

# Revised Syllabus 2014

## M.Sc. II: Drug Chemistry

### Semester III

<b>CHD- 361</b>	<b>Chemistry of Heterocycles and Drug synthesis</b>	<b>48 Lectures, 4 Credits</b>
<b>CHD-362</b>	<b>Advanced Analytical methods</b>	<b>48 Lectures, 4 Credits</b>
<b>CHD-363</b>	<b>Microbiology, Immunology &amp; Drug discovery and development</b>	<b>48 Lectures, 4 Credits</b>
<b>CHD-364</b>	<b>Stereochemistry, Assymetric synthesis and Pericyclic reactions.</b>	<b>48 Lectures, 4 Credits</b>

### Semester IV

<b>CHD-463</b>	<b>Principles and applications in Drug Design</b>	<b>48 Lectures, 4 Credits</b>
<b>CHD-461</b>	<b>Advanced Organic Synthesis- Principles and strategies</b>	<b>48 Lectures, 4 Credits</b>
<b>CHD-462</b>	<b>Advanced Medicinal Chemistry</b>	<b>48 Lectures, 4 Credits</b>
<b>CHD-464A</b>	<b>Bioinformatics, Cheminformatics, Biostatistics in Drug discovery and design</b>	<b>24 Lectures, 2 Credits</b>
<b>CHD-464B</b>	<b>Current trends in organic Chemistry: Supra-molecular, Green chemistry, photochemical &amp; free radical reactions</b>	<b>24 Lectures, 2 Credits</b>
<b>CHD-464C</b>	<b>Entrepreneurship development and project management</b>	<b>24 Lectures, 2 Credits</b>

### M.Sc. II: Drug Chemistry Practicals

<b>CHD-367</b>	<b>Practical Course I Organic Synthesis</b>	<b>6 Credits</b>
<b>CHD-468</b>	<b>Practical Course II Microbiology and Biochemistry</b>	<b>6 Credits</b>
<b>CHD-469</b>	<b>Practical Course III Project /Industrial training / Advanced practicals</b>	<b>6 Credits</b>

### Equivalence of previous Syllabus

	<b>New Syllabus 2014 Pattern</b>		<b>Old Syllabus 2008 Pattern</b>
<b>CHD-361</b>	<b>Chemistry of Heterocycles and Drug synthesis</b>	<b>CH-361</b>	<b>Chemistry of Heterocycles and biologically active compounds</b>
<b>CHD-362</b>	<b>Advanced Analytical methods</b>	<b>CH-362</b>	<b>Advanced analytical methods</b>
<b>CHD-363</b>	<b>Microbiology, Immunology &amp; Drug discovery and development</b>	<b>CH-363</b>	<b>Drug Development</b>
<b>CHD-364</b>	<b>Stereochemistry, Assymmetric synthesis and Pericyclic reactions.</b>	<b>CH-364</b>	<b>Stereochemical principles and applications</b>
<b>CHD-461</b>	<b>Advanced Organic Synthesis- Principles and strategies</b>	<b>CH-461</b>	<b>Synthetic methods in Organic Chemistry</b>
<b>CHD-462</b>	<b>Advanced Medicinal Chemistry</b>	<b>CH-462</b>	<b>Chemotherapy</b>
<b>CHD-463</b>	<b>Principles and applications in Drug Design</b>	<b>CH-463</b>	<b>Drug Design</b>
<b>CHD-464A</b>	<b>Bioinformatics, Cheminformatics, Biostatistics in Drug discovery and design</b>		
<b>CHD-464B</b>	<b>Current trends in organic Chemistry: Supra-molecular, Green chemistry, photochemical &amp; free radical reactions</b>		
<b>CHD-464C</b>	<b>Entrepreneurship development and project management</b>		
<b>CHD-367</b>	<b>Practical Course I</b>	<b>CH-367</b>	<b>Practical Course I</b>
<b>CHD-468</b>	<b>Practical Course II</b>	<b>CH-468</b>	<b>Practical Course II</b>
<b>CHD-469</b>	<b>Practical Course III</b>	<b>CH-469</b>	<b>Practical Course III</b>

## M.Sc. Organic Chemistry PART-II

### REVISED SYLLABUS-2014

#### CHD 361:- CHEMISTRY OF HETEROCYCLES AND DRUG SYNTHESIS

[4 CREDITS 48 Lectures]

##### Heterocyclic Chemistry

1. Five and six membered heterocycles with one and two hetero atoms (24 L)

Synthesis, reactivity, aromatic character and importance of following heterocyclic rings:

