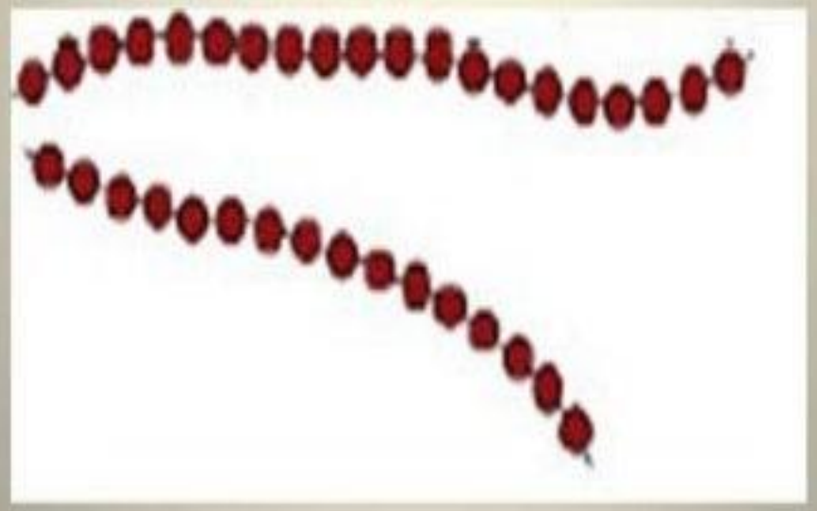


Types Of Linking In Polymers

- Linear Polymers:

A polymer in which the molecules form long chains without branches or cross-linked structures.

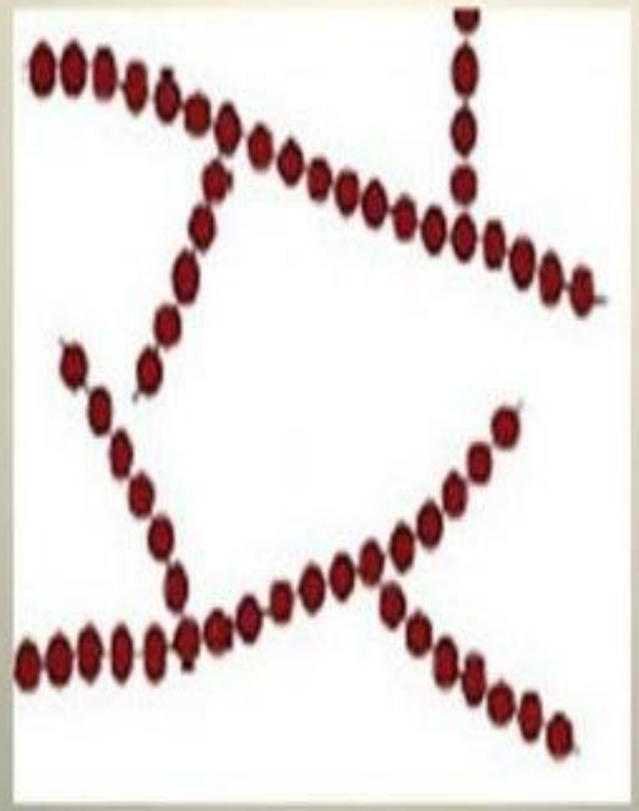
examples: nylon, polyester, PVC etc.



- Branched Polymer:

A polymer chain having branch points that connect three or more chain segments.

