

**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**



'B' Grade (CGPA 2.62)

**Name of the Faculty: Science & Technology**

**CHOICE BASED CREDIT SYSTEM**

**Syllabus: Medicinal Chemistry**

**Name of the Course: M.Sc. II (Sem.– III & IV)**

**(Syllabus to be implemented from w.e.f. June 2021)**

**PUNYAHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SM.Sc. Medicinal  
Chemistry Choice Based Credit System Revised w.e.f June 2021-22**

Two-year duration **M.Sc. Medicinal Chemistry** course syllabus has been prepared as per the CBCS semester system. M. Sc. II, SEM-III & SEM-IV Organic Chemistry syllabus will be implemented from June 2021. The syllabus has been prepared taking into consideration the syllabi of other Universities, SET, NET, UGC guidelines, and the specific inputs of the Expert Committee Members.

**General Structure of the Course:**

The course will be of four semesters spread over two academic years. Each semester will have four theory papers of 80 marks for university external examination and 20 marks for internal examination of each semester and two practical's of 40 marks, 10 marks for internal practical of each semester. The distribution of marks is mentioned below

Theory Paper (Semester exam), 16 X 80+20 marks	1600 marks
Practicals (semester end exam.), 16 X 40+10 marks	800 marks
Tutorials for each semester, 4 X 25 marks	100 marks
<b>Total</b>	<b>2500 marks</b>

**\*Add-on-self learning (MOOC /SWAYAM Course /Internship /Industrial Training/ Courses  
offered by University carries 4 Credit**

Semester	Code	Title of the Paper	Semester exam			L	T	P	Credits
			Theory	IA	Total				
<b>I</b>		<b>Hard core</b>							
	<b>HCT-101</b>	Inorganic Chemistry -I	80	20	100	4		-	4
	<b>HCT-102</b>	Organic Chemistry -I	80	20	100	4		-	4
	<b>HCT-103</b>	Physical Chemistry -I	80	20	100	4		-	4
		<b>Soft Core (Any one)</b>							
	<b>SCT-104</b>	Analytical Chemistry-I	80	20	100	4	--	0	4
	<b>SCT-105</b>	Chemistry in Life Sciences	80	20	100	4		0	
		<b>Practicals</b>							
	<b>HCP-106</b>	Practical HCP 1.1	40	10	50	-	-	2	6
	<b>HCP-107</b>	Practical HCP 1.2	40	10	50	-	-	2	
<b>HCP-108</b>	Practical HCP 1.3	40	10	50	-	-	2		
	<b>Soft core (Any one)</b>								
<b>SCP-109</b>	Practical SCP1.1	40	10	50	-	-	2	2	
<b>SCP-110</b>	Practical SCP1.2	40	10	50	-	-	2		
<b>T1</b>	Tutorial			25	-	-		1	
		<b>Total for first semester</b>	<b>480</b>	<b>120</b>	<b>625</b>				<b>25</b>
<b>II</b>		<b>Hard core</b>							
	<b>HCT-201</b>	Inorganic Chemistry -II	80	20	100	4	-	-	4
	<b>HCT-202</b>	Organic Chemistry -II	80	20	100	4	-	-	4
		<b>Soft core (Any one)</b>							
<b>SCT-203</b>	Physical Chemistry -II	80	20	100	4	-	-	4	

	<b>SCT-204</b>	Green Chemistry	80	20	100	4	-	-	
		<b>Open elective (Any one)</b>							
	<b>OET-205</b>	Medicinal Chemistry-I	80	20	100	4	-	-	4
	<b>OET-206</b>	Analytical Chemistry-II	80	20	100	4	-	-	4
		<b>Practical</b>							
	<b>HCP-207</b>	Practical HCP 2.1	40	10	50	-	-	2	4
	<b>HCP-208</b>	Practical HCP 2.2	40	10	50	-	-	2	
		<b>Soft core (Any one)</b>							
	<b>SCP-209</b>	Practical SCP 2.1	40	10	50	-	-	2	2
	<b>SCP-210</b>	Practical SCP 2.2	40	10	50	-	-	2	
		<b>Open elective (Any one)</b>							
	<b>OEP-211</b>	Practical OEP 2.1	40	10	50	-	-	2	2
	<b>OEP-212</b>	Practical OEP 2.2	40	10	50	-	-	2	
	<b>T2</b>	Tutorial			25	-	-	-	1
		<b>Total for second semester</b>	<b>480</b>	<b>120</b>	<b>625</b>				<b>25</b>
<b>III</b>		<b>Hard core</b>	<b>Theory</b>	<b>IA</b>	<b>Total</b>				
	<b>HCT-3.1</b>	Advanced Organic Chemistry-I	80	20	100	4	-	-	4
	<b>HCT-3.2</b>	Chemistry of Bioactive Heterocycles	80	20	100	4	-	-	4
		<b>Soft core (Any one)</b>							
	<b>SCT-3.1</b>	Photochemistry and Pericyclic Reactions	80	20	100		-	-	
	<b>SCT-3.2</b>	Drug Development	80	20	100	4	-	-	4
		<b>Open elective (Any one)</b>							
	<b>OET-3.1</b>	Applied Organic Chemistry	80	20	100	4	-	-	4
	<b>OET-3.2</b>	Biochemistry	80	20	100	4	-	-	4
		<b>Practical</b>							
	<b>HCP-3.1</b>	Organic Ternary Mixture	40	10	50	-	-	2	2
	<b>HCP-3.2</b>	Organic Preparation	40	10	50	-	-	2	2
	<b>SCP-3.1</b>	Spectral Analysis	40	10	50	-	-	2	2
		<b>Open elective (Any one)</b>							
	<b>OEP-3.1</b>	Column Chromatography	40	10	50	-	-	2	2
	<b>OEP-3.2</b>	Review Work	40	10	50	-	-	2	2
		Add-on-self learning (MOOC /SWAYAM Course /Internship /Industrial Training/ Courses offered by University *)	-	-	-	-	-	-	4
	<b>T3</b>	Seminar/Tutorial/Industrial Visit/ Field Tour			25	-	-	-	1
		<b>Total for third semester</b>	<b>480</b>	<b>120</b>	<b>625</b>				<b>29</b>
<b>IV</b>		<b>Hard core</b>	<b>Theory</b>	<b>IA</b>	<b>Total</b>				
	<b>HCT-4.1</b>	Pharmaceutical Dosage Forms	80	20	100	4	-	-	4
	<b>HCT-4.2</b>	Modern Organic Chemistry	80	20	100	4	-	-	4
	<b>HCT-4.3</b>	Drug Regulatory Affairs	80	20	100	4	-	-	4
		<b>Soft core (Any one)</b>							
	<b>SCT-4.1</b>	Medicinal Chemistry	80	20	100	4	-	-	4
	<b>SCT-4.2</b>	Pharmaceutical Technology	80	20	100	4	-	-	4
		<b>Practical</b>							
	<b>HCP-4.1</b>	Organic Synthesis	40	10	50	-	-	2	2
	<b>HCP-4.2</b>	Organic Chemistry	40	10	50	-	-	2	2
	<b>HCP-4.3</b>	Project Work/In Plant Training	40	10	50	-	-	2	2

