

Punjab University College of Pharmacy
Faculty of Pharmacy
University of the Punjab, Lahore
Course Outline



Programme	Pharm.D 2nd Semester	Course Code	PHARM-113 (Theory), PHARM-114 (Lab)	Credit Hours	3+1
Course Title	Pharmaceutical Chemistry-IB (Organic Chemistry-II)				
Course Introduction					
Pharmaceutical Chemistry IB (Organic Chemistry–II) is a core subject that builds upon the fundamental principles of organic chemistry and extends them toward their application in the design, synthesis, and understanding of pharmaceutical compounds. This course focuses on the structural, mechanistic, and functional aspects of organic molecules that play a vital role in drug discovery and development. The subject emphasizes important classes of organic compounds such as heterocyclic compounds, aromatic systems, and biologically relevant molecules, which form the backbone of many therapeutic agents. Students gain insight into reaction mechanisms, structure–activity relationships (SAR), and the physicochemical properties that influence drug behavior, including solubility, stability, and bioavailability. In addition, the course introduces modern concepts of organic synthesis such as green chemistry, microwave-assisted synthesis, and the use of biocatalysts, highlighting environmentally sustainable and efficient approaches to drug synthesis. Understanding these concepts enables students to appreciate how chemical modifications can optimize drug efficacy and minimize adverse effects. Overall, this course serves as a bridge between theoretical organic chemistry and its practical application in pharmacy. It equips students with the knowledge required to understand how drugs are designed, synthesized, and evaluated, forming a strong foundation for advanced studies in medicinal chemistry and pharmaceutical sciences.					
Learning Outcomes					
On the completion of the course, the students will be able to: 1. Define and recall fundamental concepts of organic synthesis, including total synthesis, semi-synthesis, biocatalysis, green chemistry, and microwave-assisted synthesis. 2. Describe the preparation, properties, and pharmaceutical relevance of key heterocyclic compounds and fused ring systems. 3. Explain the principles, mechanisms, and significance of various synthetic approaches used in the preparation of pharmaceutical compounds. 4. Analyze and differentiate between conventional and modern synthetic techniques in terms of efficiency, cost, environmental impact, and practical feasibility. 5. Evaluate the advantages and limitations of green chemistry and biocatalytic approaches compared to traditional chemical synthesis methods. 6. Design simple synthetic pathways or propose suitable strategies incorporating efficient and environmentally sustainable methods for the synthesis of organic compounds.					

7. **Apply** advanced organic synthesis methods, including green chemistry and microwave-assisted synthesis, in pharmaceutical compound development.
8. **Demonstrate** laboratory proficiency in synthesizing pharmaceutically important compounds using classical and green organic methods.

Course Content (Theory)		Assignments/Readings
Week 1	Introduction to organic reactions, Substitution, addition, elimination, rearrangement	Chapter 5. Lutfun Nahar and Satyajit Sarker. Chemistry for Pharmacy students. John Wiley & Sons, Inc. Publication. Assignment: Define a chemical reaction. Classify different types of chemical reactions involved in organic synthesis and explain each type with suitable examples.
	Oxidation, reduction, condensation, hydrolysis and polymerization	
	Baeyer-Villiger oxidation	
Week 2	Arndt-Eistert reaction	Peter Sykes. A guide to mechanisms in organic chemistry. Longman group Ltd. Assignment: Practice the covered reactions with different examples
	Diels-Alder reaction	
	Grignard's reaction	
Week 3	Metal Hydride reduction	Peter Sykes. A guide to mechanisms in organic chemistry. Longman group Ltd. Assignment: Practice the covered reactions with different examples
	Wolff-Kishner reduction	
	Friedel-Crafts reaction	
Week 4	Perkin reaction	Peter Sykes. A guide to mechanisms in organic chemistry. Longman group Ltd. Assignment: Prepare a concept map on a chart paper summing up all reactions discussed in classes. Title of the project is "A visual guide to organic reactions"
	Cannizzaro's reaction	
	Mannich reaction	
Week 5	Heterocyclic compounds and their classification	Chapter 2. Louis D. Quin and John A. Tyrell. Fundamentals of heterocyclic chemistry, John Wiley & Sons, Inc. Publication Assignment: Attempt review exercise at the end of Chapter 2
Week 6	Hantzsch Widman (HW) Nomenclature of heterocyclic compounds	Chapter 26. Bhupinder Mehta and Manju Mehta. Organic Chemistry. 2 nd Ed. PHI Learning Private Ltd. 2015. Assignment: Make a concept map of the chemical reactions given by 5-membered heterocycles
	Replacement nomenclature of heterocyclic compounds	
	Preparation and properties of pyrrole	
	Preparation and properties of furan	
Week 6	Preparation and properties of thiophene	Chapter 11. Paul M. Dewick.
	Preparation and properties of pyridine	