Examples: polythene, glycogen, starch etc



MOLECULAR STRUCTURE OF POLYMER

Linear

- High Density Polyethylene (HDPE), PVC, Nylon, Cotton

Branched

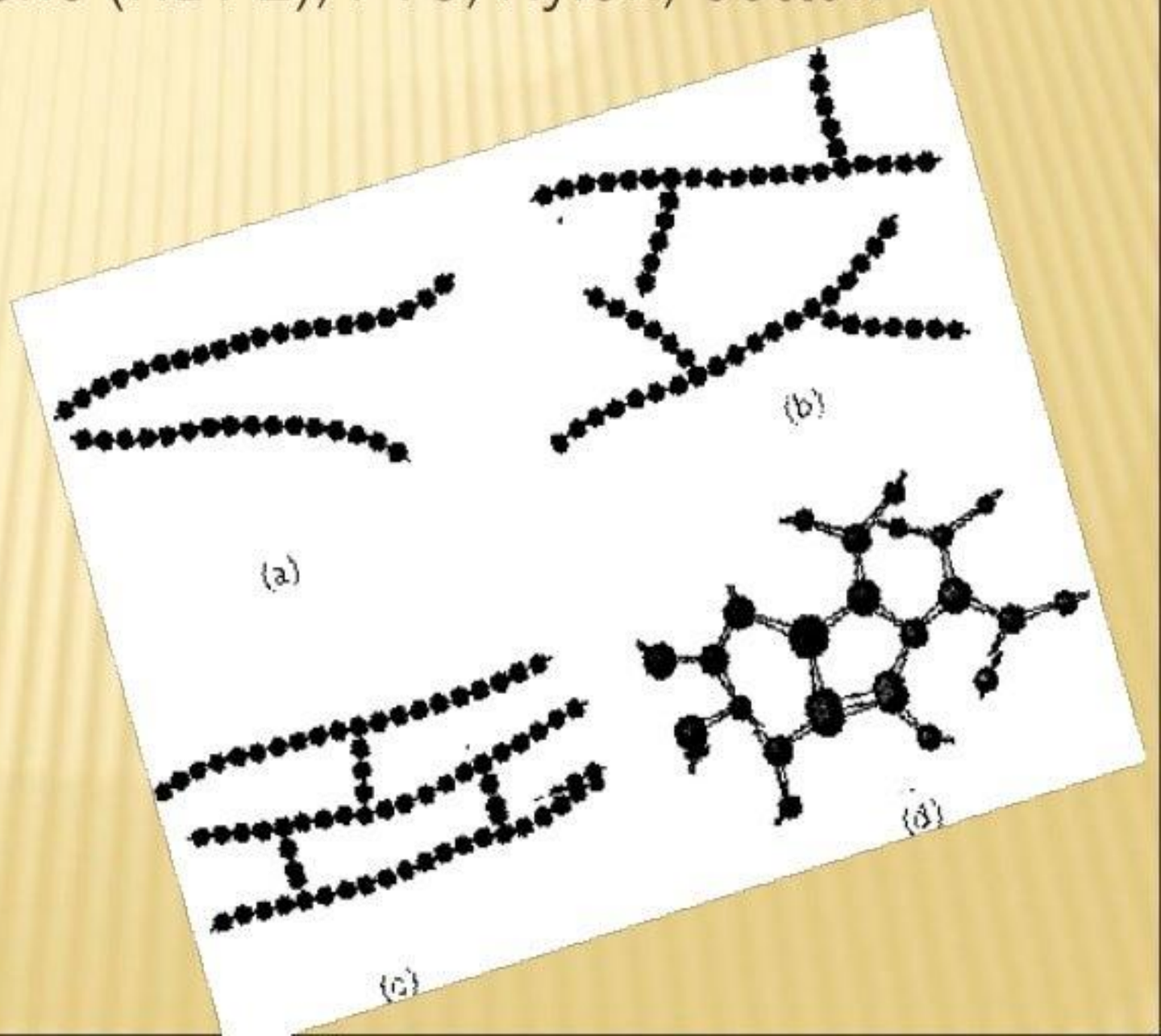
- Low Density
- Polyethylene (LDPE)

Cross-linked

- Rubber

Network

- Kevlar, Epoxy



CHARACTERISTICS OF IDEAL POLYMER

- *Should be inert and compatible with the environment.*
- *Should be non-toxic.*
- *Should be easily administered.*
- *Should be easy and inexpensive to fabricate.*
- *Should have good mechanical strength.*

POLYMERISATION

- The process by which the monomer molecules are linked to form a big polymer molecule is called '**polymerisation**'.

- **Polymerization** is a process of bonding monomer, or "single units" together through a variety of reaction mechanisms to form longer chains named Polymer

- As important as polymers are, they exist with monomers, which are small, single molecules such as hydrocarbons and amino acids.