		<b>Soft core (Any one)</b>							
	<b>SCP-4.1</b>	Pharmaceutical Formulation	40	10	50	-	-	2	2
	<b>SCP-4.2</b>	Medicinal Chemistry	40	10	50			2	2
	<b>T4</b>	Seminar/Tutorial/Industrial Visit/ Field Tour			25				1
		<b>Total for four semester</b>	<b>480</b>	<b>120</b>	<b>625</b>				<b>25</b>

Ratio of marks (Theory: Practical): (73:27)

**L = Lecture T = Tutorials P = Practical**

**4 Credits of Theory = 4 Hours of teaching per week 2**

**Credit of Practical = 4 hours per week**

**HCT = Hard core theory, SCT = Soft core theory, HCP = Hard core practical SCP = Soft core practical, OET = Open elective theory,**

**OEP = Open elective practical, HCMP = Hard core main project**

**HCT/P= Hard Core Theory/Project**

**Note:**

To train the students for the SET/NET/GATE and other competitive examinations, University/College assessment questions should test the understanding of candidate rather than the memory. The question paper should cover all the Units included in the syllabus of the respective paper and the weightage of the questions should correspond to the number of lectures allotted to the respective Units / Topics.

**Paper Code: HCT 3.1**  
**Advanced Organic Chemistry-I**

**Credit: 04**

**60 L**

**Unit-I: Alkylation of Enolates and Other Carbon Nucleophiles**

**[15]**

Generation and Properties of Enolates and Other Stabilized Carbanions: Generation of Enolates by Deprotonation, Regioselectivity and Stereoselectivity in Enolate Formation from Ketones and Esters, Other Means of Generating Enolates, Solvent Effects on Enolate Structure and Reactivity. Alkylation of Enolates: Alkylation of Highly Stabilized Enolates, Alkylation of Ketone Enolates; Alkylation of Aldehydes, Esters, Carboxylic Acids, Amides, and Nitriles; Generation and Alkylation of Dianions; Intramolecular Alkylation of Enolates; Control of Enantioselectivity in Alkylation Reactions. The Nitrogen Analogs of Enols and Enolates: Enamines and Imine Anions

**Unit -II: Name reactions**

**[18]**

Darzen, Prins, Henry, Strecker amino acid synthesis. Bamford-Steven, Baylis-Hillmann, Corey-Fuchs Reaction, Julia Olefination, Mukaiyama aldol, Mitsunobu, Corey-Winter olefination, Shapiro, Ritter, Stille, Heck, Sonogashira, Suzuki, Negishi, Kumada, Hiyama, Tsuji-Trost, Duff, Chugaev, Petasis, McMurry reaction and Coupling. Ring closing metathesis (Grubb's metathesis), Aldol-Tishchenko reaction (Evans-Tishchenko reaction).

**Unit-III: Rearrangements**

**[15]**

Pummerer, Payne, Eschenmoser fragmentation, Brook, Wagner-Meerwein, Wolf, Semipinacol, Epoxide rearrangement with Lewis acid, Tiffeneau-Demjanov, von Richter, Wittig, Neber, Smiles, Steven, Hofmann, Iodolactonisation, Hoffmann-Löffler Fretag reactions

**Unit-IV: Reagents**

**[12]**

Complex metal hydrides, Lithium dialkylcuprate, DCC, DDQ, Organotin reagents, Peterson's synthesis, Trimethylsilyl iodide, Peracids, PPA, Ozone, Selenium dioxide, Periodic acid, Iodoisobenzyl diacetate

**Reference Books:**

- 1) A guidebook to Mechanism in Organic Chemistry (Orient- Longmens)- Peter Sykes
- 2) Francis A. Carey, Richard J. Sundberg - Advanced Organic Chemistry Part B. Reactions and Synthesis-Springer (2007)

- 3) Organic Reaction Mechanism (Benjamin)-R. Bresslow
- 4) Mechanism and Structure in Organic Chemistry (Holt Reinhartwinston)- B. S. Gould
- 5) Organic Chemistry (McGraw Hill)-Hendrikson, Cram and Hammond
- 6) Basic principles of Organic Chemistry (Benjamin) J. D. Roberts and M. C. Caserio.
- 7) Reactive intermediates in Organic Chemistry 9 Jojn Wiley) N. S. Issacs.
- 8) Organic reaction mechanism (Mc Graw Hill) R. K. Bansal
- 9) Advanced organic chemistry, part B: Reaction and synthesis by Francis A. Carey, Richard Y. Sandburg.
- 10) Organic Chemistry by Clayden, Greeves, Warren and Wothers.

### **Paper Code: HCT-3.2**

### **Chemistry of Bioactive Heterocycles**

**Credits: 04**

**60 L**

Heterocyclic compounds - Nomenclature, synthesis, reactivity, aromatic character, and medicinal importance of following heterocycles:

**UNIT I: 3- and 4- Membered heterocycles**

**[10]**

Baldwin ring closure rules, formation of 3, 4, 5 and 6 membered rings

3-membered rings: Aziridines, Oxiranes, Thiaranes,

4-membered rings: Azetidines, Oxitanes and Thietanes

**UNIT II: 5-Membered heterocycles**

**[17]**

Five-membered rings with one heteroatom: Pyrrolidine, Furan, Pyrrole and Thiophene

Five-membered rings with two heteroatoms: Imidazole, Pyrazole, Oxazole, Isoxazole, Thiazole, Isothiazole.

Five-membered rings with three heteroatoms: Triazoles, Oxadiazole, Thiadiazole, Tetrazole.

**UNIT III: 6-Membered heterocycles**

**[17]**

Six-membered rings with one heteroatom: Pyran, Pyridine Six-membered rings with two

heteroatoms: Piperazine, Morphine, Thiomorphine, Pyridazines, pyrimidines, pyrazines, Six-

membered rings with three heteroatoms: Hexahydro-1,3,5-triazine Six-membered rings with three heteroatoms: Tetrazine

**UNIT- IV: Benzofused heterocycles**

**[16]**

Benzofused heterocycles Benzopyrroles, Benzofuran, Indole, Benzothiophene, Benzoxazole, benzthiazole, Benzimidazole, Quinolines, Isoquinoline, Quinazolines, Coumarins and Chromones, Purines and Pteridines

