Bioorganic Chemistry
Chemical Bonding _ Hydrogen Bond & Metallic Bond
Lecture-3

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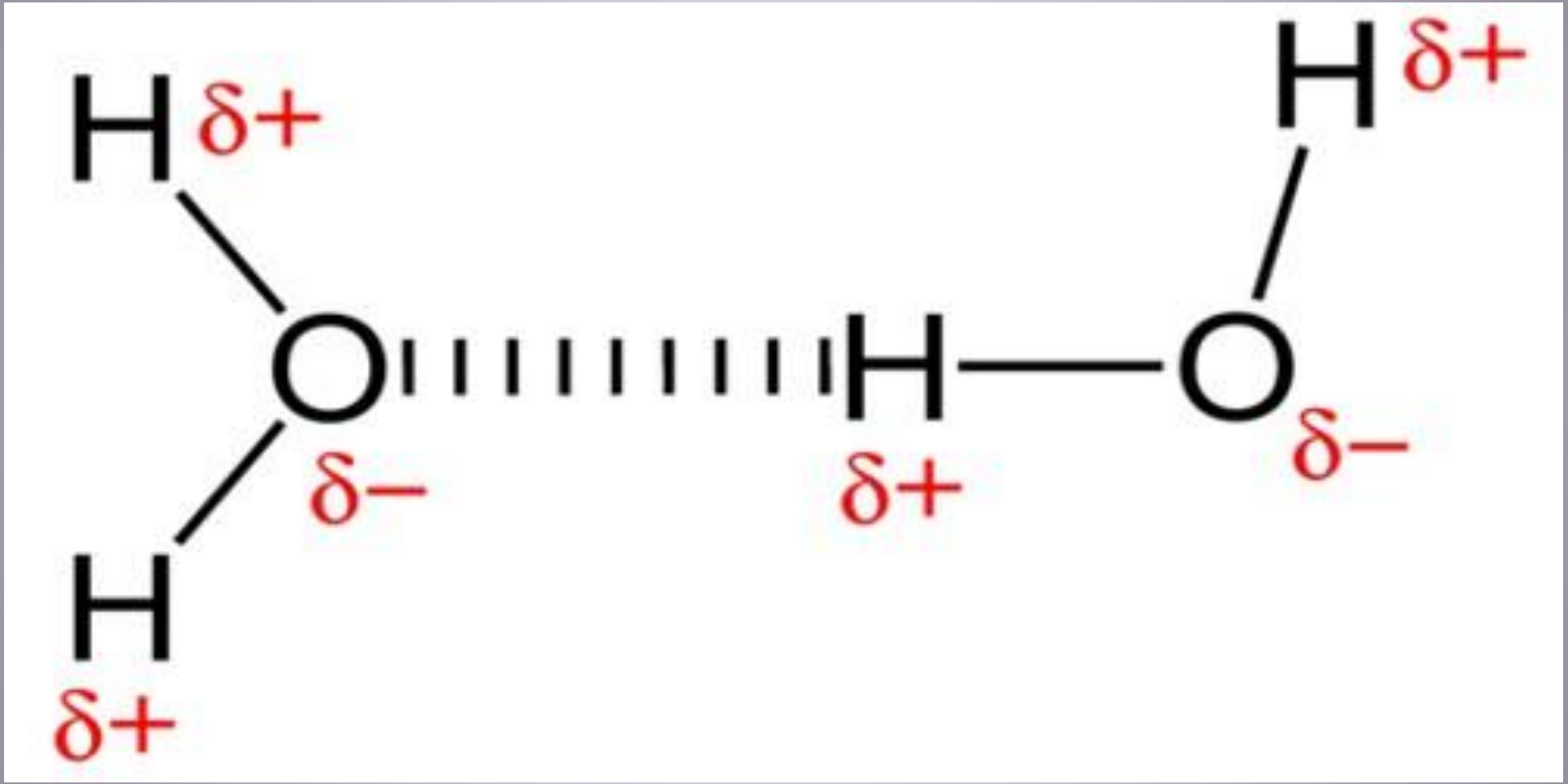
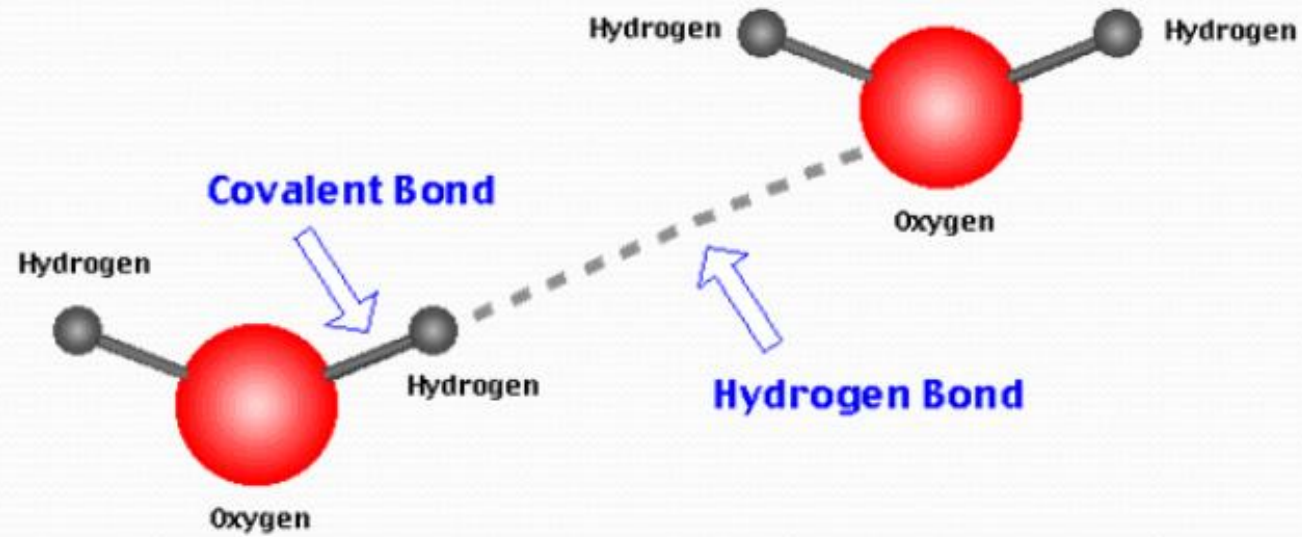
Hydrogen Bond