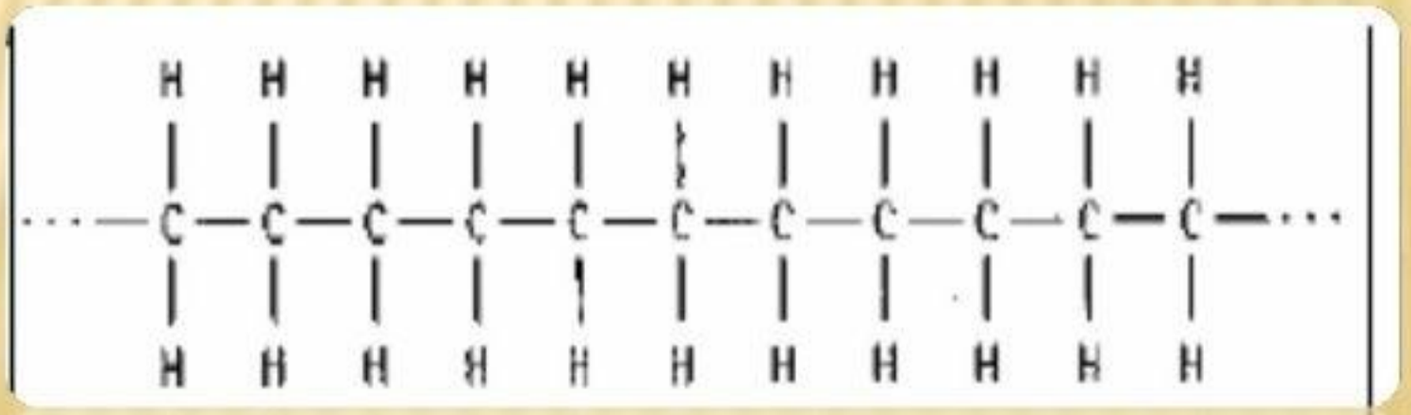
TYPES OF POLYMERIZATION

- **Addition Polymerization=**

  When monomers just add on to form the polymer, the process is called 'addition polymerisation'. The polymer is the *only* product

  e.g. Ethylene monomers add on to form polyethylene. (5 Ethylene monomers)