### Reference Books and Text Books

- 1) R. M. Acheson: An introduction to chemistry of heterocyclic compounds (Interscience)
- 2) Joule and Smith: Heterocyclic chemistry (Van Nossstrand)
- 3) R.K. BANSAL: Heterocyclic chemistry (Wiley E)
- 4) L.A. Paquette: Principals of modern heterocyclic chemistry
- 5) M.H. Palmer: The structure and reactions of heterocyclic compounds.
- 6) A.R. Katritzky and A.V. Boulton: Advances in Heterocyclic chemistry (A.P.)
- 7) Finar: Organic chemistry (Vol. 1 and 2)
- 8) Conn and Stumpf: Outline of Biochemistry
- 9) Williams, Introduction to the chemistry of enzyme action.
- 10) The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman  
Academic Press.
- 11) Strategies for Organic Drug Synthesis and Design. D. Lednicer, John Wiley.
- 12) Heterocyclic Chemistry Vol. 1-3, R. R. Gupta, M. Kumar, and V. Gupta, Springer Verlag.
- 13) The Chemistry of Heterocycles, T Eicher and S. Hauptmann, Thieme.
- 14) Heterocyclic Chemistry, J. A. Joule, K. Mills and G. F. Smith, Chapman and Hall.
- 15) Heterocyclic Chemistry, T. L. Gilchrist, Longman Scientific Technical
- 16) Contemporary Heterocyclic Chemistry, G. R. Newkome and W. W. Paudler, Wiley.
- 17) An Introduction to the Heterocyclic Compounds, R. M. Acheson, John Wiley.
- 18) Comprehensive Heterocyclic Chemistry, A. R. Katritzky and C. W. Rees, eds, Pergamon Press.

## Paper Code: SCT- 3.1

### Photochemistry and Pericyclic Reactions

**Credits: 04**

**60 Hrs.**

#### UNIT-I Molecular Orbital Theory

[15]

Energies calculation of cyclic and acyclic system orbitals, Determination energies and stabilities of different systems, Calculation of charge densities, PMO theory and reactivity index.

#### UNIT-II Pericyclic Reactions-I

[15]

Features and classification of pericyclic reactions, Phases, nodes and symmetry properties of molecular orbital in ethylene, 1,3-butadiene, 1,3,5-hexatriene. allyl cation, allyl radical, pentadienyl cation and pentadienyl radical, Thermal and photochemical reactions.

**Electrocyclic reactions:** Con-rotation and dis-rotation, electrocyclic closure and opening in  $4n$  and  $4n+2$  systems, Woodward-Hoffmann selection rules for electrocyclic reactions. Explanation for the mechanism of electrocyclic reactions by: (i) Symmetry properties of HOMO of open chain partner; (ii) Conservation of orbital symmetry and orbital symmetry correlation diagram and (iii) Huckel-Mobius aromatic and antiaromatic transition state method.

### UNIT-III Pericyclic Reactions-II

[15]

**(a) Cycloaddition reactions:** Suprafacial and antarafacial interactions. ( $\pi$ 2-cycloadditions, Cycloreversions, Stereochemical aspects in supra-supra, antara-supra and antara-antara ( $\pi$ 2 and  $\pi$ 4 cycloadditions, Diels-Alder reaction, Woodward-Hoffmann selection rules for cycloaddition reactions, Explanation for the mechanism of cycloaddition reactions by 1) Conservation of orbital symmetry and orbital symmetry correlation diagrams 2), Fukui Frontier Molecular Orbital (FMO) theory and (3) Huckel-Mobius aromatic and antiaromatic transition state method. Endo-exo selectivity in Diels-Alder reaction and its explanation by FMO theory, Examples of cycloaddition reactions.

**(b) Sigmatropic reactions:** [1,j] and [i,j] shifts. Suprafacial and antarafacial shifts, Selection rules for [i, j] shifts. Cope, degenerate Cope and Claisen rearrangements, Explanation for the mechanism of sigmatropic reactions: 1) symmetry properties of HOMO 2) Huckel-Mobius aromatic and antiaromatic transition state method, chelotropic reactions and explanation of mechanism by FMO theory.

### UNIT- IV Photochemistry

[15]

**Free radical reactions:** Types of free radical reactions, detection by ESR, free radical substitution mechanism, mechanism at aromatic substrates, neighboring group assistance. Reactivity for aliphatic and aromatic substitution at a bridge head. Reactivity in attacking radicals. The effect of solvent on reactivity. Allylic hydrogenation (NBS), Oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salt, Sandmeyer's reaction. Free radical rearrangement, Hunsdiecker reaction; **Photochemistry of ( $\pi$ ,  $\pi^*$ ) transitions:** Excited state of alkenes, cis-trans isomerisation, photochemistry state, electrocyclisation and Sigmatropic rearrangements, di  $\pi$ -methane rearrangement.



**Intermolecular reactions:** photocycloadditions, photodimerisation of simple and conjugated olefins, addition of olefins to  $\alpha$ ,  $\beta$  unsaturated carbonyl compounds, excimers and exciplexes. Photoaddition reactions. Excited states of aromatic compounds, photodimerisation of benzene, photosubstitution reactions of aromatic compounds and Photo-Fries rearrangement.

**Photochemistry of ( $n$ ,  $\pi^*$ ) transitions:** Excited state of carbonyl compounds, homolytic cleavage of  $\alpha$ -bond-Norrish type I reaction in acyclic, cyclic ketones and strained cycloalkanediones.

**Intermolecular abstraction of hydrogen:** Photo reduction and photo oxidation influence of temperature, solvent, nature of hydrogen donors and structure of the substrate.

**Intramolecular abstraction of hydrogen:** Norrish type II reaction in ketones, esters and 1, 2-diketones.

**Addition to C-C multiple bonds:** Paterno-Buchi reaction, photodecarboxylation, photochemistry of alkyl peroxides, hypohalites and nitriles. Barton reaction. Photochemistry of azo compounds, diazo compounds, azides and diazonium salts. Singlet oxygen-photo oxygenation reactions. Ene reaction, formation of dioxetanes and endoperoxides. Chemiluminescent reactions. Oxidative coupling.

#### **Recommended Books:**

1. Lehar and Merchand: Orbital Symmetry
2. R. B. Woodward and Hoffman: Conservation of Orbital symmetry.
3. Photochemistry and pericyclic reactions by Jagdamba Shingh
4. Cixon and Halton : Organic photochemistry
5. Arnold: Photochemistry
6. N. Turro : Modern Molecular Photochemistry
7. Rohatgi- mukherji : Fundamentals of photochemistry.
8. Ginsburg: Nonbenzoid aromatic compound
9. A. Streitwieser : Molecular orbital theory for organic chemistry.
10. E. Cler : The aromatic sextet.
11. Lloyd: Carbocyclic non- benzoid aromatic compounds.
12. G. M. Bandger ; The structure and reactions of aromatics compounds
13. W. B. Smith; Molecular orbital methods in Organic Chemist

**Paper Code: SCT-3.2**

**Drug Development**

**Credits: 04**

**60 L**

**Unit-I: Concept of drug**

**[15]**

Concept of drug, Sources of drugs, Drug development, Lipinski rule of 5, Physico chemical properties of molecules: lipophilicity, electrokinetic parameters, steric parameters, pKa (eg. Cimetidine development), and solubility. Types of receptors, Protein and Protein Data Bases,

**Unit-II: Computer aided drug designing**

**[15]**

Structure and ligand-based drug designing, Lead and drug like properties, concept of lead identification and modification, Structure-activity relationship (SAR), Factors affecting bioactivity, History and development of QSAR, Types of molecular descriptors, Methods of molecular descriptor selection, 2D QSAR modeling, Introduction to molecular docking and illustrations (NNRTIs and COX-inhibitors).