Furan, Pyrrole, Thiophene, pyrazole, imidazole, oxazole, thiazole, isoxazole, Pyridine, pyrimidine, pyrazine, oxazine and thiazine Condensed five and six membered heterocycles – Benzofuran, Indole, Benzothiophene, Quinoline and Isoquinoline, Coumarins and chromones, Condensed five membered heterocycles – Benzoxazole, benzthiazole, Benzimidazole

Five and six membered heterocycles with more than two hetero atoms

Synthesis, reactivity, aromatic character and importance of following heterocycles:

1,2,3-triazole, 1,2,4-triazole, 1,2,4-oxadiazole, 1,3,4-oxadiazole, 1,2,5-oxadiazole, tetrazole, 1,2,3-triazine, 1,2,4-triazine, 1,3,5-triazine, tetrazine, purines, pyrimidines and pteridines.

Ref. 14-20

2. Synthesis of biologically active natural products : Prostaglandins, Cephalosporin –C (24L)  
Reserpine , Taxol, Estrone. Epothiolone, Penicillin, Griseofulvin etc.

3 Synthetic Drugs and their derivatives: Ciprofloxacin, Iuprofen, Atenolol, Captopril, Diazepam, Chloroquine, Barbiturates, Miconazole, Vit -B<sub>6</sub>, Vitamin- A, Biotin, Ethambutol, Ranitidine, Omeprazole, Vitamin C etc.

4 Synthesis of drugs of current Interest.

#### CHD-362: Advanced Analytical methods [4 credits, 48 Lectures]

## **<sup>1</sup>H NMR Spectroscopy**

**(14 L)**

Chemical shift, factors influencing chemical shift, deshielding, chemical shift values and correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other nuclei (alcohols, phenols, enols, acids, amides and mercaptans), chemical exchange, effect of deuteration, spin-spin coupling, (n+1) rule, complex spin-spin interaction between two, three, four and five nuclei (first order spectra), factors effecting coupling constant "J", classification of spin system like AB, AX, AX<sub>2</sub>, ABX, AMX, ABC, A<sub>2</sub>B<sub>2</sub>. Spin decoupling, Factors affecting coupling constant, simplification of complex spectra, nuclear magnetic double resonance, spin decoupling, contact shift reagents, solvent effects, nuclear over-hauser effect (NOE), resonance of other nuclei like <sup>31</sup>P, <sup>19</sup>F

## **<sup>13</sup>C NMR spectroscopy**

**(8 L)**

FT NMR, Types of <sup>13</sup>C NMR Spectra: un-decoupled, Proton decoupled, Off resonance, APT, INEPT, DEPT, chemical shift, calculations of chemical shifts of aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons, factors affecting chemical shifts, Homo nuclear (<sup>13</sup>C-<sup>13</sup>C) and Hetero nuclear (<sup>13</sup>C-<sup>1</sup>H) coupling constants.

## **2D NMR Techniques**

**(6 L)**

General idea about two dimensional NMR spectroscopy, Correlation spectroscopy (COSY)-Homo COSY (<sup>1</sup>H-<sup>1</sup>H), TOCSY, Hetero COSY (HMQC, HMBC), Homo and Hetero nuclear 2D resolved spectroscopy, NOESY and 2D-INADEQUATE experiments and their applications.

## **Mass Spectrometry**

**(08 L)**

Instrumentation, various methods of ionization (field ionization, field desorption, SIMS, FAB, MALDI, Californium plasma), different detectors (magnetic analyzer, ion cyclotron analyzer, Quadrupole mass filter, time of flight (TOF)). Rules of fragmentation of different functional groups, factors controlling fragmentation

## **Problems based on joint application of UV, IR, PMR, CMR, and Mass.**

**(08 L)**

(Including reaction sequences)

## **An introduction to ESR, EPR and Raman**

**(04)**

### **Suggested Books:**

1. Introduction to Spectroscopy – D. L. Pavia, G.M. Lampman, G. S. Kriz, 3rd Ed. (Harcourt college publishers).
2. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 6th Ed. John Wiley and Sons.
3. Spectroscopic methods in organic chemistry - D. H. Williams and I. Fleming Mc Graw Hill