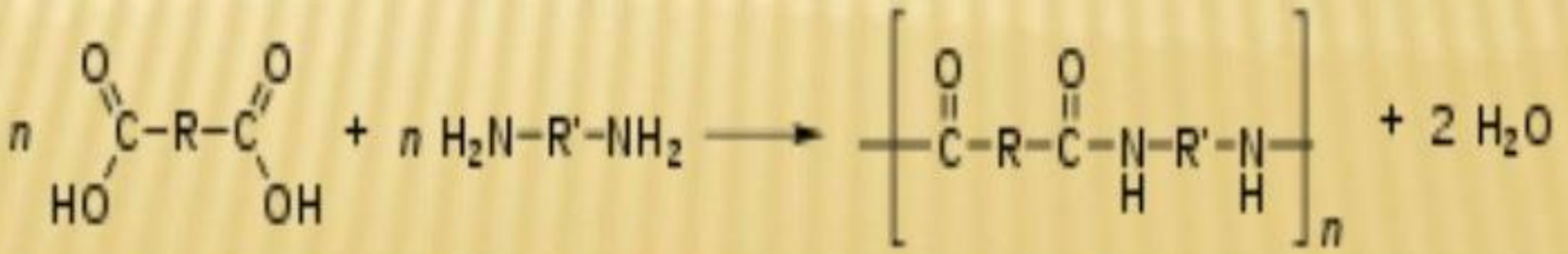
Polyethylene formation

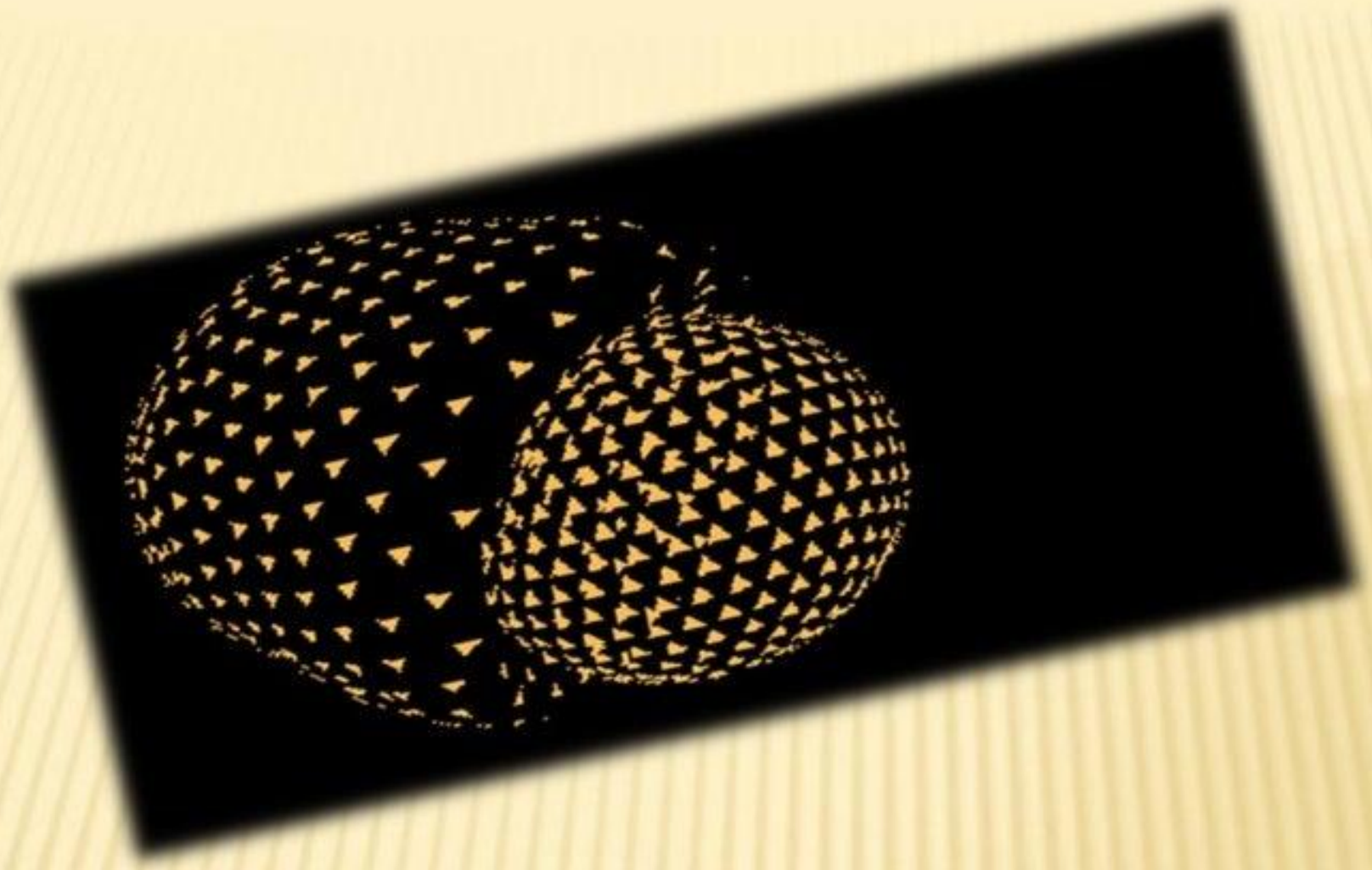


CONT....

- **Condensation polymerisation=**

- The molecules do not just add on but also undergo some reaction in forming the polymer, the process is called 'condensation polymerisation'.
- Here the two molecules condense to form a polymer.The condensation takes place between two reactive functional groups, like the carboxyl group(of an acid) and the hydroxyl group(of an alcohol). While forming the polymer water molecules also get eliminated.
- In A. P. mol. weight of polymer is roughly equal to that of all monomers, while in C. P. the mol. weight of polymer is lesser by the weight of simple molecules eliminated during the condensation process. E.g. **Condensation polymerization diacid diamine.**





CLASSIFICATION OF POLYMERS

(According to their properties & characteristics.)

1. NATURAL AND SYNTHETIC POLYMERS

- Polymers which are isolated from natural materials, are called as '**natural polymers**'.

E.g. : Cotton, silk, wool, rubber.

natur

- Polymers synthesized from low molecular weight compounds, are called as, '**synthetic polymers**'.

E.g. polyethylene, nylon, terylene.