**Unit-III: Pharmacokinetics**

**[15]**

Introduction to drug absorption, distribution, metabolism, elimination and toxicity (ADMET). Pharmacokinetic models, bioavailability, Pharmacokinetic parameters (volume of distribution, elimination half-life, clearance). Concept of pro-drug and soft drug.

**Unit-IV: Pharmacodynamics**

**[15]**

Introduction to LD<sub>50</sub>, ED<sub>50</sub>, IC<sub>50</sub>, MIC, MEC and Ki. Dose-response relationships, drug potency and efficacy. Principles of drug action, mechanisms of drug action, drug receptor interactions, combined effect of drugs.

**Reference Books:**

- 1) D. M. Brahmkar, Sunil S. Jaiswal, Biopharmaceutics and Pharmacokinetics
- 2) Graham L. Patrick, An Introduction to Medicinal Chemistry, Fifth Edition, Oxford University Press
- 3) Edward H. Kerns and Li Di, Drug-like Properties: Concepts, Structure Design and Methods, Elsevier, 2008
- 4) Ashutosh Kar, Medicinal Chemistry, New Age International Publishers, Fourth Edition
- 5) Gupta, S. P. (2011) QSAR & Molecular Modeling. Anamaya Pub.: New Delhi.
- 6) Jayashree Ghosh, A Textbook of Pharmaceutical Chemistry, 3/eS, Chand Publications
- 7) Grigauge A, Introduction to Medicinal Chemistry; Wiley-VCH
- 8) Pandey S S, Dimmock J R, An Introduction to Drug Design; New Age International

- 9) Wolff Ed M EV, Burger's Medicinal Chemistry and Drug Discovery (6th Edition); John Wiley
- 10) Silverman R B, The Organic Chemistry of Drug Design and Drug Action; Academic Press
- 11) William Foye, Lippicott, Principles of Medicinal Chemistry (6th Edition); William and Wilkins
- 12) Kadam S S, Mahadik, Bothera, Principles of Medicinal Chemistry (11<sup>th</sup> Edition); Nirali Publication
- 13) Satoskar R S, Bhandarkar, Pharmacology and Pharmacotherapeutics; Popular Prakashan
- 14) Organic Chemistry: Clayden, Greeves, Warren and Wo

**Paper Code: OET-3.1**  
**Applied Organic Chemistry**

**Credit: 04**

**Hours: 60**

**Unit-I Green Chemistry**

**[10]**

Introduction and basic principles, Ideal synthesis, theoretical and functional details of eco friendly synthetic protocols with suitable examples and applications: Neat synthesis (solvent free synthesis), Non-volatile organic media and water as green media in organic transformations like ionic liquid, PEG and water, Microwave irradiation as alternative energy source for the chemical transformations, Heterogeneous catalysis/ Immobile catalysis, Ultrasound assisted synthesis.

**Unit-II Carbohydrate Chemistry**

**[15]**

Introduction of sugars, structures of triose, tetrose, pentose, hexose. Fisher projection, D and L-configuration, Conversion of Fisher projection to furanose and pyranose form, Haworth Structure,  ${}^4C_1$  and  ${}^1C_4$  Conformations, Conformation of monosaccharides, anomeric effect, Structures and function of important derivatives of monosaccharides like Glycosides, Deoxy sugars, Myoinositol, amino sugars, N-aceylmuranic acid and sialic acid, disaccharides and polysaccharides, Reactions of five and six carbon sugars, glycoside formation, acetonide formation, reduction, synthesis of Dglyceraldehyde, Killani-Fischer Synthesis, glucal formation and reactions, Ferrier and Hanesian Reaction, Ferrier rearrangement. Structural polysaccharides: Cellulose and Chitin. Storage polysaccharides: Starch and Glycogen. Structure and biological function of Glucosaminogycans or mucopolusaccharides.

Carbohydrates of glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances, Ascorbic acid. Carbohydrate metabolism: Krebs's cycle, Glycolysis, Glycogenolysis, Gluconeogenesis and Pentose phosphate pathways.

### **Unit-III Supramolecular Chemistry** [20]

**Fundamentals of Supramolecular Chemistry:** Terminology and definitions in supramolecular chemistry. Intermolecular forces, Solvent and solution properties, solvation and hydrophobic effect. Binding constants; definition and use. **Molecular Recognition:** Principle of molecular recognition, host-guest complementarity, preorganisation, chelate effect, cooperativity. Synthesis and applications of supramolecular host (crown ethers, lariat ethers, podands, cryptands, spherands, calix[n]arenes, cyclodextrine) as cation and anion binding receptors and receptors for ion-pair recognition. **Supramolecular Reactivity and Catalysis:** Organocatalysis mediated through hydrogen bonding, acid-base catalysis.

### **Unit-IV Polycyclic Aromatic Compounds** [15]

Introduction, Comparative study of the aromatic character of linear and nonlinear Ortho fused Polynuclear Hydrocarbon. General methods of preparation of polycyclic hydrocarbons: Fittig reaction, Ullmann diaryl synthesis, Friedel-Craft reaction, Elbs reaction, Phenanthrene synthesis by Paschorr, Haworth, Stobbe condensation, Bardhan-Sengupta, Bogert-Cook methods, Dehydrogenation of hydroaromatic compounds with sulphur, selenium or palladised charcoal. Naphthalene, Rubrene (pentacene and hexacene), 2-benzanthracene, 6-benzanthracene, 4-benzopyrene and 20-methylcholanthrene, Phenanthrene Derivatives: Chrysene, Picene, Pyrene, Perylene, coronene.

#### References:

- 1) Supramolecular Chemistry: from Molecules to Nanomaterials Eds. by P.A. Gale and J.W. Steed (2012).
- 2) Modern Supramolecular Chemistry by F. Diederich, P. J. Stang, R. T. Tykwinski (2008). . Page 20 of 21
- 3) Core Concepts in Supramolecular Chemistry and Nanochemistry by J. W. Steed, D. R. Turner, K. J. Wallace (2007).
- 4) Supramolecular Chemistry by J.W. Steed and J.L. Atwood (2011).
- 5) Supramolecular Chemistry: Concepts and Perspectives by J.-M. Lehn, Wiley VCH, Weinheim (1995).
- 6) Supramolecular Chemistry by V. Balzani (Editor), L. De Cola, Kluwer, Dordrecht (1992).