Week 7	Preparation and properties of pyrimidine	Essentials of Organic Chemistry. John Wiley & Sons, Inc. Publication. Assignment: Compare in the form of a table the chemical synthesis, physicochemical properties and applications of 6-membered heterocycles
	Preparation and properties of pyrazine	
Week 8	Preparation and properties of indole	Chapter 6. Lutfun Nahar and Satyajit Sarker. Chemistry for Pharmacy students. John Wiley & Sons, Inc. Publication. Assignment: Attempt exercise at the end of Chapter 26
	Preparation and properties of quinoline	
	Preparation and properties of Isoquinoline	
Week 9	Heterocycles in pharmaceuticals: imidazole (histamine, antifungals)	Wilson and Gisvold's Text book of organic, medicinal and pharmaceutical chemistry. Lippincott Williams and Wilkins. Assignment: Make a poster entitled "Heterocycles in nature and pharmaceuticals"
	Purine/pyrimidine bases (DNA/RNA), benzoxazole and benzothiazole	
	Introduction to reactive intermediates	Chapter 1. Maya Shankar Singh. Reactive Intermediates in Organic Chemistry. Wiley-VCH Verlag GmbH & Co., Germany.
Week 10	Carbocations as reaction intermediates	Chapter 2-5. Maya Shankar Singh. Reactive Intermediates in Organic Chemistry. Wiley-VCH Verlag GmbH & Co., Germany.
	Carbanions as reaction intermediates	
	Carbenes as reaction intermediates	
		Assignment: Attempt quiz from the covered lesson
Week 11	Nitrenes as reaction intermediates	Chapter 6-7. Maya Shankar Singh. Reactive Intermediates in Organic Chemistry. Wiley-VCH Verlag GmbH & Co., Germany. Assignment: Attempt quiz from the covered lesson
	Benzynes as reaction intermediates	
	Free Radicals as reaction intermediates	Chapter 4. Maya Shankar Singh. Reactive Intermediates in Organic Chemistry. Wiley-VCH Verlag GmbH & Co., Germany. Assignment: Prepare a comparison chart for the reactive intermediates.
	Free radical scavengers and their applications	Chapter 4. Barry Halliwell and John M. C. Free radicals in biology and medicine. Gutteridge. Oxford University Press.

Week 12	Pinacol-Pinacolone rearrangement	Chapter 2. S. N. Sanyal. Reactions, rearrangements and reagents. Bharati Bhawan Publishers and Distributors. Assignment: Attempt quiz from the reactions covered
	Wagner Meerwein rearrangement	
Week 13	Wolff rearrangement	Chapter 2. S. N. Sanyal. Reactions, rearrangements and reagents. Bharati Bhawan Publishers and Distributors. Assignment: Attempt quiz from the reactions covered
	Hofmann rearrangement	
	Beckmann rearrangement	
Week 14	Aldol condensation	Chapter 2. S. N. Sanyal. Reactions, rearrangements and reagents. Bharati Bhawan Publishers and Distributors. Assignment: Attempt quiz and prepare a poster on a chart paper summing up all rearrangement reactions discussed in classes. Title of the project is “The World of Rearrangement Reactions”
	Favorskii rearrangement	
	Wittig rearrangement	
Week 15	Chemical synthesis and its environmental impact	Unit 1. Organic synthesis. Sathyabama Institute of Science and Technology. www.sathyabama.ac.in Chapter 10. Thomas, G. (2013). <i>Medicinal chemistry: A molecular and biochemical approach</i> . Oxford University Press.
	Total Synthesis, Semi-synthesis and Retrosynthesis	
	Biocatalysis, Enzymes as biocatalysts	
Week 16	Green synthesis and principles	Stefanache, A., Marcinschi, A., Marin, G. A., Mitran, A. M., Lungu, I. I., Miftode, A. M., ... & Hancianu, M. (2025). Green chemistry approaches in pharmaceutical synthesis: sustainable methods for drug development. <i>Appliedchem</i> , 5(2), 13. Assignment: Prepare a poster on conventional vs green chemical synthesis
	Methods of green synthesis	
	Microwave-Assisted Synthesis	
Textbooks and Reading Material		
Main source: Bhupinder Mehta and Manju Mehta. Organic Chemistry. 2 nd Ed. PHI Learning Private Ltd. 2015.		

