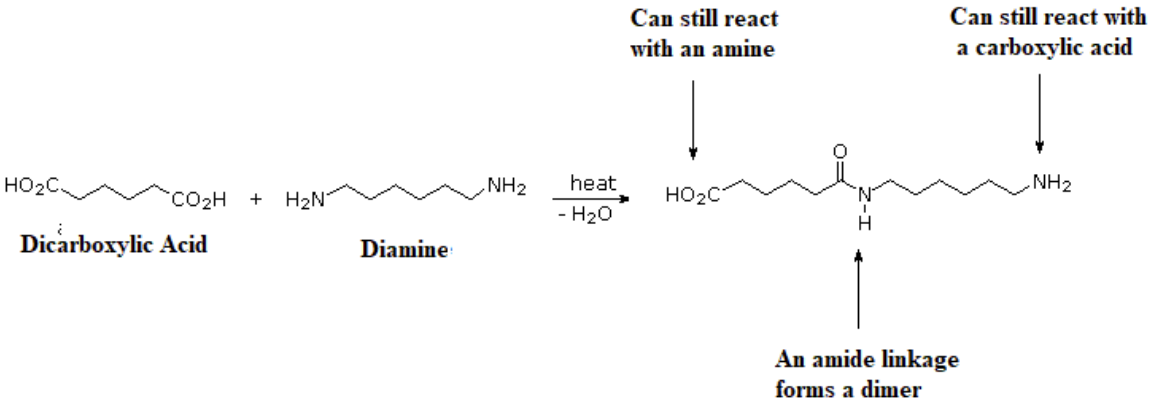
M.Sc. Sem I, CC-2, Physical Chemistry

- **Step Growth Polymerization**

  In step-growth polymerization, the polymers are formed by the independent reaction between the functional groups of simple monomer units. In step-growth, each step may consist of a combination of two polymers having a different or the same length to form a longer-length molecule.

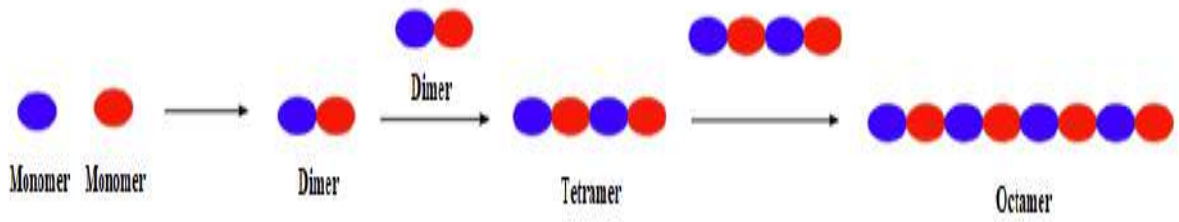
  The reaction is a lengthy process, and the molecular mass is increased at a very slow rate. An example of step-growth polymerization is condensation polymerization, where a water molecule is evolved in the reaction when the chain is lengthened.

  The process of step-growth polymerizations is fundamentally different than in chain-growth. In step-growth polymerizations, monomers are generally linked by a carbon-heteroatom bond (C-O & C-N) formed in non-sequential steps. Often, the reactions used to link these monomers include multiple nucleophilic acyl substitutions. Step-growth polymerizations usually use two different monomers, neither of which would undergo polymerization on its own. The two monomers are multifunctional and complementary to each other, such that each provides the other with a reactive partner. In this section, we will be focusing on monomers which are difunctional, meaning they contain two of the same reactive functional group. A step-growth polymerization starts with two complementary functional groups on different monomers reacting to form a dimer. Because both monomers were difunctional, each retains a reactive group and can react with additional complementary monomers.



  In fact, the difunctionality of the monomers, allows step-growth polymers to grow in two directions at once. First, two complementary monomers react with each other to form a dimer. Assuming that monomers react at roughly similar rates, when one end of the dimer reacts again it will likely find another dimer and form a tetramer. Then when the tetramer goes to react again it will most likely find another tetramer and form an

octamer. This process is repeated allowing the polymer to grow in two directions at the same time.



The Step-Growth Polymerization Process

Virtually all fibers are made from some form of polymer. In particular, silk and wool are composed of a naturally occurring protein polymer. The monomers of proteins are called amino acid residues. These residues are connected by amide linkages which are also called peptide bonds. Many of the early efforts of polymer chemistry were to artificially create fibers which mimicked the properties of silk and wool.