- 7) Introduction to Supramolecular Chemistry by H. Dodziuk, Kluwer Academic Publishers, The Netherlands (2002).
- 8) Supramolecular Assemblies Y. Murakami (Editor), Mita Press, Tokyo, (1990).
- 9) Advances in Supramolecular Chemistry, Vol 1 (1990), Vol 2 (1992), Vol 3 (1993) by G. W. Gokel (Editor), JAI Press, Greenwich.
- 10) Supramolecular Chemistry – Fundamentals and Applications. Advanced Textbook by T. Kunitake, K Ariga, Berlin: Springer-Verlag Heidelberg, 2006. 208 p. ISBN 978-3-540-01298-6.

## Paper Code: OET-3.2

### Biochemistry

**Credits: 04**

**60 L**

**Unit-I:**

**[15]**

**Introduction of Biochemistry:** The molecular logic of life; Structural hierarchy in the molecular organization of Cells. The chemical unity of diverse living organisms, prokaryotic and Eukaryotic. Scope of the subject in pharmaceutical Sciences

**Carbohydrates:** Classification, basic chemical structure, monosaccharides, aldoses, and ketoses, cyclic structure of monosaccharides, stereoisomerisms, anomers and epimers. Reducing properties of monosaccharides, disaccharides, oligosaccharides, polysaccharides, structural studies methylation and periodate oxidation. Polysaccharide's structure and function of complex carbohydrates, proteoglycans, glycoproteins, Glycolipids, mucopolysaccharides

**Unit-II:**

**[15]**

**Protein:** Classification and properties of amino acids, Primary, Secondary, Tertiary and Quaternary structure of protein. Synthesis, purification, characterization, and sequencing of protein molecules.

**Lipids:** Classification, structure, and function of lipids. Acylglycerols, circulating lipids: lipoproteins, chylomicrons, LDL, HDL, and VLDL. Pathological changes in lipid levels. Formation of micelles, monolayers, bilayer, liposomes. Lipid metabolism: Beta oxidation of fatty acids

**Unit III:**

**[15]**

**Nucleic acids:** Molecules of Heredity: Structure of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), DNA double helix, A, B and Z forms of DNA, DNA as genetic material, genetic code, flow of genetic information, DNA replication, transcription and translation

**Vitamins and Co-enzymes:** Classification, water-soluble and fat-soluble vitamins. Structure, dietary requirements, deficiency conditions, coenzyme forms.

**Unit IV:** [15]

**Bioinorganic Chemistry:** Principles of coordination Chemistry related to Bioinorganic– Proteins, nucleic acids and other metal binding biomolecules. Choice, uptake, and assembly of metal containing units in Biology. Control and utilization of metal ion concentration in cells. Metal ion folding and cross linking of biomolecules. Binding of metal ions and complexes to biomolecular active centers.

**Reference Books:**

- 1) Principle of Biochemistry, Lehinger D.L. Nelson and M.M. Cox. Macmillanworth Publishers
- 2) Biochemistry by Satyanarayana
- 3) Principle of Biochemistry, Lehinger D.L. Nelson and M.M. Cox. Macmillan worth Publishers
- 4) Biochemistry, L. Stryker, W.H. Freeman, San Francisco
- 5) Schaum's Outline Series of Theory and Problems of Biochemistry, Philip W. Kuchel and G.B.Ralston. Int. Ed., McGraw-Hill Book Co.
- 6) Problem Approaches in Biochemistry. Wood and Hood
- 7) Biochemistry, L. Stryer, W.H. Freeman, San Francisco
- 8) Problem Approaches in Biochemistry Wood and Hood

**Textbooks:**

- 1) Principles of Bioinorganic Chemistry: S.J. Lippard & J.M Berg (1994), University science books, Mill Valley, California Chapters-1,2,3,5,6,7,8
- 2) Ligand field theory & its application: B.N.Figgis & M.A. Hitchman (2000) Wiley VCH publ. Chapters 5, 6, 8, 9, 11
- 3) Inorganic Chemistry: Shriver & Atkins (1999) Oxford
- 4) Inorganic Electronic spectroscopy: A.B.P. Lever, 2<sup>nd</sup> edn (1984), Elsevier Science Publishers, New York
- 5) Biological Chemistry of the Elements: R.J.P. Williams & F.R. de Salvia, Oxford University, Press-(1991)

- 6) Bioinorganic Chemistry: Inorganic elements in the Chemistry of life: An introduction & guide: W.Kaim, B.Schwederski, VCH,(1991)

## **M. Sc. II, SEMESTER–IV (Medicinal Chemistry)**

### **Paper Code: HCT- 4.1**

#### **Pharmaceutical Dosage Forms**

**Credits: 04**

**60 L**

#### **Unit-I: Solid Dosage Forms**

**[15]**

Routes of administration, Types of dosage forms, Oral solids: tablets, types of tablets, methods of tablet production- wet granulation, coating of tablets. Quality control methods and measurement of tablet properties, packaging.

#### **Unit-II: Other Dosage Forms**

**[15]**

Oral liquids: Suspensions and Emulsions: Definition, types, stability, suspending/emulsifying agents, evaluation, and packaging. Parenterals, Ophthalmic products, Aerosols, Inhalation products. Topical lipids, semisolids, and powders.

#### **Unit-III: Drug Formulation**

**[15]**

Concept of excipients, classifications with examples, colours, flavours and preservatives in formulations. Concept of Pre-formulation, factors influencing designing of dosage forms, drug excipients interaction, stability studies.

#### **Unit-IV: Drug delivery systems**

**[15]**

Fundamental of novel drug delivery: Rationale of sustained release, controlled release dosage forms. Oral controlled drug delivery systems, mucosal drug delivery system, ocular drug delivery systems, parenteral drug delivery systems, transdermal drug delivery systems.

#### **Reference Books:**

- 1) The theory and practice of Industrial pharmacy (CBS) Leon Lachman,
- 2) Dispensing of pharmaceuticals (CBS) Cooper and Gunn
- 3) The Science and Practice of Pharmacy by Remington

- 4) Biopharmaceutics and Pharmacokinetics by Brahmankar
- 5) Pharmaceutical dosage forms and drug delivery systems by Ansel
- 6) The science of dosage forms design by Aulton

**Paper Code: HCT- 4.2**  
**Modern Organic Chemistry**

**Credits: 04** **[60L]**

**UNIT-I Multicomponent Reactions** **[20]**

Introduction to Multicomponent Reactions: Strecker amino acid synthesis, Biginelli reaction, Gewald reaction, Hantzsch pyridine synthesis, Mannich reaction, Ugi reaction, Passerini reaction, Petasis reaction

Direct synthesis of heterocycles via MCRs using a name reaction: Biginelli reaction, Hantzsch reaction, Click reaction, Gewald reaction, Ugi reaction and Ugi-azide reaction. Synthesis of heterocycles via MCRs, using a name reaction in combination with another reaction: Michael addition reaction, Mannich reaction, Aldol reaction, Knoevenagel reaction and Wittig reaction.

