Bioorganic Chemistry
Chemical Bonding _ Covalent Bond
Lecture-2

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Covalent Bonds

Covalent chemical bonds involve the sharing of a pair of valence electrons by two atoms, in contrast to the transfer of electrons in ionic bonds. Such bonds lead to stable molecules if they share electrons in such a way as to create a noble gas configuration for each atom.

Covalent Bonds

- Large inter-atomic forces are created by the sharing of electrons to form directional bonds.
- Covalent bonding takes place between atoms with small differences in electro negativity which are close to each other in periodic table (*between non-metals and nonmetals).*
- The covalent bonding is formed by sharing of outer shell electrons (i.e., s and p electrons) between atoms rather than by electron transfer

Covalent Bonds

- This bonding can be attained if the two atoms each share one of the other's electrons. So the noble gas stable electron configuration can be attained.
- Number of covalent bonds for a particular molecule is determined by the number of valence electrons.
- Rarely are compounds purely ionic or covalent but are a percentage of both.

Covalent Bonds In H_2

Two hydrogen atoms, each with 1 electron,

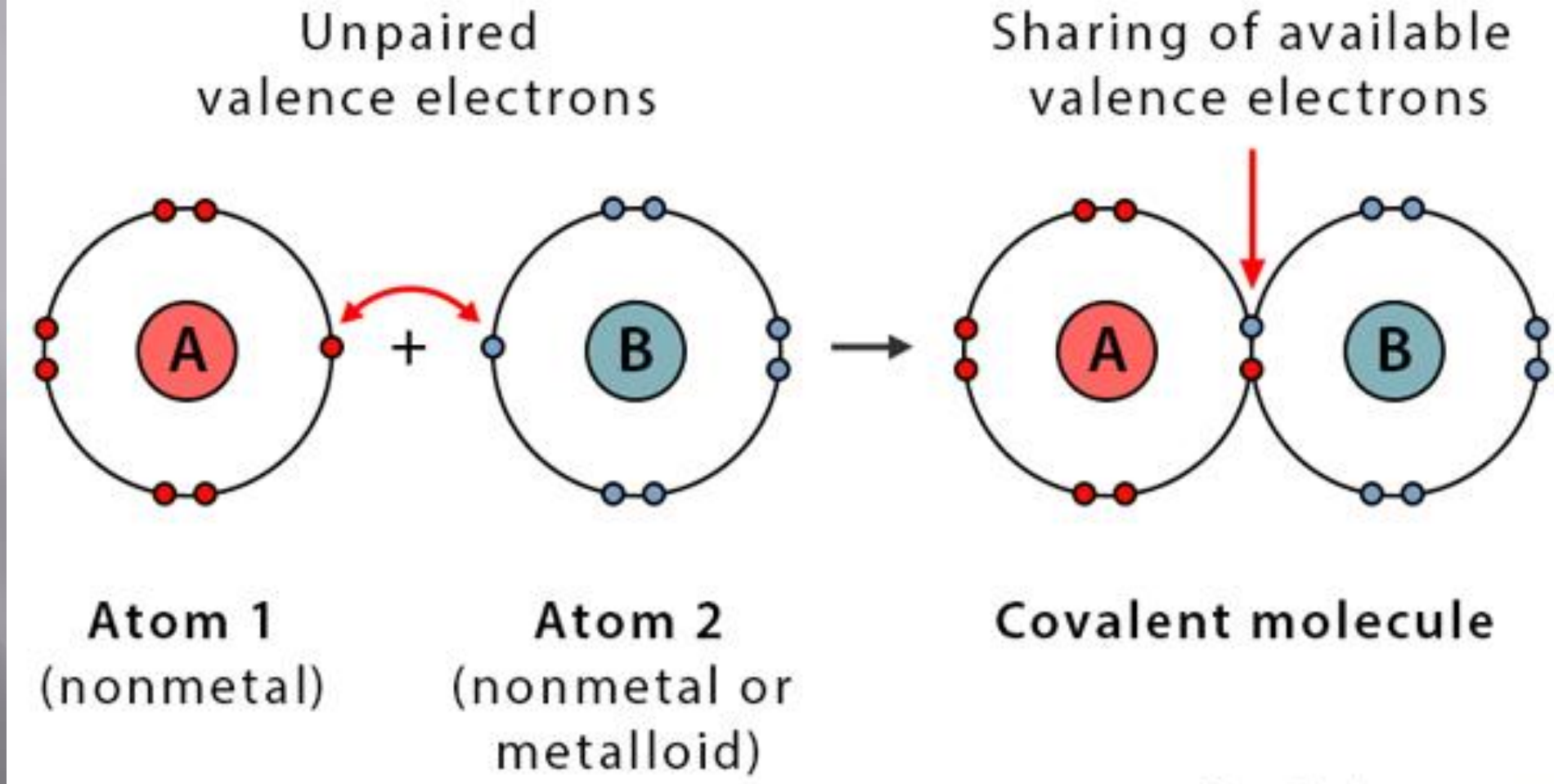
H▪ ▪H

Can share those electrons in a covalent bond.

H:H

- Sharing the electron pair gives each hydrogen an electron configuration analogous to helium.

