5.S: Organic Chemical Reactions (Summary)

To ensure that you understand the material in this chapter, you should review the meanings of the following bold terms in the following summary and ask yourself how they relate to the topics in the chapter.

Oxidation reactions are reactions in which an atom loses an electron. **Reduction reactions** are reactions in which an atom gains an electron. These two processes always occur together, so they are collectively referred to as **oxidation-reduction** (or **redox**) **reactions**. The species being oxidized it called the **reducing agent**, while the species being reduced is the **oxidizing agent**. Alternate definitions of oxidation and reduction focus on the gain or loss of oxygen atoms, or the loss or gain of hydrogen atoms. Redox reactions are easily balanced if the overall reaction is first separated into **half reactions**, which are individually balanced.

Oxidation-reduction reactions are common in organic and biological chemistry. **Respiration**, the process by which we inhale and metabolize oxygen, is a series of redox reactions. In the absence of oxygen, redox reactions still occur in a process called **anaerobic metabolism**. **Antioxidants** such as ascorbic acid also play a part in the human diet, acting as reducing agents in various biochemical reactions. **Photosynthesis**, the process by which plants convert water and carbon dioxide to glucose, is also based on redox reactions.

More reactive than alkanes, alkenes undergo **addition reactions** across the double bond:

- Addition of hydrogen (**hydrogenation**):

  $CH_2=CH_2 + H_2 \rightarrow CH_3CH_3$

- Addition of halogen (**halogenation**):

  $CH_2=CH_2 + X_2 \rightarrow XCH_2CH_2X$

  where X = F, Cl, Br, or I.

- Addition of a hydrogen halide (**hydrohalogenation**):

  $CH_2=CH_2 + HX \rightarrow HCH_2CH_2X$

  where X = F, Cl, Br, or I.

- Addition of water (**hydration**):

  $CH_2=CH_2 + HOH \rightarrow HCH_2CH_2OH$

If the alkene double bond is asymmetric, **Markovnikov's Rule** is used to determine the major product. This rule states that the –H bonds to carbon of the alkene with more hydrogen atoms and the –OH bonds to carbon of the alkene with more carbon groups attached.

Alkenes also undergo **addition polymerization**, molecules joining together to form long-chain molecules.

$\ldots CH_2=CH_2 + CH_2=CH_2 + CH_2=CH_2 + \ldots \rightarrow \ldots CH_2CH_2–CH_2CH_2–CH_2CH_2– \ldots$

The reactant units are **monomers**, and the product is a **polymer**.

Many alcohols can be synthesized by the **hydration** of alkenes. Common alcohols include methanol, ethanol, and isopropyl alcohol. When water is removed from an alcohol in a **dehydration** step, the result is either an alkene or an ether, depending on the reaction conditions. **Aldehydes** are synthesized by the oxidation of **primary alcohols**. Mild oxidizing agents can be further oxidized the aldehyde to a **carboxylic acid**. **Ketones** are prepared by the oxidation of **secondary alcohols**. Ketones are not oxidized by these reagents. **Tertiary alcohols** are not easily oxidized.

Another type of reaction that occurs with organic compounds is the condensation reaction. A **condensation reaction** is a reaction in which two molecules combine to form a single molecule. An **esterification reaction** is a condensation reaction in which a carboxylic acid and an alcohol are combined under acidic conditions. Esters are neutral compounds that undergo **hydrolysis**, a reaction with water. Under acidic conditions, hydrolysis is essentially the reverse of esterification. When carried out under basic conditions, the process is called **saponification**.

An **amidation reaction** is a condensation reaction in which an amide is formed from an amine and a carboxylic acid. Amides are neutral compounds. They resist hydrolysis in water, but acids, bases, and enzymes catalyze the reaction.