**UNIT-II Asymmetric synthesis-I** **[12]**

Introduction to Stereoselective and stereospecific reactions

**Chiral Pool:** [ $\alpha$ -hydroxy acids and  $\alpha$ -amino acids]

**Chiral auxiliary:** SAMP/RAMP, Mayers Oxazolines, Evans Oxazolidinones, L-valine (Schollkopf Bislactimethers), Seebach Imidazolens from (S)-mandelic acid, Seebach  $\alpha$ -hydroxy acids i.e. (S)-lactic acids, Cyclic hydrazones.

**Chiral reagent:** BINAL, BINAP; Hydroboration- Ipc<sub>2</sub>BH, IpcBH<sub>2</sub>, R/S-Alpine borane, DIP-Cl (diisopinocampylborone chloride), Misamane's Ligand (2,5-dimethylborolane);

**Chiral catalyst:** CBS, NADH, baker's yeast. Asymmetric epoxidation: Sharpless epoxidation, Jacobson-katsuki epoxidation and Shi epoxidation. Sharpless asymmetric dihydroxylation

**UNIT-III Asymmetric synthesis-II** **[12]**

Acyclic Stereocontrol – attack on aldehydes and ketones with  $\alpha$ -stereocentres (Cram's Model, Felkin-Anh model, Cram-Chelate model); Diastereoselective enolate alkylation, Diastereoselectivity of aldol reactions (Zimmerman-Traxler transition state model),



Diastereoselective enolate alkylation by Evans oxazolidinone auxiliaries; Diastereoselective allylation reactions of crotyl boronates and chiral allyl boron reagents; Proline catalyzed asymmetric aldol reactions, mannich reactions; Diastereoselective Reduction; Diastereoselective reduction (Evans-Saksena and Evans-Tishenko); Stereocontrol– attack on alkenes with  $\alpha$ -stereocentres in hydroboration and epoxidation reaction.

#### **UNIT-IV Metal-organic framework (MOFs) [16]**

Molecules to Materials, Materials of Functional Metal-organic framework (MOF): Introduction, Nomenclature of metal-organic frameworks, Structural features of metal-organic frameworks, Basic methods of synthesis of metal-organic frameworks, Functionalization of metal-organic frameworks, Traditional methods of analysis of metal-organic frameworks, Application of MOF.

#### **References:**

- 1) (Topics in Heterocyclic Chemistry 25) Géraldine Masson, Luc Neuville (auth.), Romano V. A. Orru, Eelco Ruijter (eds.) - Synthesis of Heterocycles via Multicomponent Reactions II-Springer-Verlag Berlin
- 2) Jieping Zhu, Qian Wang, Meixiang Wang - Multicomponent Reactions in Organic Synthesis-Wiley-VCH (2015)
- 3) K.L. Ameta Ph.D., Anshu Dandia - Multicomponent Reactions\_ Synthesis of Bioactive Heterocycles-CRC Press (2017)
- 4) Zhu J., Bienhame H. (eds.) - Multicomponent Reactions-Wiley-VCH (2005)
- 5) Raquel P. Herrera, Eugenia Marqués-Lpez - Multicomponent Reactions\_ Concepts and Applications for Design and Synthesis-Wiley (2015)
- 6) Majid M. Heravi, Vahideh Zadsirjan - Recent Advances in Applications of Name Reactions in Multicomponent Reactions-Elsevier (2020)
- 7) Stereochemistry of Organic Compounds (Principle and application): D. Nasipuri
- 8) Stereochemistry : Conformation and Mechanism: P. S. Kalsi
- 9) Stereochemistry of Organic compounds: Ernest L. Eliel / Samuel H. Wilen
- 10) Advanced Organic Chemistry; Part A and B: F. A. Carey & R. J. Sundberg
- 11) Organic Chemistry: Clayden, Greeves, Warren and Wothers
- 12) 6. Organic Synthesis: M. B. Smith
- 13) Lukehart, Charles M. MacGillivray, Leonard R - Metal-Organic Framework Materials-Wiley (2014)

- 14) Xian-He Bu, Michael J. Zaworotko, Zhenjie Zhang - Metal-Organic Framework-From Design to Applications-Springer International Publishing\_Springer (2020)
- 15) Wei Xia- Fabrication of Metal–Organic Framework Derived Nanomaterials and Their Electrochemical Applications-Springer Singapore (2018)
- 16) Wang Zhenqiang.- Design of metal-organic framework materials based upon inorganic clusters and polycarboxylates

**Paper Code: HCT- 4.3**  
**Drug Regulatory Affairs**

**Credits: 04** **60 L**

**Unit-I: Drug Regulatory Aspects** **[15]**

Central and State regulatory bodies (FDA, DCGI, CDSO); Drugs and Cosmetics Act (Special emphasis-Schedule M and Y); Various licenses: (Test license, Import license for testing of drugs and API's, Mfg., Contract and Loan license manufacturing)

**Unit-II: Good Manufacturing Practices (GMP)** **[15]**

GMP, cGMP, WHO, ICH guidelines. Export permissions and manufacturing for other countries; Understanding of the plant layouts with special emphasis on the environment & safety (HVAC, Water systems, Stores management, Effluent etc.); Quality Assurance Vs Quality Control.

**Unit-III: Drug Approval Agencies** **[15]**

USFDA, CDER, INDA, NDA, ANDA, CTD Formats of dossiers, e-submission, DMF, BMR, Orange Book, RLD (Reference listed drug)

A brief introduction to the guidelines for Europe, Japan, Australia, South Africa, GMP audits, role of Quality Assurance, product approvals and supply.

**Unit-IV: IPR & Patents** **[15]**

Development of IP law in India, IPR regime, Role of IP in Pharma industry. Indian Patents Act, Procedure for patent application, Grant and opposition proceedings, Patent licensing, Patent infringement proceedings. Patent search, Patent analysis & Patent drafting. Other countries patent system.

**Reference books:**

- 1) CDSO publications and updates of drug and Cosmetics act and rules (Govt. of India).