NATURAL RUBBER-
HEVEA BRASIILENSIS

2. ORGANIC AND INORGANIC POLYMERS

- A Polymer whose backbone chain is essentially made of carbon atoms is termed an **'Organic polymer'.**

  Examples- cellulose, proteins, polyethylene, nylons.

- A Polymer which does not have carbon atom in their chain is termed as **'Inorganic polymer'** .

  Examples- Glass and silicone rubber

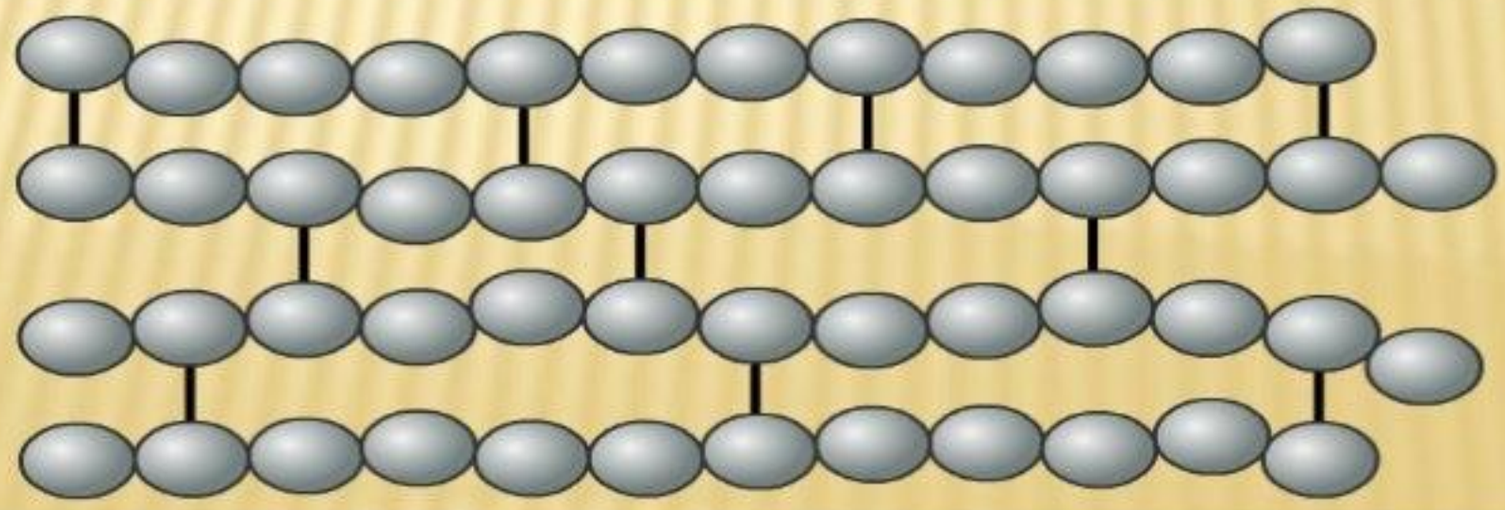
3. THERMOPLASTIC AND THERMOSETTING POLYMER

- Some polymer are soften on heating and can be converted into any shape that they can retain on cooling.

- Such polymer that soften on heating and stiffen on cooling are termed as `**thermoplastic**' polymers.

  Ex. Polyethylene, PVC, nylon, sealing wax.

- Polymer that become an infusible and insoluble mass on heating are called '**thermosetting**' polymers. Plastics made of these polymers cannot be stretched, are rigid and have a high melting point.



4. PLASTICS, ELASTOMERS, FIBRES & LIQUID RESINS

- Polymer is shaped into hard and tough utility articles by application of heat and pressure, is known as '**plastics**'.

  E.g. polysterene, PVC, polymethyl methacrylate.

- When plastics are vulcanised into rubbery products exhibiting good strength and elongation, polymers are known as '**elastomers**'.

  E.g. silicone rubber, natural rubber, synthetic rubber, etc.

