Learning Objectives

• To describe the preparation procedure for amides.

The addition of ammonia (NH₃) to a carboxylic acid forms an amide, but the reaction is very slow in the laboratory at room temperature. Water molecules are split out, and a bond is formed between the nitrogen atom and the carbonyl carbon atom.

\[
CH₃COOH + NH₃ \rightarrow CH₃CONH₂ + H₂O
\]

In living cells, amide formation is catalyzed by enzymes. Proteins are polyamides; they are formed by joining amino acids into long chains. In proteins, the amide functional group is called a \textit{peptide bond}.

\textbf{Polyamides}

Just as the reaction of a diol and a diacid forms a polyester, the reaction of a diacid and a diamine yields a polyamide. The two difunctional monomers often employed are adipic acid and 1,6-hexanediamine. The monomers condense by splitting out water to form a new product, which is still difunctional and thus can react further to yield a polyamide polymer.

\[
n\text{HNCOCH}_2\text{CH}_2\text{CH}_2\text{NH}_2 + n\text{HOOCCH}_2\text{CH}_2\text{CH}_2\text{COOH} \rightarrow \text{NiCh}_{2}\text{CH}_2\text{CH}_2\text{CONHCH}_2\text{CH}_2\text{CH}_2\text{CONH}_2 + 2n\text{H}_2\text{O}
\]

Some polyamides are known as \textit{nylons}. Nylons are among the most widely used synthetic fibers—for example, they are used in ropes, sails, carpets, clothing, tires, brushes, and parachutes. They also can be molded into blocks for use in electrical equipment, gears, bearings, and valves.

\textbf{Concept Review Exercises}

1. Write the condensed structural formulas and give names of the two compounds from which butanamide (CH₃CH₂CH₂CONH₂) is formed.

2. Write the condensed structural formulas and names of the two compounds from which CH₃CH₂CH₂CH₂CH₂CONHCH₂CH₂CH₃ is formed.

\textbf{Answers}

1. CH₃CH₂CH₂COOH (butanoic acid) and NH₃ (ammonia)

2. CH₃CH₂CH₂CH₂CH₂COOH (hexanoic acid) and CH₃CH₂CH₂NH₂ (propylamine)
Key Takeaway

- Amides are prepared by the reaction of a carboxylic acid with ammonia or an amine.

Exercises

1. Write the condensed structural formulas and names of the two compounds from which pentanamide (CH₃CH₂CH₂CH₂CONH₂) is formed.

2. Write the condensed structural formulas and names of the two compounds from which CH₃CONHCH₃ is formed.

Answer

1. CH₃CH₂CH₂CH₂COOH (pentanoic acid) and NH₃ (ammonia)