

CH-461 Stereochemistry

Credit Hours: 3-0

Prerequisite: Nil

Course Objectives

By the end of this course, students will:

1. Understand the principles of stereochemistry including chirality, symmetry, and conformational analysis.
2. Interpret stereochemical outcomes in organic reactions.
3. Apply stereochemical principles to design enantio- and diastereoselective reactions.
4. Analyze stereochemistry using Cahn–Ingold–Prelog (CIP) rules and stereochemical descriptors.
5. Explore real-world applications in asymmetric synthesis, drug design, and catalysis.

Course Contents

1. Fundamentals of Stereochemistry: Symmetry elements and molecular chirality, Types of isomerism: constitutional, configurational, conformational, CIP priority rules, R/S and E/Z nomenclature
2. Chiral Molecules and Stereoisomers: Enantiomers, diastereomers, meso compounds, Fischer, Newman, and Sawhorse projections, Chirality in molecules without stereocenters (axial, planar, helical),
3. Conformational Analysis: Conformations of acyclic systems: butane, substituted alkanes, Cyclohexane ring flip, mono- and disubstituted derivatives, Stereoelectronic effects and conformational control in reactivity,
4. Stereochemistry of Organic Reactions: Stereospecific vs. stereoselective reactions, Reactions involving chiral centers: SN1, SN2, E1, E2, Additions to alkenes and carbonyls, Neighboring group effects and retention/inversion
5. Asymmetric Synthesis & Chiral Reagents: Enantioselective and diastereoselective synthesis, Chiral auxiliaries, chiral catalysts (e.g., Sharpless epoxidation, CBS reduction), Use of enzymes in asymmetric synthesis
6. Applications in Natural Products and Pharmaceuticals: Chirality in biologically active molecules, Stereochemistry in drug action and design, Case studies: Thalidomide, Ibuprofen, L-Dopa.

Course Outcomes

After completing this course, students will be able to:

7. Distinguish between different stereoisomers and assign their absolute configuration.
8. Analyze reaction mechanisms in terms of stereochemical outcomes and transition state models.
9. Predict conformational stability and stereoelectronic effects in cyclic and acyclic systems.
10. Evaluate and interpret stereochemical data in pharmaceuticals and natural products.
11. Apply concepts of stereochemistry in asymmetric catalysis and synthetic design.

Recommended Books:

15. Stereochemistry of Organic Compounds — Ernest L. Eliel & Samuel H. Wilen, Wiley, 1994
16. Modern Stereochemistry — D. Nasipuri, New Age International, 2010 (3rd Edition)
17. Organic Stereochemistry — Michael J. T. Robinson, Oxford University Press, 2005
18. Principles of Organic Synthesis — R. O. C. Norman and James M. Coxon, CRC Press, 1993
19. Organic Chemistry — Clayden, Greeves, Warren, Oxford, 2012 (2nd Edition) (Supplementary Reading).