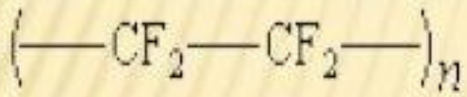
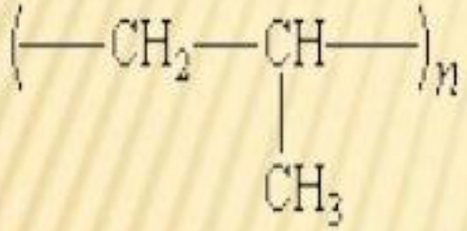
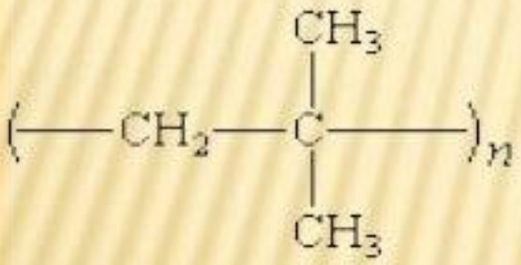
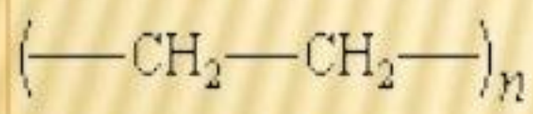
- Long filament like material whose length is atleast 100 times it's diameter, polymers are said to be '**fibres**'.

  E.g. Nylon, terylene.

- Polymers used as adhesives, potting compounds, sealants, etc., in a liquid form are described as '**liquid resins**'.

  E.g. Epoxy adhesives and polysulphides sealants.

COMMON ADDITION POLYMERS

Structure	*Chemical Name*	*Trade Name or CommonName*
	poly(tetrafluoroethylene)	Teflon
	polypropylene	Herculon
	polyisobutylene	butyl rubber
	polyethylene	

STEPS FOR SYNTHESIS OF POLYMERS

There are three significant reactions that take place in addition polymerization:

Initiation (birth)

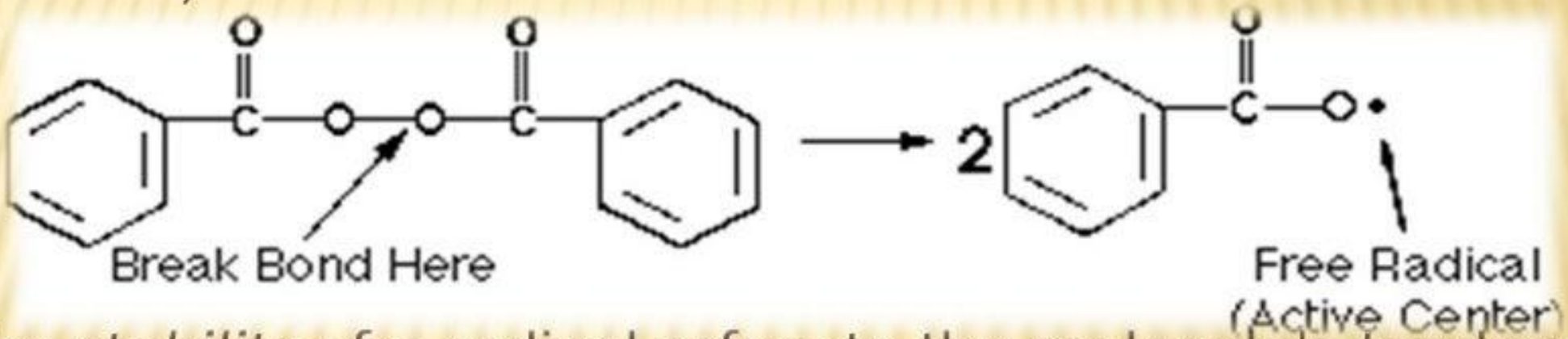
Propagation (growth)

Termination (death)

1. INITIATION

INITIATOR:

- A relatively unstable molecule that decomposes into a free radical. Used to "initiate" a polymer growth reaction. (A molecule with an unpaired electron, making it highly reactive).



- The *stability* of a radical refers to the molecule's tendency to react with other compounds. An unstable radical will readily combine with many different molecules. However a stable radical will not easily interact with other chemical substances.

CONT....

- The first step in chain polymerization- Initiation involves the formation of a free radical. Addition can occur at either end of the monomer. This process is illustrated in the following animation in which a chlorine atom possessing an unpaired electron (often indicated as cl-) initiates the reaction.