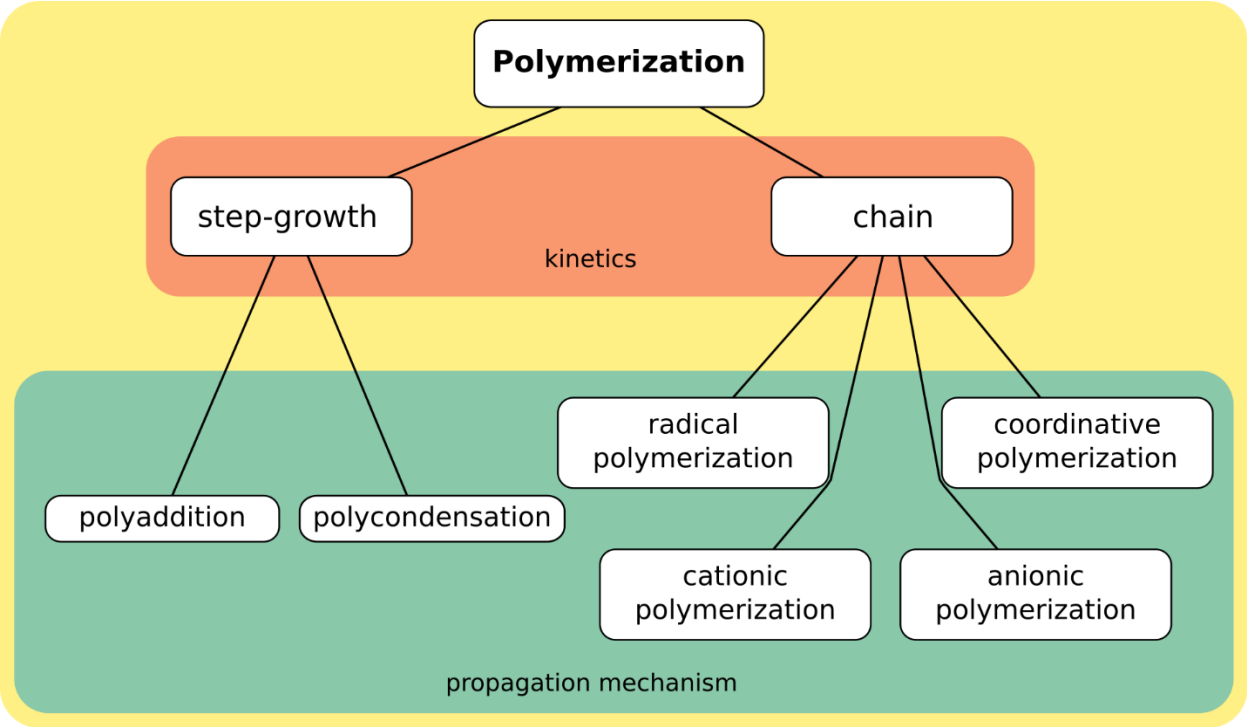
Condensation Polymerization



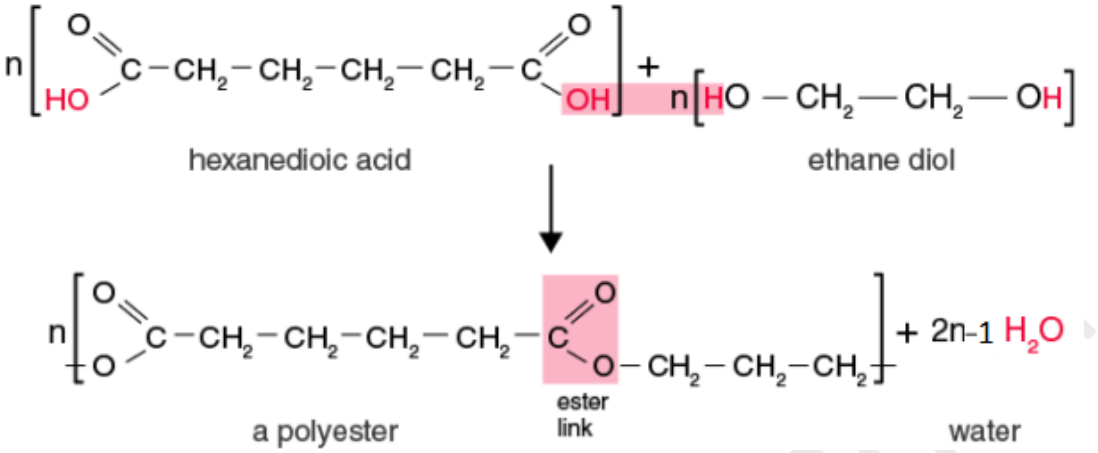
Characteristics of Condensation Polymerization

Some main characteristics of this type of polymerization are;

- ✓ The molecules should have **one or two functional groups** (like **alcohol, amine, or carboxylic** acid groups).
- ✓ The reaction occurs between **two similar or different functional groups or monomers**.
- ✓ Smaller molecules usually combine to form larger molecules.
- ✓ Mixed properties of both the molecules or functional groups are taken into consideration.
- ✓ A **linear polymer** is obtained as the condensation product when both **functional groups are difunctional**.
- ✓ When one of the functional groups is **tri- or tetra-functional, the polymer formed will be a cross-linked polymer** having a three-dimensional network.

Differences between Condensation and Addition Polymerization---H.W.