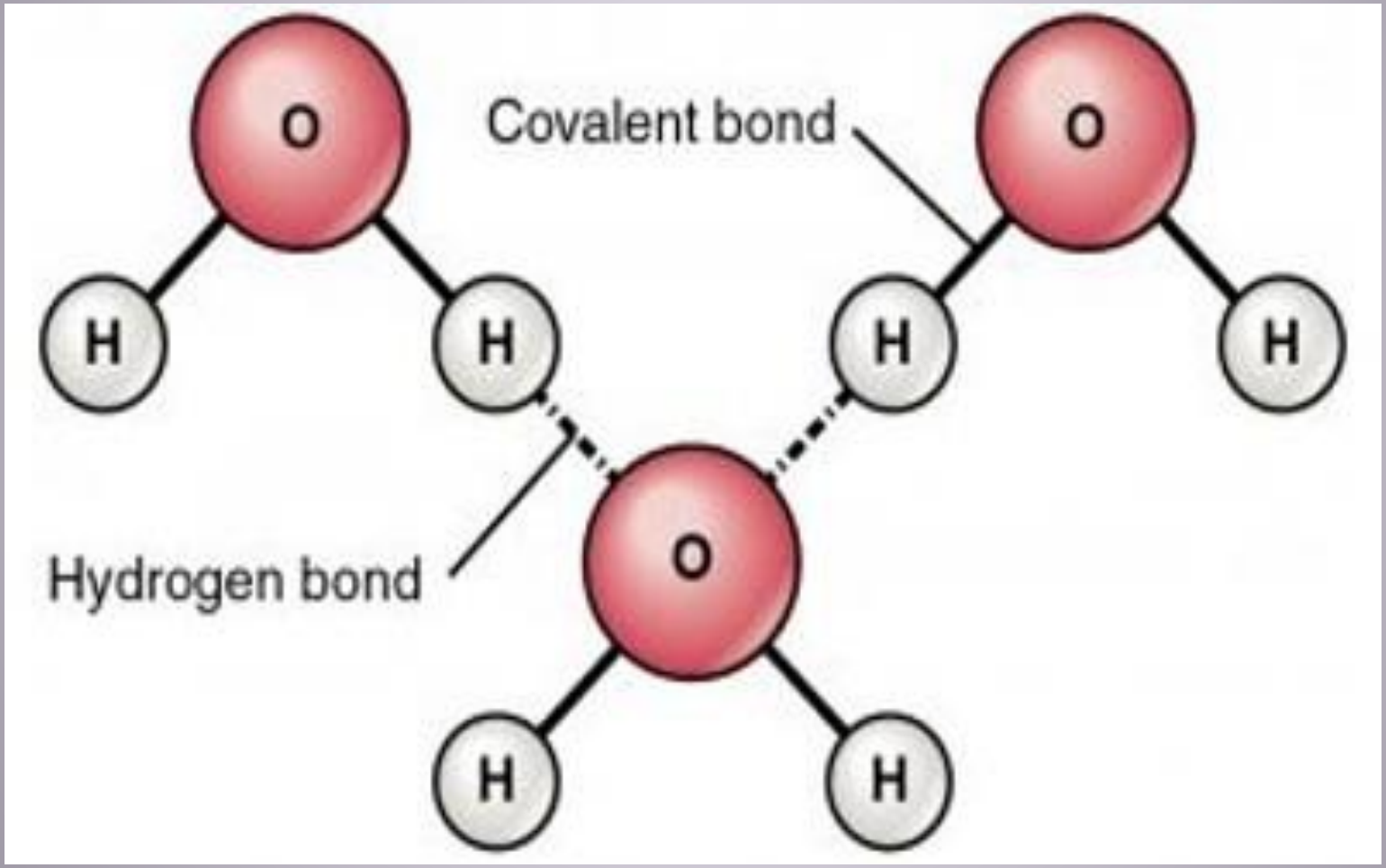
Hydrogen Bond

- Hydrogen bonds can occur within one single molecule, between two like molecules, or between two unlike molecules.



Hydrogen Bond

- **A hydrogen bond** is a low kind type of dipole-dipole bond that exists between an electronegative molecule and a hydrogen molecule bonded to another electronegative molecule. It can exist between atoms in different molecules or in parts of the same molecule. The hydrogen is attached directly to one of the most electronegative