4. Absorption spectroscopy of organic molecules – V. M. Parikh
5. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer-Verlag (1986).
6. One and Two dimensional NMR Spectroscopy – Atta-Ur-Rehman, Elsevier (1989).
7. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998)
8. Organic structural Spectroscopy- Joseph B.Lambert, Shurvell, Lightner, Cooks, Prentice-Hall (1998).
9. Organic structures from spectra –Field L.D., Kalman J.R. and Sternhell S. 4th Ed. John Wiley and sons Ltd.
10. Spectroscopic identification of organic compound- R M Silverstein, G C Bassler and T C Morrill, John Wiley
11. Introduction to NMR spectroscopy-R J Abraham, J Fisher and P Loftus Wiley
12. Organic spectroscopy-William Kemp, E L B with McMillan
13. Spectroscopy of organic molecule-PS Kalsi, Wiley, Esterna, New Delhi
14. Organic spectroscopy-RT Morrison and RN Boyd
15. Practical NMR spectroscopy-ML Martin, J J Delpench, and D J Martyn
16. Spectroscopic methods in organic chemistry-D H Willson, I Fleming
17. Spectroscopy in organic chemistry- C N R Rao and J R Ferraro
18. NMR –Basic principle and application-H Guntur
19. Interpretation of NMR spectra-Roy H Bible
20. Mass spectrometry organic chemical applications, J H Banyon

### **CH-363 DRUG DEVELOPMENT [4 Credits 48 L]**

#### **Part A: Immunology and Microbiology**

- 1 Microbial Drug Development - Introduction to Microbiology and classification of Microbes. Characterisation and Screening of Microbes fermentation process, Microbial growth, kinetics, Isolation and Improvement of Individual micro- organism, fermenter designing, Media designing, antimicrobial assays; Down Stream process and effluent treatment (Microbial and Chemical)
- 2 Immunology and Immunopharmacology- Overview of the immune system and its role, Adaptive and innate Immunity. Immune response and the underlying mechanisms, Regulation of immune response. Hypersensitivity, immunodeficiency, Autoimmunity, Immunization, Immunosuppressants, Immunomodulators, Immunological techniques.

#### **Part B: Drug discovery and Development**

- 3 Introduction to the different systems of medicines
- 4 Sources of drugs, Microbial, Plant, Marine, synthetic, A historical perspective.
- 5 Discovery and Development of Drugs- History of drug discovery, Strategies in drug discovery, lead discovery, pharmacophore identification, lead development, Bioassays, screening of compounds. Toxicological evaluation of new drugs, Pre-Clinical testing, Clinical trials, Patents and intellectual property rights, Bioavailability of drugs, Bioequivalence, Pharmacokinetics and Pharmacodynamics of drug action.

From R & D to plant. Strategies in process development, scale up process. GMP, QA, QC, FDA, Documentation, Pharmacoeopia, Industrial hygiene and safety, Routes of drug administration, formulation of Dosage forms.

Case studies of drug discovery

References

- 1 Introduction to Microbiology- II<sup>dn</sup>. Edn Ingraham and Ingraham(Thomson Books)
- 2 Microbiology-Stanies,
- 3 Microbiology- Pleczar.
- 4 Immunology-Roitt Bostolf,Malc (2001) Mosby
- 5 Physiology and Anatomy -Carolla.
- 6 Industrial Microbiology-Cassida.
- 7 The Chemical Industry-Healton CA ( hapman end Hall)
- 8 Comprehensive Medicinal Chemistry Vol-I ( Hansch (1990) Pergamon pres
- 9 Basic and Chemical Immunology-Stites(1987) Prentice Hall.
- 10 Principle of Drug action-Goldstein.
- 11 Bioavailabinty and Bio equivalence-H.P.Tinis.
- 12 Pharmacoeopia of India, British pharmecoeopia, US Pharmacoeopia
- 13 Introduction to medicinal Chemistry, III Edn. Patrick (2001) Oxford
- 14 Pharmaceutical Dosage forms and Drug Delivery system VI<sup>th</sup> Edn. .Arnel (Wessl
- 15 Organic Chemistry of Drug Design and Drug Action. R.B.Silverman (1993) Academic Press

### **CHD-364: Stereochemistry, Assymetric synthesis and Pericyclic reactions**

**[4 credits, 48 Lectures]**

1. Stereochemistry of six membered rings. Ref. 1, 4, 5 (7L)
2. Stereochemistry of rings other than six membered Ref. 1, 4, 5 (6L)
3. Fused Bridged and caged rings Ref. 1, 2, 4, 5 (5L)
4. Principles and applications of asymmetric synthesis: (18L)  
stereoselectivity in cyclic compounds, enantio-selectivity, diastereo-selectivity, enatiomeric and diastereomeric excess, stereoselective aldol reactions. Cram's rule, Felkin Anh rule, Cram's chelate model, Asymmetric synthesis, use of chiral auxiliaries, chiral reagents and catalysts, asymmetric hydrogenation, asymmetric epoxidation and asymmetric dihydroxylation. Synthetic and Industrial applications.
5. Pericyclic reactions [12L]  
Electrocyclic, cycloaddition, sigmatropic and ene reactions. 1,3-dipolar additions, Analysis by correlation diagrams, FMO approach and ATS concept. Applications of pericyclic reactions. Ref. 3 chapters 33, 34, 35