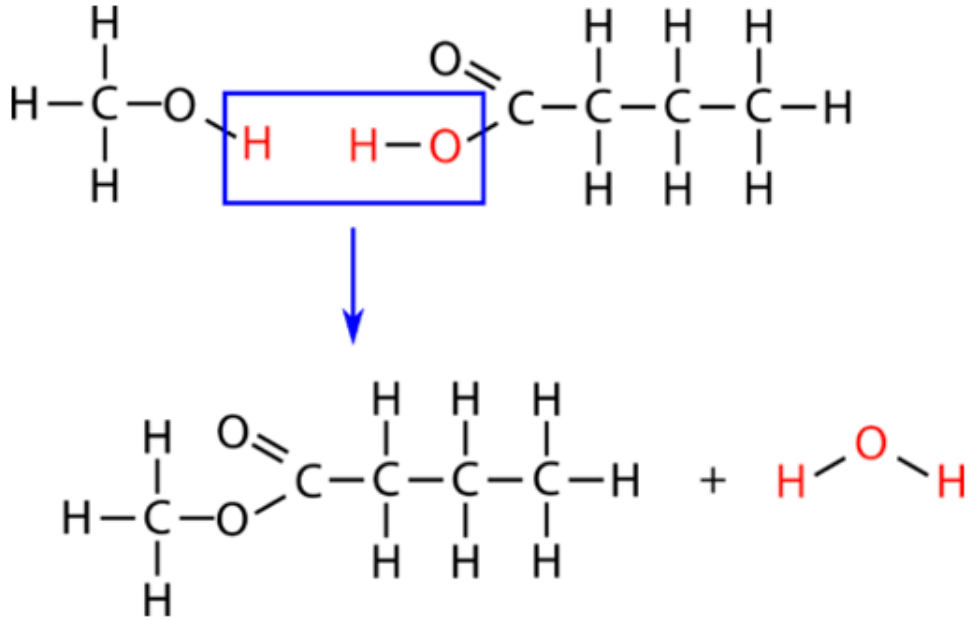
CONDENSATION POLYMERISATION



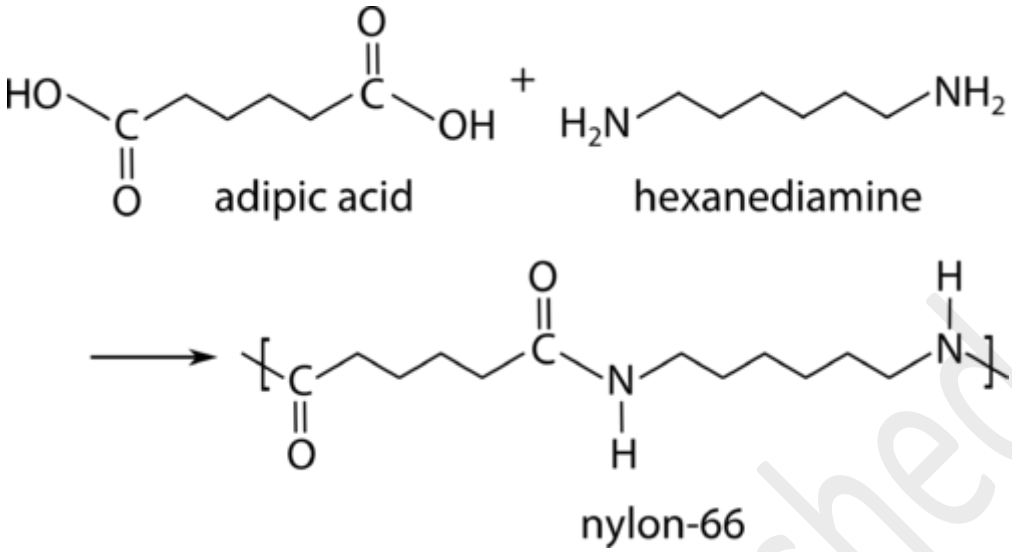
Types of Condensation Reaction

Two types of condensation reactions used to produce polymers:

Esterification: reaction between alcohol (-OH) and carboxylic acid (-COOH) to form an ester.



Amidation: reaction between amine ($-NH_2$) and carboxylic acid (-COOH) to form an amide. (extension)



Types of Condensation Polymerization:

1) Polyaddition Polymerization:

A polyaddition polymerization describes a reaction in which **monomers with different functional groups** react to form macromolecules/polymers **without splitting off by-products.**

Notes

1. The growth steps are expressed by

$$P_x + P_y \rightarrow P_{x+y} \{x\} \in \{1, 2, \ldots \infty\}; \{y\} \in \{1, 2, \ldots \infty\}$$

where P_x and P_y denote chains of degrees of polymerization x and y, respectively.

2. The earlier term *addition polymerization* embraced both the current concepts of *polyaddition* and *chain polymerization*, but did not include *condensative chain polymerization*.

Polyurethane, for example, is formed by a **polyaddition polymerization process** between **two hydroxyl groups**.

2) Polycondensation Polymerization:

It is a form of a **step-growth polymerization** where smaller molecules or monomers react with each other to form larger structural units (usually polymers) while **releasing by-products such as water or methanol molecule**. The by-products are normally **referred to as condensate**.

Notes

1. The growth steps are expressed by

$$P_x + P_y \rightarrow P_{x+y} + L \; \{x\} \in \{1, 2, \ldots \infty\}; \; \{y\} \in \{1, 2, \ldots \infty\}$$

where P_x and P_y denote chains of degree of polymerization x and y, respectively, and L a low-molar- mass by-product.

2. The earlier term *polycondensation* was synonymous with *condensation polymerization*. It should be noted that the current definitions of polycondensation and condensative chain polymerization were both embraced by the earlier term *polycondensation*.

Polyester, Polyamide etc. are formed by the Polycondensation polymerization process.