elements, causing the hydrogen to acquire a significant amount of positive charge. This type of bond always involves a hydrogen atom. Greater electronegativity of the hydrogen bond acceptor will lead to an increase in hydrogen-bond strength. It is a type of dipole-dipole interaction; it is not a true chemical bond


O
Covalent bond
O
H
H
H
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Hydrogen bond
O
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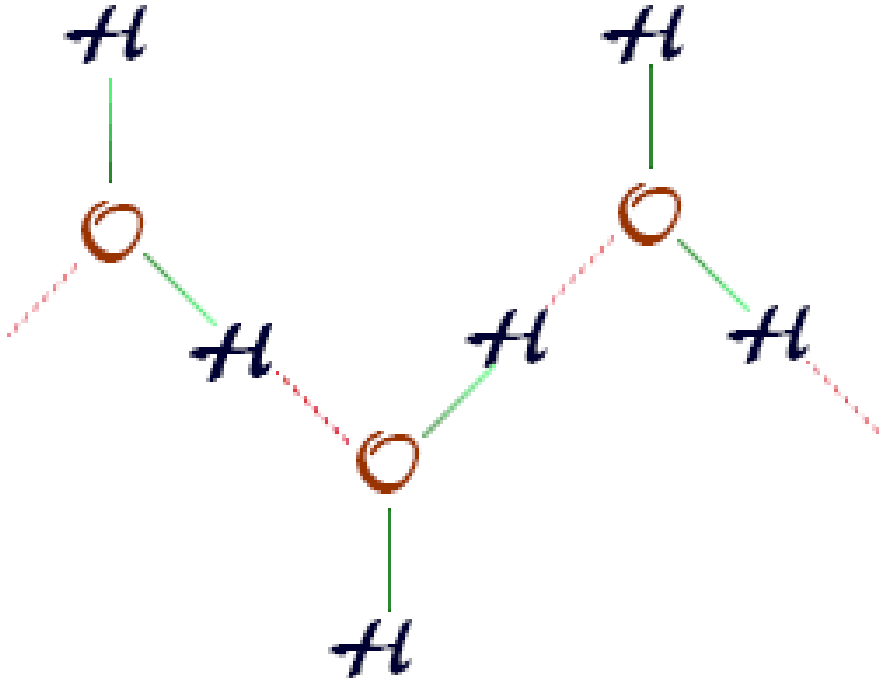
H

