

Punyashlok Ahilyadevi Holkar Solapur University, Solapur



Name of the Faculty: Science & Technology

CHOICE BASED CREDIT SYSTEM

Syllabus: PHARMACEUTICAL CHEMISTRY

Name of the Course: M.Sc.II (Sem-III & IV)
(Syllabus to be implemented from w.e.f. June 2019)

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

M. Sc. II, PHARMACEUTICAL CHEMISTRY COURSE SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

(w.e.f. June 2019)

Two-year duration **M. Sc. Pharmaceutical Chemistry** course syllabus has been prepared as per the CBCS semester system. M. Sc. II, SEM-III & SEM-IV Pharmaceutical Chemistry syllabus will be implemented from June 2019. 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 from Karnataka State Women's University, Vijaypur, and Dr. BAMU, Aurangabad.

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 70 marks for university external examination and 30 marks for internal examination of each semester and two practical's of 70 marks, 30 marks for internal practical of each semester. The distribution of marks is mentioned below

Theory Paper (Semester exam), 16 x (70+30) marks =1600 marks

Practicals (Semester end exam.), 8 x (70+30) marks =800 marks

Tutorials for each semester, 4 x 25 =100 marks

Total: 2500 marks

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

M. Sc. I (Pharmaceutical Chemistry)

Semester I and II

| Semester | Paper Code | Title of the Paper | Semester exam | | | L | T | P | Credits |
|----------|--|----------------------------|---------------|------------|------------|---|-----------|-----------|---------|
| | | | Theory | IA | Total | | | | |
| I | | Hard core | | | | | | | |
| | HCT-101 | Inorganic Chemistry -I | 70 | 30 | 100 | 4 | -- | - | 4 |
| | HCT-102 | Organic Chemistry -I | 70 | 30 | 100 | 4 | | - | 4 |
| | HCT-103 | Physical Chemistry -I | 70 | 30 | 100 | 4 | | - | 4 |
| | | Soft Core (Any one) | | | | | | | |
| | SCT-104A | Analytical Chemistry -I | 70 | 30 | 100 | 4 | | 0 | 4 |
| | SCT-104B | Chemistry in Life Sciences | 70 | 30 | 100 | 4 | | 0 | |
| | | Practicals | | | | | | | |
| | HCP-I | Inorganic Chemistry | 35 | 15 | 50 | - | - | 2 | 6 |
| | HCP-I | Organic Chemistry | 35 | 15 | 50 | - | - | 2 | |
| | HCP-II | Physical Chemistry | 35 | 15 | 50 | - | - | 2 | |
| | | Soft core (Any one) | | | | | | | |
| | SCP-IIA | Analytical Chemistry | 35 | 15 | 50 | - | - | 2 | 2 |
| | SCP-IIB | Analytical Chemistry | 35 | 15 | 50 | - | - | 2 | |
| | T-1 | Tutorial | | | | | 25 | | 1 |
| | Total for 1st semester | | 420 | 180 | 600 | | 25 | 25 | |

| | | | | | | | | | |
|-----------|-----------------|--------------------------------|----|----|-----|---|----|---|---|
| II | | Hard core | | | | | | | |
| | HCT-201 | Inorganic Chemistry -II | 70 | 30 | 100 | 4 | -- | - | 4 |
| | HCT-202 | Organic Chemistry -II | 70 | 30 | 100 | 4 | | - | 4 |
| | | Soft core (Any one) | | | | | | | |
| | SCT-203A | Physical Chemistry -II | 70 | 30 | 100 | 4 | | - | 4 |
| | SCT-203B | Green Chemistry | 70 | 30 | 100 | 4 | | - | |
| | | Open elective (Any one) | | | | | | | |

