DISCIPLINE SPECIFIC ELECTIVE COURSE-14 (DSE-14)

ADVANCED BIOORGANIC CHEMISTRY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced Bioorganic Chemistry	**4**	**2**	**-**	**2**	**XII Passed**	**Basic knowledge of chemistry and biology**

Learning Objectives:

The introduction of Advanced Bioorganic Chemistry course at undergraduate level to the students has been conceived to make them understand:

- Concepts of organic chemistry and its application in the field of medicinal chemistry and biology.
- Application of supramolecular chemistry and use of macromolecules in molecular diagnosis and therapeutics
- Different phases in clinical testing and new drug approval processes.

Learning Outcomes:

- After completing the course, students shall be able to understand the structure and function of different heterocyclic molecules and their use in modern day medicine, chemistry of stereoisomers and importance of asymmetric synthesis.
- Student will also learn and appreciate the polymer supported synthesis and its relevance in drug synthesis.
- They will also get insights into use of macromolecules and molecular frame work in molecular diagnosis and therapeutics.
- Student will learn rational drug design methods, various phase of clinical testing of drugs and process involved in new drug testing and approval.
- They will get grasp of industrially relevant insilico techniques useful for identification of suitable drug candidate during rational drug design.

SYLLABUS **30 hours**

Unit I: Heterocyclic Chemistry (6 hours)

Aromaticity and Huckel rule, Active methylene groups, aldol and mixed aldol reaction, Michael addition and schiffs base reaction. Nomenclature and Reactivity of the five and six membered heterocycles, Pyrrole, Furan, thiophene, indole, oxazole, thiazole, Pyridine, Quinoline and Isoquinoline, Industrial methods for the synthesis of medicines involving heterocyclic compounds.

Unit II: Stereochemistry (6 hours)

Optical activity, specific rotation, enantiomerism, D and L designation, racemic modification, R and S sequence rules, diastereoisomers. conformation of ethane and butane, inter conversion of projection formula, optical purity. E and Z nomenclature. Prochirality (enantiomer, diastereomer) Stereochemical aspects of drug action Strategies. Enantiotopic and diastereotopic faces, (endo and exo faces). Regioselective, enantioselective, stereoselective and stereospecific reactions, Walden inversion, syn and anti addition on double bond. Asymmetric synthesis (definition and its use in drug synthesis).

Unit III: Polymer-Supported Synthesis & Supramolecular Nanostructures (8 hours)

(a): Introduction to Polymer Supported synthesis

Concept of combinatorial and mixed combinatorial synthesis, Limitations of combinatorial synthesis. Polymer supported organic reactions: different types of resins, protecting and deprotecting group, activating group coupling group (Merrified synthesis), Phase transfer catalysis.

(b): Applications of Synthetic macromolecules and Nanomolecules

Macromolecules and molecular framework (crown ether and supra molecular probes) in molecular diagnosis and therapeutic applications of supramolecular chemistry. Synthetic artificial systems that mimic biological entities. Nanomolecules and application in nanotechnology.

Unit IV : Drug Formulation, Release & Regulatory Framework (10 Hours)

(a) Pharma-informatics : Drug discovery pipeline, Rational drug design methods, Optimization of lead compounds, Drug target identification and validation for microbial pathogen, Selection of gene unique to the pathogen/target, screening for its presence in other microbes and human host.

Various Databases to search for new molecules, calculating drug-like properties of molecules, virtual screening of the drug like compounds with biomolecule- such as receptor/protein using online tools, Pharmacophore generation- principle and methods, prediction methods of 3D structure of protein. Drug interaction with Protein.

(b) New Drug Approval Process and regulatory affairs **:** New Drug Approval processes and timelines, Preclinical testing, Clinical testing **-** Phase I, II, III and IV, Developing clinical trial protocols, Safety monitoring in clinical trials, Introduction of Drugs and Cosmetics Act (1940 and 1945) and patent act 1970. Process of patent filing- specifications, framing of claims and various forms.

Practical: **(60 hours)**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Thin Layer Chromatography (mixture of 2 compounds)/(mixture of 3 compounds)
2. Perform Claisen Schmidt reaction and report yield
3. Perform Cannizarro reaction and report yield
4. Column chromatography using Silica gel to separate mixture of 2 compounds
5. Perform Schotten Baumann reaction and report yield
6. Carry the hydrolysis of ethyl benzoate and report the melting point and yield of benzoic acid
7. Prepare Semicarbazone derivative of one the following compounds: acetone, ethyl methyl ketone, diethylketone, cyclohexanone, benzaldehyde. and and report the melting point and yield of the product.
8. Determine the antioxidant activity of any compound by DPHH scavenging assay/FRAP assay.
9. Measurement of total phenolic content of any compound by Folin Ciocateu Method.
10. Synthesis and characterization of nanoparticles.
11. Finding the active sites in a receptor/proteins (eg glucose Dehydrogenase).
12. Molecular docking of ligand with receptor/protein (Glucose dehydrogenase) using AutoDock or HEX.

Essential Readings:

- Silverman, R. B. (2020). *Organic Chemistry of Drug Design and Action* (4th ed.). Academic Press. ISBN-13: 9780123820303.
- Patrick, G. L. (2021). *An Introduction to Medicinal Chemistry* (6th ed.). Oxford University Press. ISBN-13: 978-0198749691.
- March, J. (2020). *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure* (8th ed.). Wiley.Ed.8th
- Kalsi, P. S. (2020). *Stereochemistry: Conformation and Mechanism* (6th ed.). New Age International Publishers
- Sengupta, A., & Sarkar, C. K. (2015). *Introduction to Nano: Basics to Nanoscience and Nanotechnology*. Springer.Lehn, J.-M. (1995). Supramolecular chemistry. *Chemical Reviews, 71*, 199–223.
- Stromgaard, K., Krogsgaard-Larsen, P., & Madsen, U. (Eds.). (2016). Textbook of drug design and discovery, Fifth Edition. United States: Taylor & Francis.
- Gu, J., &Bourne, P. E. (Eds.). (2011). Structural bioinformatics, Second Edition. John Wiley & Sons. ISBN: 9781118210567
- Finar, I. L. (2002). *Organic Chemistry: Volume 1* (6th ed.). Pearson Education.
- Finar, I. L. (2002). *Organic Chemistry, Volume 2: Stereochemistry And The Chemistry Natural Products* (6th ed.). Pearson Education
- Ashutosh Kar (2020) Advanced Practical Medicinal Chemistry3rd Edition New Age International Private Limited.
- Vogel, A. I.*Practical Organic Chemistry* (5th ed.) Longman Group Ltd., 2012.
- V.K Ahluwalia and Sunita Dhingra, College practical chemistry, University Press(India) Ltd.

Suggested Readings:

- Rostron, C. (2020). Drug Design and Development. United Kingdom: Oxford University Press.
- Adejare, A. (Ed.). (2020). Remington: The Science and Practice of Pharmacy (23rd ed.).
- Bajorath, J., (2013) Chemo informatics for Drug Discovery, John Wiley & Sons.
- Jhoti, H., & Leach, A. R. (Eds.). (2007). Structure-based drug discovery. Springer Netherlands.
- Gasteiger, J., & Engel, T. (Eds.). (2006). Chemo informatics: a textbook. John Wiley & Sons.
- Leach, A. R. (2001). Molecular modelling: Principles and applications. Pearson Education.
- Ager, D. J., & East, M. B. (1996). *Asymmetric Synthetic Methodology*. CRC Press.
- Mahrwald, R. (Ed.). (2011). *Enantioselective Organocatalysed Reactions II*. Springer.