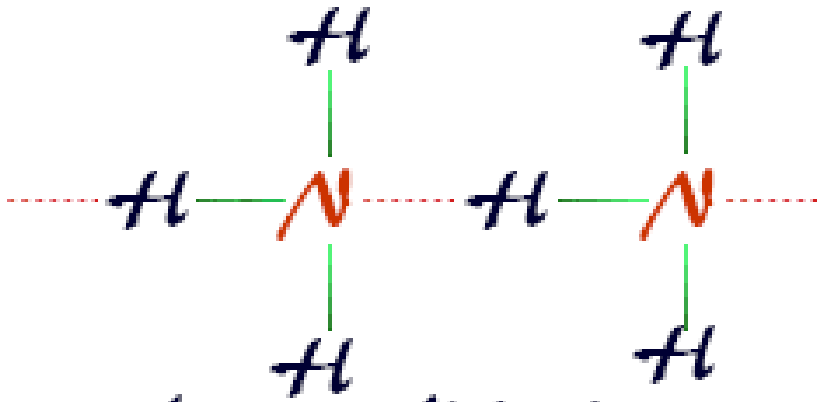
Hydrogen bonds can occur between molecules (intermolecularly), or within different parts of a single molecule (intramolecularly). It is a weak type of force that forms a special type of dipole-dipole attraction which occurs when a hydrogen atom bonded to a strongly electronegative atom exists in the vicinity of another electronegative atom with a lone pair of electrons. The typical hydrogen bond is stronger than van der Waals forces but weaker than covalent, ionic and metallic bonds. The increase in the boiling point happens because the molecules are getting larger with more electrons, and so van der Waals dispersion forces become greater.