- 2) CDER Publications and Guidance
- 3) EMEA Publications and Guidance
- 4) Orange Book, ICH guidelines, Indian Patents Act
- 5) Country specific Regulatory Guidelines (available from internet)
- 6) Govt. Publications on issues affecting sales, distribution, manufacturing, excise, etc.
- 7) J. D. Nally, "Good manufacturing Practice for Pharmaceuticals" Informa Healthcare
- 8) I. Kanfer & L. Shargel, "Generic Product Development BE issued" Informa Healthcare
- 9) R. A. Guarino, "New Drug Approval Process. The Global challenges". Informa Healthcare
- 10) Watcher and Nash, "Pharmaceutical Process Validation". Marcel Dekker
- 11) Pharmaceutical Product Dev. IVIVC by Murthy, Sunkara and David
- 12) USPTO and WIPO Guidelines
- 13) S. W. Deshpande, Drugs and Cosmetics Act, 1940 and Rules, 1945 and Drugs
- 14) [PriceControl] Order, 1995

**Paper Code: SCT-4.1**  
**Medicinal Chemistry**

**Credits: 04**

**60 L**

Classification, SAR, Mechanism of action and Synthesis\* of drugs for following classes:

**Unit-I**

**[15]**

**Sulfonamides:** Sulfisoxazole, Sulfapyridine, Sulfacetamide\* and Sulfamethoxazole\*

**Antibiotics:** Penicillin: Ampicillin\*, Amoxycillin. Cephalosporin: Cefazolin, Cefadroxil, Cefixime\*, Tetracycline, Chloramphenicol\*, Amino glycosides: Streptomycin

**Antimalerials:** Chloroquine\*

**Unit-II**

**[15]**

**Antiviral:** Acyclovir, Remdesivir.

**Antifungal:** Clotrimazole, Miconazole, Itraconazole

**NSAIDs:** Aspirin\*, Ibuprofen\*, Paracetamol\*, Diclofenac\*, Aceclofenac, Indomethacin, Nimesulide and COX-II inhibitors

**Unit-III**

**[15]**

**Antianginal:** Nitrates, Nifedipine, Propranolol\*

**Anti-hypertensive Drugs:** Verapamil, Captopril\*, Atenolol

**Antidiabetics:** Insulin, Tolbutamide, Glipizide, Metformin\*, Pioglitazone

**Antihistamines:** Diphenylhydramine\*, Chlorpheniramine, Cetrizine

**Unit-IV**

[15]

**Anaesthetics:** Halothane, Lidocaine and Thiopental\*

**Sedative and hypnotics:** Phenobarbital, Diazepam\*, Alprazolam

**Anticonvulsant:** Phenytoin\*, Carbamazepine, Valproic acid

**Antidepressant:** Amitriptyline, Phenelzine\*

**Antineoplastic:** Alkylating agent, Antimetabolites

**Reference Books:**

- 1) Medicinal chemistry-Burgers (Vol: I-VI)
- 2) Principles of medicinal chemistry-William O Foye
- 3) Comprehensive medicinal chemistry- Corwin and Hansch
- 4) Textbook of medicinal chemistry- Vol-I & II-Surendra N Pandey
- 5) Principles of medicinal chemistry- S SKadam, K R Mahadik and K G Bothara
- 6) Introductory medicinal chemistry- Kennewell and Taylor
- 7) Wilson and Giswold's Text book of Organic medicinal and Pharmaceutical chemistry- Jaimes N Delgado and William A Remere
- 8) Fundamentals of microbiology- Forpischer
- 9) Genetics of antibiotics producing microorganisms- G Sermouti
- 10) Organic Synthesis: The Disconnection Approach: Stuart Warren
- 11) Organic Chemistry: Clayden, Greeves, Warren and Wo
- 12) Designing Organic Synthesis: Stuart Warren

**Paper Code: SCT-4.2**

**Pharmaceutical Technology**

**Credits: 04**

**60 L**

**Unit-I: API manufacturing units**

[15]

Chemical process, Chemical plants/Industry, Process flow diagram, Factors affecting chemical processes, Reaction systems, Reactors used in API manufacturing, Plant layout and Effluent Treatment Plant (ETP).

**Unit-II: Unit Process**

[15]

Scale up techniques, plant layout of Oxidation: oxidation of Methanol, Liquid phase oxidation with oxygen-Acetaldehyde to Acetic acid, Halogenation: Technical Halogenations-Manufacturing processes for monochloroacetic acid, Chloral, Monochlorobenzene, and Vinyl chloride (Ethylene and Acetylene), Nitration: Typical industrial Nitration process (Nitrobenzene, and  $\alpha$ -Nitronaphthalene); Esterification: Esterification by organic acid, Manufacture of Vinyl acetate and Cellulose related to active pharmaceutical ingredients (API) manufacturing-plant layout, Technology transfer.

**Unit-III: Unit operation in tableting** [15]

Milling/Mixing, Granulation, Screening, Drying, Blending, Compression, Coating, Plant layout.

**Unit-IV: Validation** [15]

Validation, Qualifications (DQ, IQ, OQ, PQ), Master plan of validation, Process validation, Cleaning validation, Computer system validation, Utilities validation, Validation of manufacturing equipments and analytical instruments, Analytical method validation, Regulatory guidelines.

**Reference Books:**

- 1) The Theory and Practice of Industrial Pharmacy (CBS) by Leon Lachman
- 2) The Science and Practice of Pharmacy by Remington
- 3) Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale-Up, Peter J. Harrington, John Wiley and Sons Inc. Publication 2011
- 4) Strategies for Organic Drug Synthesis and Design by Daniel Lednicer, 2nd Edition, John Wiley and Sons Inc. Publication, 2008
- 5) Process Chemistry in Pharmaceutical Industry, Kumar Gadamasetti, Vol I & II, CRC Press; First edition, 2007.
- 6) Practical Process Research and Development, Neal G. Anderson, Academic Press., 2000
- 7) Principles of Process Research and Chemical Development in the Pharmaceutical Industry by O. Repic, John Wiley & Sons. Inc Publication New York, NY, 1998.
- 8) Organic Synthesis, Groggins P. H, (Third Edition). P. H. Groggins. McGraw-Hill, New York, 1947.
- 9) Fire Safety Management by Satish Tandon, Arise Publishers & Distributors; 1st edition, 2008.

- 10) Pollution Prevention of Chemical Processes, Allen David, Wiley-Blackwell, 1996.
- 11) The Treatment and Handling of Wastes, Bradshaw, A.D. Chapman and Hall for the Royal Society; First Edition edition, 1992.
- 12) Good Pharmaceutical Manufacturing Practice: Rationale and Compliance by Sharp John, CRC Press; 1st edition, 2004
- 13) Management Information Systems by Laudon Kenneth C. Prentice Hall; 12th edition, 2011.
- 14) Plant Design and Economics for Chemical Engineers by Peters, Max S., McGrawHill Science/Engineering/Math; 5 editions, 2002.
- 15) Textbook of Pharmaceutical Validation (First Edition), by A. A. Kulkarni, V.S. Kashikar, A.H. Hosmani, I.D. Gonjari, Pharma Career Publications
- 16) ICH Guidelines, [www.ich.org](http://www.ich.org)
- 17) WHO Guidelines and GMP Guidelines
- 18) P.H.Groggins: Unit processes in organic synthesis (MGH)
- 19) F.A.Henglein: Chemical Technology (Perga mon)
- 20) M.G.Rao & M. Sitting: Outlines of Chemical Technology (EWP)
- 21) Clausen, Mattson: Principle of Industrial Chemistry

## **M. Sc. II SEMESTER-III (Medicinal Chemistry)**

### **PRACTICAL COURSE**

#### **HCP 3.1: Organic Ternary Mixture**

Separation, purification and identification of organic compounds (THREE components mixtures) by chemical tests, derivatives etc. using microscale technique. IR spectra to be used for functional group identification. TLC and Column Chromatography.