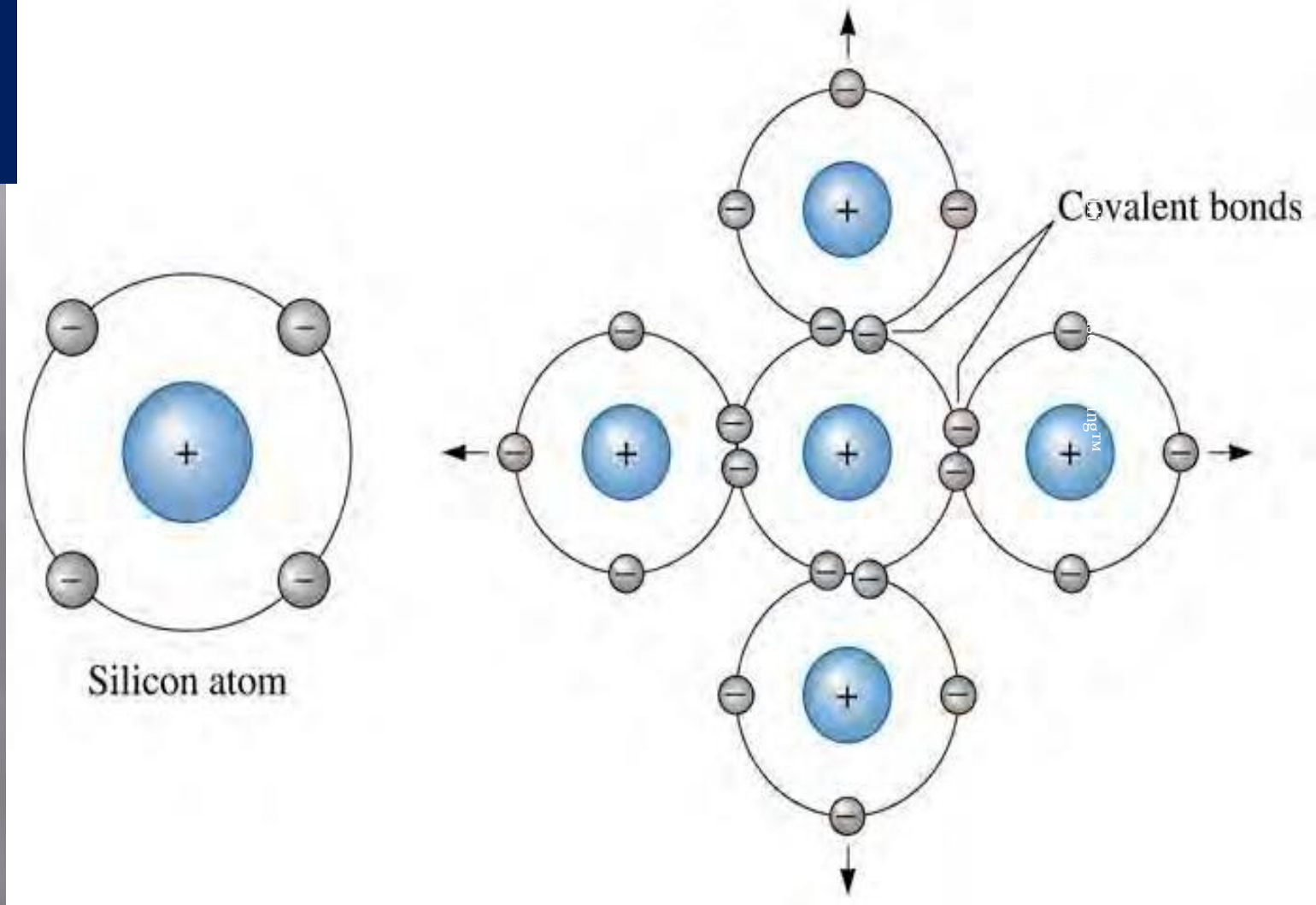
Covalent Bond



Covalent Bonding

Pure element - silicon (Si):

Si (Z=14):
$1s^2 2s^2 2p^6 3s^2 3p^2$

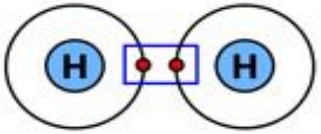


Covalent bonding requires that electrons be shared between atoms in such a way that each atom has its outer *sp* orbital filled.In silicon, with a valence of four, four covalent bonds must be formed.

Types of Covalent Bond

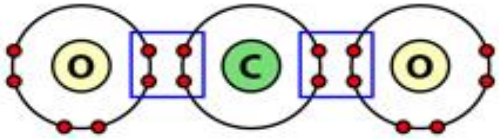
Based on the number of shared electron pairs

Single Bond



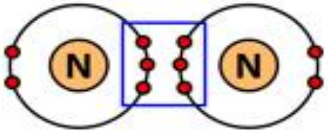
Hydrogen (H_2)

Double Bond



Carbon dioxide (CO_2)

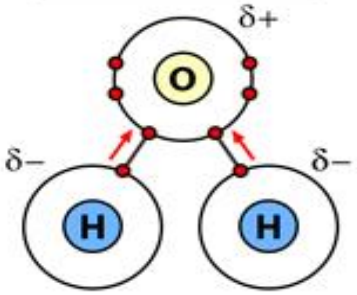
Triple Bond



Nitrogen (N_2)

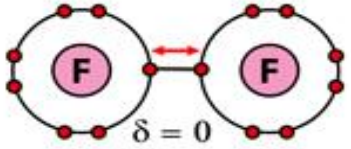
Based on the polarity and coordination of the atoms

Polar Bond



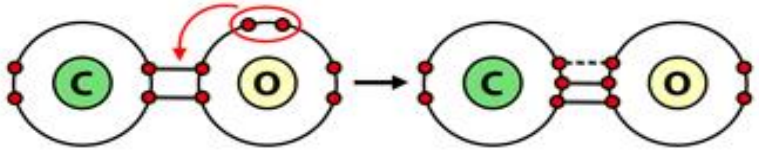
Water (H_2O)

Nonpolar Bond



Fluorine (F_2)

Coordinate Bond



Carbon monoxide (CO)

Some Properties of Covalent Bonding

Property	Explanation
Melting point and boiling point	Very high melting points because each atom is bound by strong covalent bonds. Many covalent bonds must be broken if the solid is to be melted and a large amount of thermal energy is required for this.
Electrical conductivity	Poor conductors because electrons are held either on the atoms or within covalent bonds. They cannot move through the lattice.
Hardness	They are hard because the atoms are strongly bound in the lattice, and are not easily displaced.
Brittleness	Covalent network substances are brittle. If sufficient force is applied to a crystal, covalent bond are broken as the lattice is distorted. Fracture failure occurs rather than deformation of a shape.

Atomic Bonding - Summary

Type	Bond Energy	Comments
Ionic	Large!	Nondirectional (ceramics)
Covalent	Variable large-Diamond small-Bismuth	Directional (semiconductors, ceramics polymer chains)
Metallic	Variable large-Tungsten smll-Mercury	Nondirectional (metals)

The End