## ICH 402: ORGANIC CHEMISTRY

## Course objective

- To study the acid base concept in organic chemistry
- To know the nature of reaction intermediates and the factors affecting reaction conditions such as nature of solvent, isotope effects and salt effects.
- To learn about reaction types and their kinetics, thermodynamic and effect of thermodynamic parameters on reaction with kinetic aspects.
- To understand aliphatic and aromatic nucleophilic and electrophilic substitution by studying their mechanism with factors effecting and related named reactions.
- To discover various aspects of stereochemistry and applications of chirotechnology.

**UNIT I:** **14 hr**

**Reaction intermediates:** Generation, structure, stability, reactivity & detection of classical & non-classical carbocations, carbanions, free radicals, carbenes, nitrenes & arynes. N, S & P ylides & enamines.

**Organic Reactions and Mechanism**: Reaction mechanism & types, types of organic reactions, reaction profile diagrams, thermodynamic & kinetic control, leaving group and solvent. Methods of determining reaction mechanisms: Kinetic & non-kinetic methods-identification of products, detection of intermediates, isotopic labelling, stereochemical evidences, cross-over experiments, kinetic evidences & kinetic isotopic effects. The Hammond postulate. Principle of microscopic reversibility and Marcus theory. **Acids and Bases**: Introduction to acids and bases, Bronsted-lowry and acid-bases concept, organic acids and bases, pKa and pH, effect of solvent on acid and base strength, effect of structure of organic compound on acid and base strength. Reactivity in relation to molecular structure and conformation. Steric effects. F strain, B-strain. Bond angle strain. The Hammett equation and its applications, Ortho effect. Taft equation. Linear free energy relationships

**UNIT II: Organic Reactions and Mechanism (Part-I)** **14 hr**

**Aliphatic Nucleophilic Substitution reactions:** Mechanisms Nucleophilic substitution: Substitution reactions of ambident nucleophiles, neighbouring group participation of O, S, N, halogens, aryl groups, alkyl and cycloalkyl groups in nucleophilic substitution reactions. Sigma, Pi bond participation in acylic and bicyclic systems (Non-classic carbocations) Substitution at allylic, trigonal and Vinylic carbons, Meyer's synthesis of aldehydes, ketones and carboxylic acids, alkylation with trialkyl boranes. **Aliphatic Electrophilic substitutions:** SE1 SE2 and SEi mechanisms hydrogen exchange, migration of double bonds, halogenation of aldehydes, ketones, acids, acylhalides sulphoxides and sulphones, aliphatic diazonium coupling, nitrosation at carbon and nitrogen diazo transfer reaction. Decarboxylation of aliphatic acids. Haloform reaction and Haller-Bauer reaction.

**UNIT III: Organic Reactions and Mechanism (Part-II)** **14 hr**

**Aromatic nucleophilic substitution:** A general introduction to different mechanisms of aromatic substitution SN Ar, AN and aryne, Von Richter rearrangement, Sommlet, Hauser rearrangement Smiles rearrangement. Radical substitution Mechanism: Reaction at sp3 carbon: Reactivity in aliphatic substrates reactivity at bridged position, reactivity at sp2 carbon. Reactivity in aromatic substrates neighbouring group assistance in free radical reactions, effect of reactivity in the attacking radical, effect of solvent on reactivity halogenation at an alkyl carbon and allylic carbon, hydroxylation at aromatic carbon by means of Fenton's reagent, oxidation of aldehydes to carboxylic acids, formation of cyclic ethers with $Pb(OAC)_4$ Reed reaction, Sandmayer reaction, Kolbe reaction and Hunsdiecker reaction.

**Addition Elimination Mechanisms:** (a) Addition to carbon multiple bonds- Addition reactions involving electrophiles, necleophiles and free radicals, cyclic mechanisms, orientation and stereochemistry, hydrogenation of double and triple bonds, hydroboration, Birch reduction. Michael reaction, (b) Addition to carbon-hetero atom multiple bonds: Mannich reaction AH reductions of Carbonyl compounds acids, esters, nitrites, addtion of Grignard reagents, Reformatsky reaction, Tollen'sreaction, witting reaction, Prins reaction: (c) Elimination reactions:

Stereochemistry of eliminations in acyclic and cyclic systems, orientation in eliminations - Saytzeff and Hoffman elimination propolitic elimination.

**UNIT IV: Stereochemistry** **14 hr**

Concept of chirality, optical isomerism, D,L-; R,S- designations, geometrical isomerism and E,Z designations, Stereoselective and stereospecific reactions, Racemisation, mechanism of racemisation, resolution of racemic mixtures, Asymmetric synthesis-definition, importance, mechanism, energy consideration, advantages and limitations, methods of determination of enantiomeric excess. Enantioselective reactions, The chiral pool, chiral auxiliaries and chiral reagents. Use of α-amino acids in the synthesis of benzodiazepines, carbohydrates in the synthesis of swainosonine (D-mannose) and timolal (mannitol). Synthesis and applications of oxazaborolidines, $IPC_2BH$, (S)-BINAP-DIAMINE and (R)-BINAL-H.

## Course outcome

- The student would understand the acid base concept in organic chemistry ad would know the nature of reaction intermediates and the factors affecting reaction conditions such as nature of solvent, isotope effects and salt effects
- The kinetics and energetics of $S_N2$, $S_N1$, $S_Ni$, $S_E1$, $S_E2$, $S_Ei$, aromatic nucleophilic and electrophilic substitution by understanding their mechanisms with factors effecting and related named reactions would be understood by the student .
- Basic concept of stereochemistry and applications of stereochemistry would be learnt by studying asymmetric synthesis and use of chiral reagents.

**References:**


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