#### **HCP 3.2: Organic Preparation**

**One/Two organic preparations starting with 5g or less (Any five)**

(TLC, MP /BP analysis and recrystallization of product is recommended)

- 1) Preparation of aromatic aldehydes by Vilsmer Haack reaction or R. T.
- 2) Preparation of 3-formylindole by the Vilsmer Haack reaction
- 3) Preparation of p-chloronitrobenzene by Sandmeyer reaction

- 4) Preparation of p-Iodonitrobenzene by Sandmeyer reaction
- 5) Stork enamine synthesis
- 6) Mukaiyama Esterification
- 7) Pechmann Condensation (Coumarin synthesis)
- 8) Aldol condensation (Chalcone)
- 9) Benzilic acid rearrangement
- 10) Fischer indole synthesis
- 11) Fries rearrangement
- 12) Preparation of Benzanilide by Beckmann rearrangement
- 13) Preparation of Anthranilic acid
- 14) Preparation of Phthalimide
- 15) Preparation of N-Bromosuccinamide
- 16) Preparation of p-Aminobenzoic acid
- 17) Pinacol- Pinacolone rearrangement
- 18) Preparation of Acetophenones by Fries rearrangement
- 19) Wittig reaction
- 20) Preparation of Benzopyrazole

(Note: Other suitable experiments may be added)

### **SCP 3.1: Spectral Analysis**

Identification of unknown organic molecules by analysis of their spectra. Photocopies of UV, IR, NMR and Mass spectra of standard compounds are to be interpreted to determine the structure of the compound. At the time of practical examination, candidates are expected to submit the Journal.

### **OEP 3.1: Column Chromatography**

Separation of the given mixture by using column chromatography method  
(TLC Analysis is recommended)

### **OEP 3.2: Review Work**

There will be computer laboratory session for hands on Chem draw software and literature survey by using Google Scholar/ Science Direct/Scopus/Web of Science etc. A student shall be expected to carry out literature survey in the field of interest and to select a topic for his/her project work in consultation with the supervisor. It shall be expected that a student

justifies the gravity and also the relevance of the problem through his/her seminar. Candidates are expected to do the following work at computer laboratory.

- 1) Literature survey
- 2) Work plan
- 3) Handling of Chem draw software for structure drawing
- 4) Chem draw assignment
- 5) Synopsis preparation

Evaluation based on the efforts put in by the student to carry out his/her dissertation work & the results obtained thereof. At the time of practical examination, candidates are expected to submit the synopsis which includes work done/ review of literature for the proposed work along with presentation. It will be valued for 40 marks.

## **M. Sc. II, SEMESTER-IV (Medicinal Chemistry)**

### **PRACTICAL COURSE**

#### **HCP 4.1: Organic Synthesis**

**Study of following reactions/organic preparations starting with 5g or less (Any five)**

(TLC, MP /BP analysis and recrystallization of product is recommended)

- 1) Hantzsch pyridine synthesis
- 2) Ugi Reaction
- 3) Biginelli reaction
- 4) Gewald reaction
- 5) Dess-Martin Oxidation: Oxidation of benzyl alcohol to benzaldehyde
- 6) Synthesis of benzil from deoxybenzoin using  $\text{SeO}_2$  reagent
- 7) Nifedipine synthesis
- 8) Hydrolysis of ester (Saponification)
- 9) Amine to azide via diazotization reaction

(Note: Other suitable experiments may be added)

#### **HCP 4.2: Organic Chemistry**

**Isolation of following constituents from the natural sources: (Any five)**

- 1) Isolation of lycopene from tomato fruits
- 2) Isolation of limonene from citrus rinds
- 3) Isolation of  $\beta$ -carotene from carrots
- 4) Isolation of Eugenol from cloves



- 5) Isolation of Piperine from black pepper
- 6) Isolation of Nicotine from tobacco
- 7) Isolation of Curcumin from turmeric
- 8) Isolation of capsaicinoids from peppers by Soxhlet extraction

(**Note:** Other suitable experiments may be added)

### **HCP 4.3: Project Work /In Plant Training**

Candidates are expected to work on assigned research project and submit the results at the end of the semester in the form a dissertation. Open defense of the student on his/her dissertation shall be arranged. This defense shall be in front of the panel of examiners. This will be valued for 40 marks.

Project work involving organic synthesis/evaluation of biological studies or in-plant training in any of the pharmaceutical or chemical industry for at least 21 days will be considered. Project should be completed under the guidance of a faculty member in the same Department or Industry or research organization. In case of Industry/research organization one member of that body can also be included as project guide.

#### **Guidelines for Assessment**

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Clarity of objective and scope
- Quality of work attempted
- Presentation skills

### **SCP 4.1: Pharmaceutical formulation (Any five)**

- 1) Preparation of weak Iodine solution
- 2) Preparation of Paracetamol Suspension,
- 3) Preparation of Castor Oil Emulsion
- 4) Preparation of Simple Syrup IP
- 5) Preparation of Lemon Syrup
- 6) Preparation of Sodium chloride eye lotion
- 7) Preparation of Methyl salicylate Ointment
- 8) Pre-formulation studies: Drug-drug interaction and drug excipient interaction in physical mixture,
- 9) Determination of solubility of Paracetamol in water, 0.1N HCl, 0.1N NaOH, Phosphate buffer pH 6.8 and 7.4

10) Study of Stability drug: Room Temperature, UV light, and Sun light

(Note: Other suitable experiments may be added)

### **SCP 4.2: Medicinal Chemistry**

Drug synthesis/Molecular modeling: Synthesis of medicinally important compounds:

(TLC Analysis is recommended)

(Any five)

- 1) Benzocain
- 2) Coumarins
- 3) Benzimidazole
- 4) Paracetamol
- 5) Iodoform
- 6) Phenyl azo-2 naphthol
- 7) 2-Phenyl quinoline-4-carboxylic acid from benzaldehyde.

(Note: Other suitable experiments may be added)

#### **Reference books:**

- 1) A Textbook of Practical Organic Chemistry - A. I. Vogel.
- 2) Practical Organic Chemistry - Mann & Saunders.
- 3) A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.
- 4) Organic Synthesis Collective Volumes by Blat.
- 5) Reagents in Organic Synthesis by Fieser and Fieser.
- 6) Organic Practicals by Ahluwalia.
- 7) Systematic Lab Experiments in Organic Chemistry by Arun Sethi. (New Age).
- 8) Advanced Practical Medicinal Chemistry by Ashutosh Kar