#### **References:**

1. Stereochemistry of carbon compounds - E. L. Eliel
2. Stereochemistry of carbon compounds - E. L. Eliel and S. H. Wilen
3. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers
4. Stereochemistry of organic compounds –Nasipuri

5. Stereochemistry of organic compounds-Kalsi
6. Organic stereochemistry – Jagdamba Singh
7. Pericyclic reactions: A text book –S. Sankararaman
8. Pericyclic reactions- Gill and Willis
9. Frontier orbitals and organic chemical reactions-Ian Fleming, John Wiley & sons
10. Conservation of orbital symmetry – R. B. Woodward and R. Hoffmann; Verlag Chemie, Academic press (1971).
11. Orbital Symmetry : A problem solving approach- R. E. Lehr and A. P. Marchand; Academic (1972)

### **CHD-461 Advanced organic synthesis, Principles and strategies [4 Credits 48 L]**

- 1 Organolithium, Aluminium, Phosphorous and Boranes, Synthetic applications
- 2 Transition metal complexes in Organic synthesis. Suzuki, Heck, Sonogashira, Stille, Fukuyama, Kumada, Hiyama, Negishi, Buchwald-Hartwig, Noyori, Reppe, Oxo process
3. Multi-component reactions: Ugi, Passerini, Biginelli and Mannich reactions
4. Ring formation reactions: Pausan-Khand, Bergman and Nazarov cyclization
5. Click chemistry: criterion for click reaction, Sharpless azides cycloadditions
3. Enamines in Organic synthesis.
4. Umpolung in Organic synthesis
5. Designing Organic synthesis.
6. Protecting groups for hydroxyl, amino, carboxyl, aldehyde and ketone functions as illustrated in the synthesis of polypeptide and polynucleotide
7. Biomimetic synthesis
8. Green Chemistry.
9. Domino Reactions

#### **References**

- 1 Principles of Organo metallic Chemistry- G.E.Coates, Green and K. Wade
- 2 Transition Metal Intermediates in Organic synthesis C W Bird, Logos (1967)
- 3 Organometallics in Organic synthesis- J. M. Swan and DC Black (Chapman Hall)
- 4 Designing Organic synthesis - S Warren (Wiley Interscience)
- 5 Some modern methods of Organic synthesis. W Carruthers (Cambridge)
- 6 Modern synthetic Reactions- HO House, Benjamin.
- 1 Organic Chemistry -Clayden, Greeves, Warrcn of wothers (Oxford press)
- 8 Organic synthesis M. B. Smith.

### **CH-462 Advanced Medicinal Chemistry [4 Credits 48 L]**

1. Antimicrobial therapy -Development and mechanism of action for Penicillins, Cephalosporins and Quinolones. An Overview of Aminoglycosides, Macrolides, Tetracyclines, Sulfa drugs. Peptides polyenes and miscellaneous antibiotics.
2. Antifungals, Antiviral, Antimalarial, Antimycobacterials
3. Cancer and its Chemotherapy, including developments in Immunotherapy
4. Cardiovascular system and its disorders: Hypertension, Heart Failure, Angina

Pectoris, Arrhythmia, Myocardial Infarction, Ischaemic heart diseases, Stroke. Management of these disorders with drugs.

5. Central Nervous System, CNS disorders, A study of antidepressants, Hypnotics and sedatives, Tranquilizers and Anticonvulsants.
6. Pain , Inflammation ,Analgesics, anti- inflammatory agents.
7. Endocrine system and Hormonal therapy.
8. Gastrointestinal tract disorders and Drugs.
9. Diabetes and Management of Diabetes.