Hydrogen Bonding

Intermolecular H-Bonding

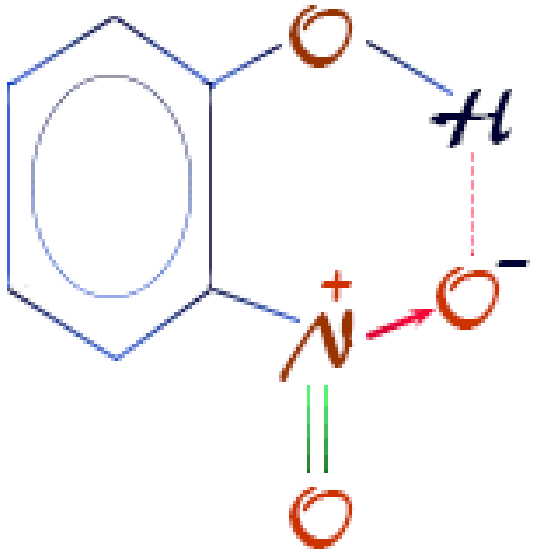


Water Molecule

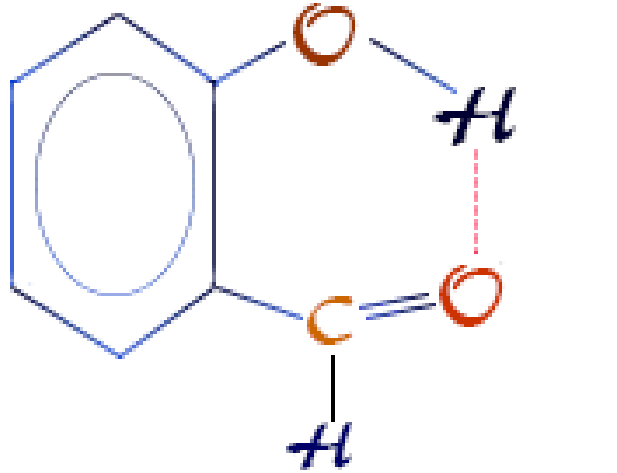


Ammonia Molecule

Intramolecular H-Bonding



Ortho-Nitrophenol

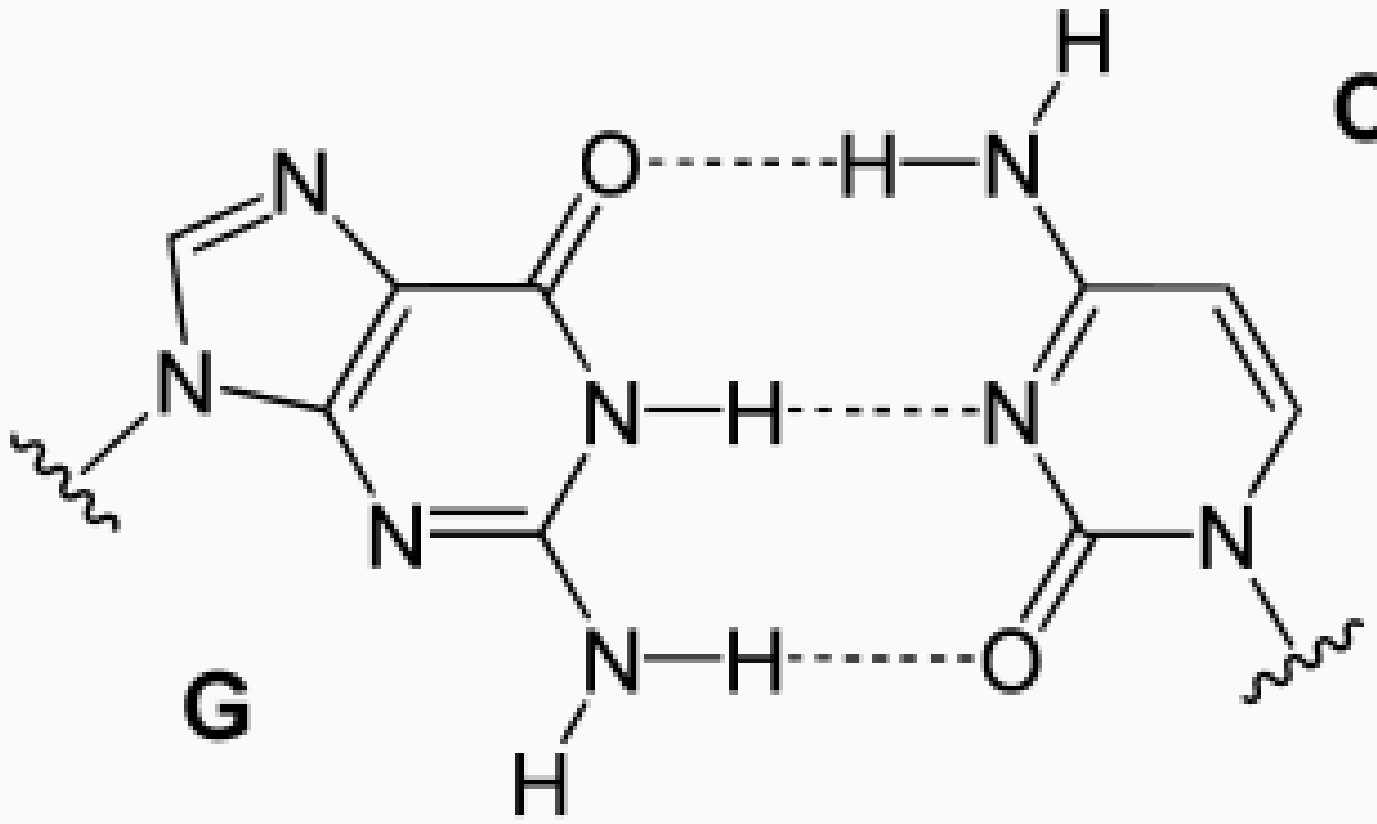


Ortho-Hydoxybenzaldehyde

Types of Hydrogen Bonds

1. **Intramolecular hydrogen bonds** – Intramolecular hydrogen bonds occur within a single molecule. This happens when two functional groups in a molecule are arranged so they can attract each other. An example occurs in salicylic acid. The alcohol (-OH) group on the ring attracts the carboxylic acid group (the double-bonded oxygen). Intermolecular hydrogen bonding also occurs between DNA base pairs.

