POLYMERS

2.1 Synthetic Addition Polymers

- Monomer: a molecule of relatively low molar mass that is linked with other similar molecules to form a polymer.
- Polymer: a molecule of larger molar mass that consists of many repeating subunits called monomers.
- Polymerization: the process of linking monomer units into a polymer.
- Addition Polymer: a polymer formed when monomers units are linked throughout addition reactions.

Polyethylene

- Polyethene is commonly called polyethylene and is used in plastic containers.
- E.g. Ethene monomers are linked to produce polyethene.

- Polymers are written in condensed form, the repeating unit bracketed and the subscript *n* to show that it is repeating.
- E.g. polyethene made from the addition of ethene monomers

Polypropene

- Polypropene is commonly called polypropylene and is used to make rope and carpet.
- E.g. Propene monomers are linked to produce polypropene.

Polyvinyl Chloride

- PVC is a polymer of chloroethene and is often used for raincoats.
- E.g. Vinyl chloride monomers make polyvinyl chloride (PVC)

Polystyrene

- Polystyrene is a polymer of phenylethene and is used in meat packing trays.
- E.g. Vinyl benzene monomers make polystyrene.

The Addition Polymerization Process

- First stage → initiation (the reaction is started by an initiation molecule)
- Second stage → propagation (the linking of monomers)
- Third stage → termination (when the last molecule cannot bond to continue the chain)

Properties of Plastics

- Plastic: a synthetic substance that can be molded and will retain its given shape (usually under heat and pressure).
- Most plastics made of ethene monomers are unreactive since the double bond is lost and a less reactive saturated alkane is produced.
- Most plastics are quite strong because the long chains are held together by van der Waal's forces (which is strong in a polymer with thousands of monomers) but is flexible and moldable for the same reason.

Effects of Substituted Groups on Polymer Properties

- Teflon (monomer → $F_2C = CF_2$) only contains very strong C – F bonds which makes it unreactive with most reagents.
- Plexiglas (monomer → $CH_2 = CH - COOCH_3$) is transparent and strong like real glass but it contains the carbonyl group that can be attacked by organic solvents (acetone).

Crosslinking

- Polymers made of dienes that allow them to form bonds in different directions.
- E.g. neoprene with crosslinkages

- The amount of crosslinking can be controlled by using a crosslinking agent or monomer. By increasing the concentration of the crosslinking agent, the rigidity of the plastic can be increased.
- E.g. polystyrene linked with 1,4-diethenylbenzene

- Crosslinking can also occur using inorganic crosslinkers.
- E.g. Vulcanized rubber

- Plastics can be divided into 2 families. *Thermoplastics* which can be heated and moulded into new shapes and *thermoset* plastics which are highly crosslinked and are not softened by heat

Homework

Practice 1,2,3 Questions 1,2,3,4,6

2.2 Synthetic Condensation Polymers
Needs to have two reactive functional groups, one at each end of the molecule

Example 1: Polyesters from Carboxylic Acids and Alcohols
- E.g. Dacron from *p*-phthalic acid (1,4-benzenedicarboxylic acid) and ethylene glycol (1,2,3-propanetriol)

Example 2: Polyamides from Carboxylic Acids and Amines
- E.g. hexanedioic acid and 1,6-diamino hexane (nylon 6,6 *1st number is the # of C's in the amide and the 2nd is the # of C's in the carboxylic acid*)

- Carbonyl group contributes to hydrogen bonding with the amide group and creates crosslinks between the polymers.

Diapers – Ultimate example of a polymer collection
- Composed of many types of synthetic and natural polymers.
- Disposable: Synthetic: polyethylene film, glues, polypropylene, Lycra, polyurethane, polymethylacrylate. Natural: rubber, cellulose, cotton
- Cotton: cotton is a natural polymer (cellulose).

Homework
Practice 1,2,3 Questions 1,2,3,4,5,6

Other common polymers

2.2 – Proteins
2.3 – Starches and Cellulose
2.4 – Nucleic Acids

E.g. Peptide bond
amino acid + amino acid → dipeptide