#### References

- 1 Medicinal Chemistry -Burger vols. I to IV (John Wiley)
- 2 Principles of Medicinal Chemistry- W.Foye.
- 3 Comprehensive Medicinal Chemistry -C.Hansch (Pergamon Press).
- 4 Selective Toxicity –A. Albert (Chapman Hall)
- 5 Principles of Drug action - A. Goldstein.
- 6 Organic Chemistry of Drug action and Drug design -LB. Silverman (Elsevier)
- 7 Physiology and Anatomy- Carolla.
- 8 Medicinal Chemistry-Biochemical approach, Thomas Nogardy.
- 9 Essential of pharmacology -K. D. Tripathi.
- 10 Pharmacology-Haney
- 11 Pharmacology-Goodman and Gilman.
- 12.An introduction to medicinal Chemistry Graham Patrick (Oxford)
13. Introduction to the Principles of Drug design and action. IVth Ed. H.John Smith (Taylor and Francis )2010
14. Introduction to Medicinal chemistry Alex Gringauz (Wiley India)
- 15.Medicinal Chemistry An introduction II nd Edition. Gareth Thomas (Wiley India)2011
16. Wilson and Gisvolds Textbook of Organic, Medicinal and Pharmaceutical Chemistry 12<sup>th</sup> Ed John M beale and John H Block 2011 Lippincott Williams and Wilkins

#### **CH- 463CH- 463 DRUG DESIGN**

1. Membrane and Receptors- Structure, functions and the mechanism of drug action (Receptor Response), Clasifications, types of receptors. GPCR & Ion channels Design of agonist and antagonists as drugs. Receptor theories, Models and their types. Receptors and metabolic disorders imp in drug design.
2. Drug design: Optimising target interactions and optimizing access to target .
3. Case studies on drug design from Patricks 5<sup>th</sup> Ed.2013
4. Physicochemical principles of Drug action- Drug Receptor interactions, Quantitative description of physicochemical parameters and their calculation. QSAR, Hanschanalysis, COMFA, COMSIA, Free Wilson Method, Topliss manual and batchwise approach. Craig's models. Current trends
4. Design of Drugs based on pharmacokinetics, Bio activation and metabolism Pro-drug Design. Design of enzyme inhibitors.
5. Molecular Biology , Genetic engineering and Biotechnology in production of biological as drugs. Antisense therapeutic agents: design and use of siRNA with examples. An overview of Genomics, Metabolomics, pharmacogenomics and Toxicogenomics etc.

5. Combinatorial Chemistry and high throughput Screening. Peptide and peptidomimetic drug designing
6. Bio-informatics and applications in drug design.
7. Computers Aided Drug design: Basic concept of Computational chemistry like Quantum Mechanics, Molecular Mechanics, Force fields, Energy minimization, Conformational search, Molecular dynamics. Ligand based drug design, Receptor based drug design. Analog approach, pharmacophore mapping. Molecular-modeling, Dock, Autodock and Flexidock etc. Virtual Screening.
9. Current trends in the field of drug discovery and design.

#### References

1. An Introduction to Medicinal Chemistry- 5th Edn. Patrick(Oxford 2013)
2. Medicinal Chemistry Vol. I Burger.
3. Molecular Modeling, Principles and applications -Andrew Leach(Longman) 1998.
4. Comprehensive Medicinal Chemistry vol.4 Corwin Hansch(1990) pergamon press.
5. Organic Chemistry of drug design and drug action-RB. Silverman 2<sup>nd</sup> Ed. (2004) Elsevier
6. Statistical MethodS in Biology-Norman Bailey(1995) Cambridge.
7. A Text book of Drug design and development IInd Edn. Povl..Krogsgaard-Larsen Tommy L. and U Madsen (1996) Harwood Acad. Publishers.
8. Medicinal Chemistry An introduction Gareth Thomas 2<sup>nd</sup> Edition (Wiley India)
9. Introduction to the Principles of Drug design and action. IVth Ed. H.John Smith (Taylor and Francis )2010
- 10.Principles of Medicinal Chemistry including Proteomics S.Rangnathan & Jerad Suresh 2011 CBS press

#### **CHD-464A Bioinformatics, Cheminformatics, Genomics, Proteomics, Metabolomics & Biostatistics in Drug discovery and design ( 2 Credits 24 L)**

Introduction: Introduction to biological databases, types of databases, Information retrieval from biological databases. Gene prediction programs, promoter and regulatory elements prediction programs.

Structural bioinformatics, Phylogenetics and structural bioinformatics.

Elements of genomics, transcriptomics proteomics and metabolomics and applications

Elements of Cheminformatics:

Representation of molecular structure, graphs connection tables, linear notations, canonical representations. Structure and substructure searching algorithms. Reaction databases, representation of patents and patent databases. Relational databases for molecules.

Use of Chembioinformatics in drug designing with case studies.

References:

- 1.Principles of Medicinal Chemistry including Proteomics S.Rangnathan & Jerad Suresh 2011 CBS press
- 2.