Intramolecular hydrogen bonds

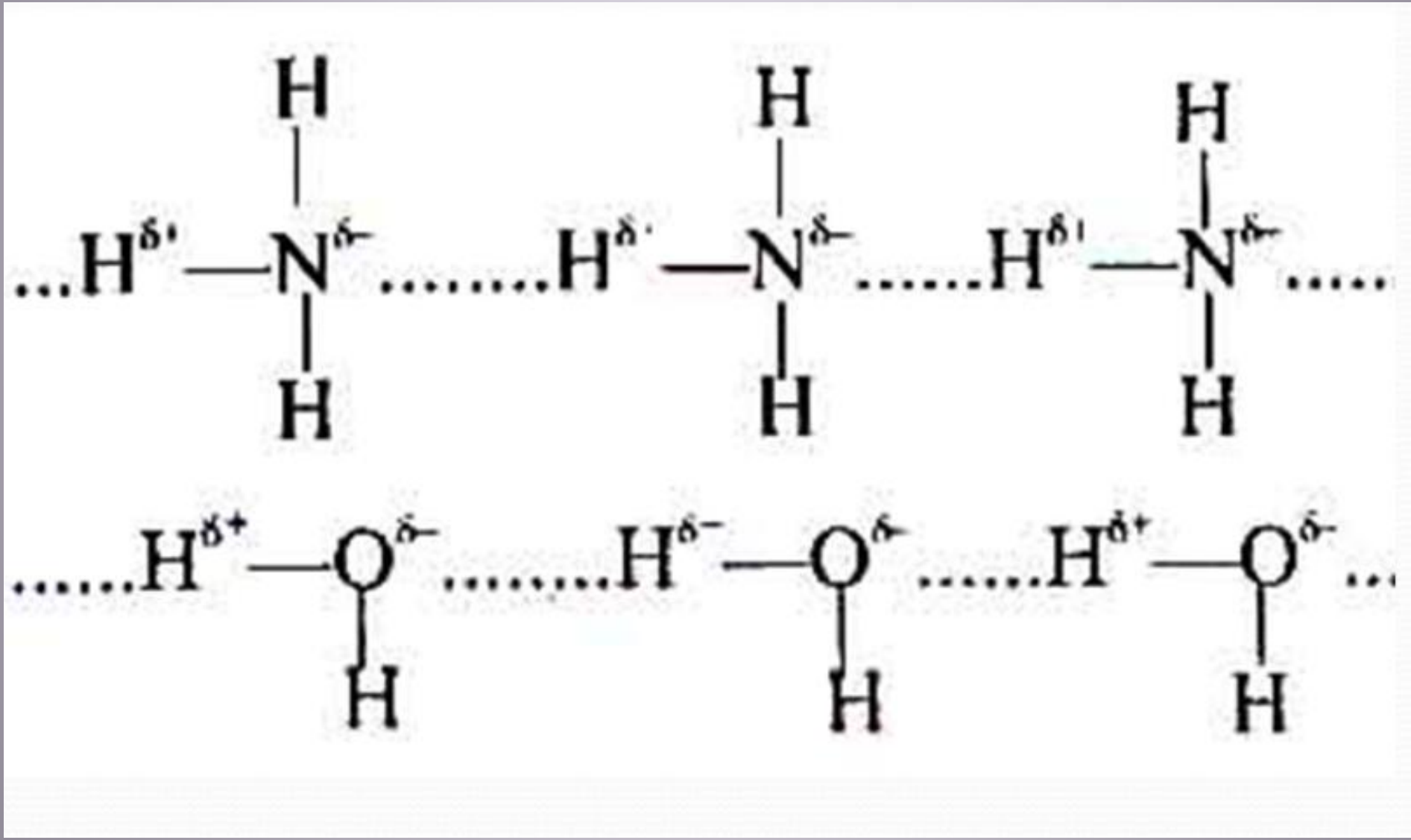


Hydrogen bonds form between base pairs in DNA.

Intermolecular hydrogen bonds

2. Intermolecular hydrogen bonds – Intermolecular hydrogen bonds occur between atoms of two different molecules. This occurs when one molecule contains a partially positive hydrogen atom and the other molecule contains a partially negative atom. This type of bonding occurs between water molecules. It also occurs between water and alcohols and aldehyde.

Intermolecular hydrogen bonds



Effects of Hydrogen Bonds

Hydrogen bonding results in some interesting and unusual effects:

- **Melting and Boiling Point** – Usually, substances of similar molecular weights have similar melting and boiling points. But, alcohols have much higher boiling points than ethers of comparable molecular weight. The hydrogen bonding in alcohol increases the boiling point because extra energy is required to break the hydrogen bonds and permit boiling.

- **Volatility** – Molecules that experience hydrogen bonding have higher boiling points, so they are less volatile.

