

## 2.S: Unsaturated Hydrocarbons (Summary)

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

Any hydrocarbon containing either a double or triple bond is an **unsaturated hydrocarbon**. Organic molecules that have a carbon-carbon double bond are called **alkenes**. If the molecule contains two carbon-carbon double bonds, it is called a **diene**. When more than two carbon-carbon double bonds are present, the molecule is called a **polyene**. If the carbon-carbon double is present in a cyclic hydrocarbon, the molecule is called a **cycloalkene**.

The general formula for alkenes with one double bond is  $C_nH_{2n}$ . These molecules can be straight-chained, branched-chained, or cyclic. Simple alkenes often have common names, but all alkenes can be named by the system of the International Union of Pure and Applied Chemistry.

**Cis-trans isomers (or geometric isomers)** are characterized by molecules that differ only in their three-dimensional configuration around a rigid part of the structure, such as a carbon-carbon double bond or a ring. The molecule having two identical (or closely related) atoms or groups on the same side is the **cis isomer**; the one having the two groups on opposite sides is the **trans isomer**. When naming geometric isomers, the cis or trans designation is included as a prefix prior to identifying the substituents.

The physical properties of alkenes are quite similar to those of alkanes. Like other hydrocarbons, alkenes are insoluble in water but soluble in organic solvents.

**Alkynes** have a carbon-carbon triple bond. The general formula for alkynes is  $C_nH_{2n-2}$ . The properties of alkynes are quite similar to those of alkenes. They are named much like alkenes but with the *-yne* ending and no geometric isomers.

The cyclic hydrocarbon *benzene* ( $C_6H_6$ ) has a ring of carbon atoms. The molecule seems to be unsaturated, but it does not undergo the typical reactions expected of alkenes. The electrons that might be fixed in three double bonds are instead *delocalized* over all six carbon atoms.

A hydrocarbon containing one or more benzene rings (or other similarly stable electron arrangements) is an **aromatic hydrocarbon**, and any related substance is an **aromatic compound**. One or more of the hydrogen atoms on a benzene ring can be replaced by other atoms. When two hydrogen atoms are replaced, the common name is based on the relative position of the replacement atoms (or atom groups). A 1,2-disubstituted benzene is designated as an *ortho* (*o-*) isomer; 1,3-, a *meta* (*m-*) isomer; and 1,4-, a *para* (*p-*) isomer. An aromatic group as a substituent is called an **aryl** group. When benzene is a substituent, it is called a **phenyl** group.

A **polycyclic aromatic hydrocarbon (PAH)** has fused benzene rings sharing a common side.

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