**CHD-464B Current trends in organic Chemistry: Supra-molecular, Green chemistry, photochemical & free radical reactions [2 credits, 24 Lectures]**

**1. Supra-molecular Chemistry [5L]**

Properties of covalent bond, bond length, inter-bond angles, force constant, bond and molecular dipole moments, molecular and bond polarisability, bond dissociation enthalpy, entropy, Intermolecular forces, hydrophobic effects, Electrostatics, induction, dispersion and resonance energy, magnetic interactions, magnitude of interaction energy, force between microscopic bodies, medium effects, hydrogen bond, Principles of molecular association and organization as exemplified by in biological macromolecules like enzymes, nucleic acids, membrane and model systems like micelles and vesicles, molecular receptors and design principles. Cryptands, cyclophanes, calixarenes, cyclodextrins. Supramolecular reactivity and catalysis. Molecular channels and transport processes. Molecular devices and nanotechnology.

Ref.1

**2. Green chemistry [5L]**

1. Atom Economy and Principles of chemistry Green
2. Solvent free reactions
3. Organic synthesis in solid state: Michael addition, Beckmann rearrangement, solid support organic synthesis, synthesis of aziridine, pyridine, chromones and flavones.
4. Aqueous phase Reactions: Diels –Alder reaction, Heck reaction, epoxidation, dihydroxylation (syn & Anti).
5. Microwave Technology: Microwave solvent free reactions- Deacetylation, deprotection, saponification of ester, alkylation of reactive methylene compounds, synthesis of nitrile from aldehyde,, reductions.
6. Microwave assisted reaction in water: Hoffmann elimination, hydrolysis, oxidation, saponification reactions
7. Ultrasound assisted reactions: introduction, substitution reactions, addition, oxidation, reduction reactions.
8. Ionic liquids: Introduction and application in organic synthesis.
9. Use of bio-catalyst in organic synthesis.

Ref. 2,3,4

**3. Photochemistry & Free Radical chemistry [14L]**

General basic principles, photochemistry of carbonyl compounds, alkenes, dienes, polyenes and aromatic compounds, photorearrangements, Barton \ reaction  
Ref. 1,2,3, Free radicals:

4. Free radicals :Generation of radicals, Stable free radicals, Nucleophilic and electrophilic radicals, Characteristics reactions, -Free radical substitution, addition to multiple bonds, Radicals in synthesis: Inter and intra molecular C-C bond formation via mercuric hydride, tin hydride, thiol donors, cleavage of C-X, C-Sn, C-Co, C-S, O-O bonds.

References :

References:

1. Supramolecular Chemistry- Concepts and perspectives by J.M. Lehn
2. Green Chemistry-Theory and practical, By Paul and Anastas and John C. Warner.
3. New trends in greenchemistry-by V.K. Ahuwalia and Kidwai
4. Organic synthesis special techniques. by V.K. Ahuwalia and Renu Agrawal
  
5. Mechanism and structure in Organic Chemistry – E. S. Gould (Holt, Rinehart and Winston)
6. Advanced Organic Chemistry, Part A – F. A. Carey and R. J. Sundberg, 5<sup>th</sup> Ed. Springer (2007)
7. Excited states in Organic Chemistry- J.A. Barltrop and J.D.Coyle, John Wiley & sons
8. Photochemistry and Pericyclic reactions-Jagdamba Singh, Jaya Singh 3<sup>rd</sup> Ed.
9. Organic photochemistry: A visual approach-Jan Kopecky, VCH publishers (1992).

### **CHD-464C: Entrepreneurship development and project management [2 credits, 24 Lectures]**

- 1. Fundamentals of Entrepreneurship Development:** [6L]  
Concept and need of Entrepreneurship, Development and Definition of Entrepreneurship, Entrepreneurship, Innovation, Invention, Creativity, Business, Idea, Opportunities, through change, Concept of Entrepreneurship, Manager, Entrepreneur/ cooperate Entrepreneur-comparative study-Roles, Responsibilities, Career opportunity, Entrepreneurship as a carrier, Entrepreneurship as style of management, The changing role of Entrepreneur: mid career dilemmas, -Closing the window, : Sustaining competitive-Maintaining competitive advantages  
Ref. 1
- 2. Theory of Entrepreneurship** [6L]
  - a. Innovation Theory by Schumpeter & Imitating
  - b. Theory of High Achievement by McClelland
  - c. X-Efficiency Theory by Leibenstein
  - d. Theory of profit by Knight
  - e. Theory of Social change by Everett HagenRef. 2
- 3. Influence of Entrepreneurship development** [6L]
  - a. Entrepreneur Traits
  - b. External influence on Entrepreneurship Development: Socio-cultural , political, Economical, Personal, Entrepreneurial culture with special reference to Entrepreneurship, Corporate Entrepreneurship