Other sources: Lemke, T. L., & Williams, D. A. (2013). *Foye's principles of medicinal chemistry* (7th ed.). Lippincott Williams & Wilkins.

- Johnson, W. S. (2003). *Organic chemistry in the laboratory*. W. H. Freeman and Company.
- Abraham, D. J. (2017). *Burger's medicinal chemistry and drug discovery* (8th ed.). Wiley.
- Brown, W. H., & Bursten, M. L. (2014). *Introduction to organic chemistry* (8th ed.). Wiley.
- Vollhardt, K. P. C., & Schore, N. E. (2014). *Organic chemistry: Structure and function* (7th ed.). W. H. Freeman and Company.
- Thomas, G. (2013). *Medicinal chemistry: A molecular and biochemical approach*. Oxford University Press.
- Carey, F. A. (2007). *Advanced organic chemistry: Part A: Structure and mechanisms* (5th ed.). Wiley.
- Prasad, N. D. V. G. S., & Shinde, S. C. (2009). *Pharmaceutical organic chemistry*. Pharma Book Syndicate.
- Silverman, R. B. (2014). *The organic chemistry of drug design and drug action* (2nd ed.). Academic Press

Course content (Practical/lab)

1. Synthesis of iodoform
2. Synthesis of Methyl salicylate by condensation reaction.
3. Synthesize paracetamol (acetaminophen) through nucleophilic and elimination reactions.
4. Synthesis of Aspirin (Acetylsalicylic Acid) via SN Nucleophilic Acyl Substitution.
5. Synthesis of Acetanilide via nucleophilic Acyl Substitution reaction.
6. Synthesis of Dibenzalacetone using crossed aldol (or mixed-aldol) reaction, which is used extensively in organic synthesis to form C-C bonds.
7. Synthesis of Butyl Acetate (Fruit Fragrance) via Nucleophilic Acyl Substitution
8. Synthesis of 2,4,6-Tribromophenol via electrophilic aromatic Substitution
9. Synthesis of Acetone from Isopropyl Alcohol via Elimination (E1) reaction.
10. Synthesize salicylic acid from phenol using the Riemer-Tiemann reaction, involving the formation of the phenoxide ion, carboxylation, and hydrolysis.
11. Synthesize Nifedipine using the classical Hantzsch method, involving condensation and reduction reactions.
12. Development of Green Methodology for Surfactant-Assisted Williamson Synthesis of 4-Benzyloxy Benzoic Acid (Ether) in Aqueous Media.
13. Synthesis of Sulfathiazole using a safer and convenient sulfonylation method.
14. Synthesize salicylic acid from phenol using Kolbe's electrolysis, a simple and recent method in organic compound synthesis, especially for drugs.
15. Synthesis of 1-Bromo-3-Chloropropane via SN2 Nucleophilic Substitution

Assignments: Types and Number with Calendar

Assignment/presentation (20 marks)			Class quiz (30 marks)	
No.	Week	Deadline for submission	No.	Week
Assignment 1 (Pre-mid)	Week 3	Within the timeline assigned by the teacher	Quiz 1 (pre-mid)	Week 4
			Quiz 2 (pre-mid)	Week 7
Assignment 2 (Post-mid)	Week 11		Quiz 3 (post-mid)	Week 10
			Quiz 4 (post-mid)	Week 14