- **Solubility** – Hydrogen bonding explains why alcohols are soluble in water, but alkanes are not. Intermolecular hydrogen bonding in alcohols lets them form hydrogen bonds with water, too. Nonpolar alkanes can’t form these bonds. However, increasing the length of the carbon chain in alcohols decreases their solubility because the chain gets in the way of hydrogen bond formation

- V**iscosity and Surface Tension** – Hydrogen bonding reduces an affected molecule's ability to flow, so it has higher viscosity and surface tension.

- **Lower Density of Ice Than Water** – Hydrogen bonding produces a cage-like structure in ice. In contrast, liquid water is not as closely packed. So, ice has a lower density than water and floats.

- **Phase Change Anomalies** – Hydrogen bonding causes some compounds to be liquid at a certain temperature, then solid as temperature increases, and then liquid past another temperature.

- **Deliquescence** – Sodium hydroxide (NaOH) displays deliquescence partly because the OH^- reacts with moisture in air to form a hydrogen-bonded species. A similar process occurs with some other molecules.

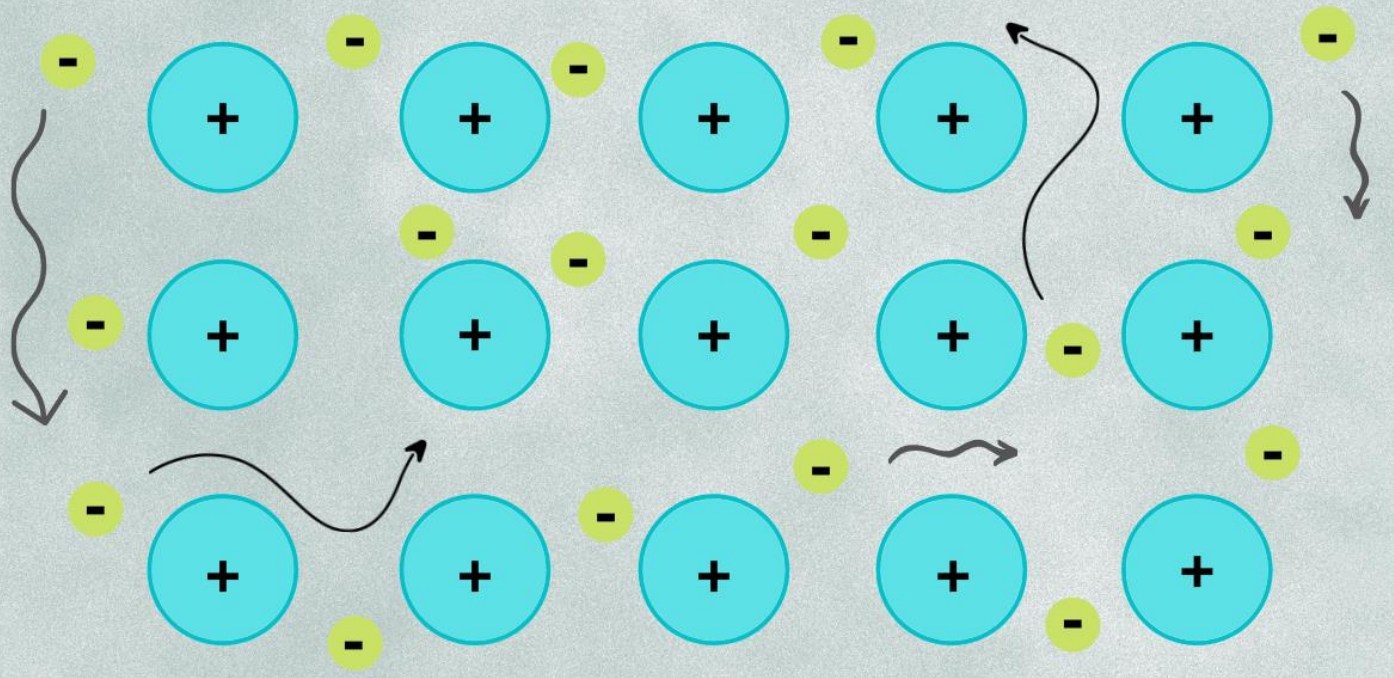
Metallic Bond

Metallic Bond: Metallic bonding is a special type of bonding that holds the metals together in metal crystal.

This bond is neither covalent nor ionic. Metals have tendency to give up electrons and none is their to accept it.

Metallic Bonding

Metallic bonding occurs when a group of metal atoms shares a cloud of valence electrons.



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