- c. Entrepreneurial Success and failure: Reasons and Remedies  
Ref. 2

**4. Business planning process:** [6L]

The business plan as Entrepreneurial tool, Element of Business plan, Objectives, market Analysis, Development of product /idea, Marketing Finance, Organization & Management, Ownership, Critical risk, contingencies of the proposal, Scheduling and milestones

Ref. 4

**References:**

1. Entrepreneurship –Robert D Hisrich, Michael P, Peters, Dean A Shepherd
2. Entrepreneurship as strategy –G, Dale Meyer, Kurt A. Heppard
3. Project Management: K. Nagarajan
4. The Culture of Entrepreneurship-Brigitte Berger
5. Entrepreneurship: New venture Creation –David H Holt

**CH-367: PRACTICAL COURSE- I ORGANIC SYNTHESIS**

**Single , Two stage and three stage synthesis from the sets given below or any other relevant.**

**Single stage:**

1. 2-Phenyl indole (Fischer indole synthesis),
2. 7-Hydroxy -3-methyl flavone (Baker-Venkatraman reaction),
3. Benzyl alcohol and benzoic acid from benzaldehyde (Cannizzaro reaction)
4. 4-Chlorotoluene from p-toluidine (Sandmeyer reaction)
5. Benzilic acid from benzoin (Benzilic acid rearrangement)
6. Benzopinacol (Photochemical reaction),
7. 7-Hydroxy-4-methyl coumarin (Pechmann Reaction)
8. 4-Methyl benzophenone (Friedel Craft reaction)
9. Benzanilide (Beckmann rearrangement)
10. Vanillyl alcohol from vanillin (NaBH<sub>4</sub> reduction)
11. 2- and 4-nitrophenols (nitration and separation by steam distillation)
12. Acridone
13. Stilbene from benzyl chloride (Wittig reaction)
14. Ethyl cinnamate from benzaldehyde (Wittig reaction)
15. Triphenyl or diphenyl methyl carbinol (Grignard reaction)
16. Benzotriazole
17. 1-Phenyl-3-methyl pyrazol-5-one

18. Glucose pentaacetate
19. 2,4-diethoxycarbonyl-3,4-dimethyl pyrrole from ethyl acetoacetate
20. Quinoline from aniline (Skraup synthesis)
21. Benzimidazole from benzyl
22. Cyclohexanol from cyclohexanone (LAH reduction)
23. Glycine → 2,5-dioxopiperazine
24. PABA → Benzocaine
25. 3,5-diacetyl-1,4-dihydro-2,6-trimethylpyridine

1. **Two stage:** Benzaldehyde → Benzalacetophenone → Epoxide
2. 4-Nitro toluene → 4-nitro benzoic acid → 4-Amino benzoic acid
3. Resorcinol → 4-methyl-7-hydroxy coumarin → 4-Methyl-7-acetoxy coumarin
4. Cyclohexanone → Phenyl hydrazone → 1,2,3,4-tetrahydrocarbazole
5. Hydroquinone → Hydroquinone diacetate → 1,2,4-Triacetoxy benzene
6. Acetanilide → p-Acetamidobenzene sulphonyl chloride → p-Acetamidobenzene sulphonamide
7. p-Amino phenol → p-acetyl amino phenol → p-Ethoxy acetanilide
8. Hippuric acid → Azalactone → 4-benzylidene 2-phenyl oxazol-5-one
9. p-Cresol → p-Cresyl benzoate → 2-Hydroxy-5-methyl benzophenone
10. Phthalimide → N-benzylphthalimide → benzylamine
11. O-nitroaniline → O-phenylene diamine → Benzimidazole
12. Phthalic acid → phthalimide → Anthranilic acid
13. Benzyl cyanide → p-Nitrobenzyl cyanide → p-Nitro phenyl acetic acid
14. Hydroquinone → Hydroquinone diacetate → 2,5-dihydroxy acetophenone
15. Cyclohexanone → Enamine → 2-acetyl cyclohexanone
16. α-Pinene → Disiamyl borane → Pinanol
17. Benzoin → Desylbenzoate → 2,4,5-triphenyl Oxazole
18. Phenylacetate → O-Hydroxyacetophenone → Chromone-2-carboxylic acid

