

**College of science**

**Department of Biochemistry**

**Second class**

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## **Lecture2: Alkanes**

Alkanes are a fundamental group of organic compounds, consisting entirely of hydrogen and carbon atoms arranged in a structure of single bonds. They are also known as saturated hydrocarbons because each carbon atom is fully "saturated" with hydrogen atoms through single covalent bonds. Alkanes are a key topic in organic chemistry due to their simplicity and presence in everyday life, from fuels to natural gases.

### **1. General Formula and Structure**

The general molecular formula for alkanes is  $C_nH_{2n+2}$ , where "n" represents the number of carbon atoms. Each carbon atom in an alkane forms four sigma ( $\sigma$ ) bonds, either with hydrogen atoms or other carbon atoms.

Alkanes can be:

**Linear (straight-chain):** Carbon atoms are connected in a continuous line, such as in methane ( $CH_4$ ), ethane ( $C_2H_6$ ), and propane ( $C_3H_8$ ).

**Branched:** One or more carbon atoms are attached to a carbon in the main chain, leading to compounds like isobutane ( $C_4H_{10}$ ).

### **2. Nomenclature of Alkanes**

The naming of alkanes follows the International Union of Pure and Applied Chemistry (IUPAC) system. The root name is determined by the number of carbon atoms in the longest chain:

**Methane (1 carbon,  $CH_4$ )**

**Ethane (2 carbons,  $C_2H_6$ )**

**Propane (3 carbons,  $C_3H_8$ )**

**Butane (4 carbons,  $C_4H_{10}$ )**

**Pentane (5 carbons,  $C_5H_{12}$ )** The rest follow a similar pattern with prefixes derived from Greek or Latin numbers (hexane, heptane, octane, etc.)

### **3. Physical Properties**

**Alkanes are non-polar molecules, meaning they do not dissolve in water (which is polar) but are soluble in organic solvents. Their physical properties depend on their molecular weight:**

**State:** The first four alkanes (methane to butane) are gases at room temperature, while those with 5 to 16 carbon atoms are liquids, and higher alkanes are solids.

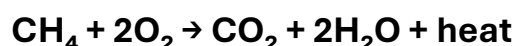
**Boiling and Melting Points:** Both increase with the molecular weight. Branched alkanes tend to have lower boiling points compared to their straight-chain counterparts due to less efficient packing of molecules.

**Density:** Alkanes are less dense than water, which is why oils and hydrocarbons float on water.

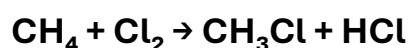
### **4. Chemical Properties**

**Alkanes are relatively unreactive compared to other organic compounds. This is because they only contain strong carbon-carbon and carbon-hydrogen single bonds, which require a significant amount of energy to break. However, they undergo a few key reactions:**

**Combustion:** Alkanes readily burn in the presence of oxygen to produce carbon dioxide, water, and energy (heat). This reaction is the basis for their use as fuels:



**Halogenation:** In the presence of ultraviolet light, alkanes react with halogens like chlorine or bromine in a substitution reaction. For example, methane reacts with chlorine to form chloromethane:



## **5. Sources and Uses of Alkanes**

**Alkanes** are found primarily in natural gas and petroleum. Methane is the main component of natural gas, while longer-chain alkanes are present in crude oil. Through refining processes like fractional distillation, alkanes are separated based on their boiling points and used in various industries:

**Fuels:** Methane (natural gas), propane, butane, gasoline (a mixture of alkanes), and kerosene are used as energy sources.

**Lubricants and Waxes:** Higher alkanes like paraffin are used in candles, lubricants, and coatings.

**Feedstock for Chemical Synthesis:** Alkanes are precursors to many chemicals and plastics.

## **6. Isomerism in Alkanes**

Alkanes exhibit a type of structural isomerism known as chain isomerism. This occurs when the same molecular formula corresponds to different structures due to branching. For example, butane ( $\text{C}_4\text{H}_{10}$ ) exists as:

n-Butane (a straight chain).

Isobutane (a branched chain).

