Organic Chemistry

PG SEMESTER- 1
CC-3
UNIT-III

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1. Structure and Bonding

Organic chemistry is built on understanding how atoms bond and arrange in molecules.

- Atomic Structure & Hybridization

Carbon can form sp^3, sp^2, and sp hybridized orbitals.
sp^3 (tetrahedral) → e.g., methane (CH■).
sp^2 (trigonal planar) → e.g., ethene (C=C).
sp (linear) → e.g., ethyne (C≡C).

- Bonding

σ (sigma) bonds: formed by head-on overlap of orbitals, stronger, allow free rotation.
π (pi) bonds: formed by sideways overlap of p-orbitals, weaker, restrict rotation.

- Resonance and Delocalization

Some molecules cannot be represented by one structure (e.g., benzene).
Delocalization stabilizes molecules (resonance energy).

- Polarity

Due to electronegativity differences (e.g., C–O, C–Cl bonds).
Affects solubility and reactivity.

2. Stereochemistry

The 3D arrangement of atoms plays a huge role in reactivity and properties.

- Isomerism

Structural isomers: different connectivity (e.g., butane vs isobutane).

Stereoisomers: same connectivity, different 3D arrangement.

- Chirality & Optical Activity

A carbon with four different substituents → chiral center.
Non-superimposable mirror images → enantiomers.
Mixture of enantiomers → racemic mixture.

- Geometrical Isomerism (Cis-Trans / E-Z)

Restricted rotation in alkenes leads to cis (same side) and trans (opposite side) isomers.

3. Reaction Mechanisms

Understanding how reactions occur step by step.

- Nucleophiles vs Electrophiles

Nucleophiles: electron-rich species (–OH■, NH■, Cl■).
Electrophiles: electron-deficient species (H■, carbocations, carbonyl C).

- Substitution Reactions

SN1: Unimolecular, carbocation intermediate, favored by tertiary carbons, polar protic solvents.
SN2: Bimolecular, backside attack, inversion of configuration, favored by primary carbons, strong nucleophiles, polar aprotic solvents.

- Elimination Reactions

E1: Carbocation intermediate, two steps, competes with SN1.
E2: One step, base abstracts proton while leaving group departs, Zaitsev’s Rule applies.

4. Functional Group Chemistry

The reactivity of organic molecules depends on functional groups.

- Alcohols (–OH group)

Physical properties: H-bonding → high boiling points.
Reactions: Oxidation, Substitution, Esterification.

- Carbonyl Compounds (C=O group)

Highly polar; carbonyl carbon is electrophilic.

Aldehydes: oxidize to acids, reduce to alcohols.
Ketones: more resistant to oxidation.
Undergo nucleophilic addition reactions (HCN, NaHSO■, Grignard).

5. Hydrocarbons (Alkanes, Alkenes, Alkynes)

Hydrocarbons form the base framework of organic molecules.

- Alkanes

Saturated hydrocarbons.
Reactions: combustion, free radical halogenation.

- Alkenes

Unsaturated hydrocarbons.
Reactions: electrophilic addition, polymerization, oxidation.

- Alkynes

More acidic than alkanes/alkenes.
Reactions: addition of halogens/HX, oxidation to acids, formation of acetylide anions.