**Reactions involving the following could be done:**

- 1 Clemmensen/ Wolf kischner Reduction.
- 2 NaBH<sub>4</sub>/ LiAlH<sub>4</sub> Reductions.
- 3 Hydroboration-Oxidation.
- 4 Synthesis of chiral auxiliary.
- 5 Asymmetric induction using Disopinanyl borane.
- 6 Oxidation using H<sub>2</sub>CrO<sub>4</sub>
- 7 Synthesis of Heterocycles.
- 8 Grignard reaction.
- 9 Synthesis of some Drug Molecules
- 10 Lithiation and other Metalation reactions
- 11 Determination of partition Coefficients and Ionisation constant of Drug molecules.

### **CH- 468: PRACTICAL COURSE-II Biochemistry and Microbiology**

1. Microbiology - Differentiation, Gram staining Morphology, Protoplast fusion, Screening of bacterial substances, sterility testing. Microbial assays, Production of penicillin by fermentation
2. Biochemistry- Isolation, purification and characterisation of Enzymes, stability studies, Kinetics determination of  $K_m$ ,  $V_{max}$ , 1-50, Inhibition studies, reversible, irreversible and K Cat. Electrophoresis, Isolation and estimation of DNA, DNA-drug interaction studies, Determination of drug in blood and urine.

### **CH-469: PRACTICAL COURSE III PROJECT WORK / INDUSTRIAL TRAINING/ ADVANCED PRACTICALS**

The students who will not do project course, shall carry out at least 12 experiments to illustrate the principles of Organic mechanism and synthesis.

Synthesis of Heterocycles Viz.

Quinoline, Barbiturates, Acridines, Indole, Carbazole, Pyrazole, Pyrrole, Coumarins, Thiazole, Imidazole, Triazole etc.

Synthesis involving following reactions.

Beckmann rearrangement, Hoffman rearrangement, Friedel Crafts acylation, Sandmeyer, Fries rearrangement. Biginelli reaction, Aldol Claisen condensation, Hydroboration etc.

Use of spectroscopic methods for structure determination and/or carryout biological activity studies for some of the compounds prepared during the course.

### **Green chemistry and chemical biology practicals from list below or other relevant:**

1. Preparation of acetanilide from aniline and acetic acid using Zn dust
2. Base catalyzed aldol condensation using  $\text{LiOH}\cdot\text{H}_2\text{O}$  as a Catalyst.
3. Bromination of *trans*-stilbene using sodium bromide and sodium bromate
4. [4+2] cycloaddition reaction in aqueous medium at room temperature
5. Benzil Benzilic acid rearrangement under solvent free condition
6. Thiamine hydrochloride catalyzed synthesis of benzoin from benzaldehyde
7. Clay catalyzed solid state synthesis of 7-hydroxy-4-methylcoumarin
8. Ecofriendly nitration of phenols and its derivatives using Calcium nitrate
9. Bromination of acetanilide using ceric ammonium nitrate in aqueous medium
10. Green approach for preparation of benzopinacolone from bezopinacol using iodine catalyst
11. Preparation of 1, 1-bis-2-naphthol under grinding at room temperature.
12. Solvent free aldol condensation between 3,4-dimethoxybenzaldehyde and 1-indanone
13. Solvent free quantitative solid phase synthesis of azomethines from substituted anilines and substituted benzaldehydes.
14. Sucrose to ethyl alcohol (Bakers yeast)
15. Assymmetric reduction of EAA by using Bakers yeast

### References

1. Practical Organic Chemistry, Al. Vogel (ELBS).

2. Pharmacological Basis of Therapeutics (Pergman press, New York) Goodman and Gilman.
3. Evaluation of Drug Activities- Pharmacometrics, Lawrence D. R. Bacharach AL. (Academic press London)
- 4 Screening Methods in Pharmacology, Turner R..A (Academic press London).
- 5 Physiological Chemistry, Hawk.
- 6 Clinical Biochemistry, Vol I and II Varley.
- 7 Fundamentals of Experimental Pharmacology, Ghosh M.N.(Scientific Book Agency, Calcutta)
8. Practical Biochemistry Plummer
- 9 Practical Microbiology. :
- 10 Practical Biochemistry, Jayaraman.
- 11 Microscale and Macro scale Preparations Williamson and Williamson.
- 12 Practical Heterocyclic Chemistry, Fitton and Smalley (AP)
- 13 Organic Synthesis Collective Volumes, Vol I to VIII
14. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal
15. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST
16. Practical Chemistry Fitton and Smalley