| | | | | | | | | | |
|--|-----------------|--|------------|------------|------------|---|-----------|---|-----------|
| | OET-204A | Instrumental Methods of Analysis | 70 | 30 | 100 | 4 | | - | 4 |
| | OET-204B | Medicinal Chemistry -I | 70 | 30 | 100 | 4 | | - | |
| | | Practicals | | | | | | | |
| | HCP III | Inorganic Chemistry | 35 | 15 | 50 | - | - | 2 | 4 |
| | HCP III | Organic Chemistry | 35 | 15 | 50 | - | - | 2 | |
| | | Soft core (Any one) | | | | | | | |
| | SCPIVA | Physical Chemistry | 35 | 15 | 50 | - | - | 2 | 2 |
| | SCPIVB | Physical Chemistry | 35 | 15 | 50 | - | - | 2 | |
| | | Open elective (Any one) | | | | | | | |
| | OEP IVC | Analytical Chemistry | 35 | 15 | 50 | - | - | 2 | 2 |
| | OEP IVD | Medicinal Chemistry | 35 | 15 | 50 | - | - | 2 | |
| | T-2 | Tutorial | | | | | 25 | | 1 |
| | | Total for 2nd semester | 420 | 180 | 600 | | 25 | | 25 |

M. Sc. II (Pharmaceutical Chemistry)

Semester III and IV

| Semester | Paper Code | Title of the Paper | Semester Exam | | | L | T | P | Credits |
|------------|------------------|---|---------------|----|-------|----|----|----|---------|
| | | | Theory | IA | Total | | | | |
| III | | Hard core | | | | | | | |
| | HCT-301 | Basics in Pharmaceutical Chemistry | 70 | 30 | 100 | 4 | | -- | 4 |
| | HCT-302 | Organic Spectroscopy | 70 | 30 | 100 | 4 | | -- | 4 |
| | | Soft core (Any one) | | | | | | | |
| | SCT-303A | Bioactive Heterocycles and Natural Products | 70 | 30 | 100 | 4 | | -- | 4 |
| | SCT- 303B | Biochemistry, Biomolecules and Bioinorganic chemistry | 70 | 30 | 100 | 4 | | -- | |
| | | Open elective (Any one) | | | | | | | |
| | OET- 304A | Medicinal Chemistry-I | 70 | 30 | 100 | 4 | | -- | 4 |
| | OET- 304B | Drug regulatory affairs | 70 | 30 | 100 | 4 | | -- | |
| | | Practicals | | | | | | | |
| | HCP -V | Drug synthesis/Isolation/Biochemistry estimations | 70 | 30 | 100 | -- | -- | 4 | 4 |
| | SCP –VI | Drug assay/Analysis | 35 | 15 | 50 | -- | -- | 2 | 2 |
| | | Open elective (Any one) | | | | | | | |

| | | | | | | | | | |
|-----------|------------------|---|-----|-----|------|----|----|----|-----|
| | OEP –VIA | Spectral Problems | 35 | 15 | 50 | -- | -- | 2 | 2 |
| | OEP- VIB | Colum chromatography | 35 | 15 | 50 | -- | -- | 2 | 2 |
| | T-3 | Tutorial/Seminar | | | | | 25 | | 1 |
| | | Total for 3rd semester | 420 | 180 | 600 | | 25 | | 25 |
| | | | | | | | | | |
| IV | | Hard core | | | | | | | |
| | HCT-401 | Stereochemistry, Photochemistry and Pericyclic reactions | 70 | 30 | 100 | 4 | | -- | 4 |
| | HCT-402 | Drug Discovery and Dosage Forms | 70 | 30 | 100 | 4 | | -- | 4 |
| | HCT-403 | Medicinal Chemistry-II | 70 | 30 | 100 | 4 | | -- | 4 |
| | | Soft Core (Any one) | | | | | | | |
| | SCT-404A | Advanced Organic Synthesis | 70 | 30 | 100 | 4 | | | 4 |
| | SCT-404B | Modern Organic Chemistry | 70 | 30 | 100 | 4 | | | |
| | | Practicals | | | | | | | |
| | HCP –VII | Organic Preparations (2/3 Stages) | 70 | 30 | 100 | -- | -- | 4 | 4 |
| | HCMP-VIII | Main Project/In plant training & Spectral Problems | 70 | 30 | 100 | -- | -- | 4 | 4 |
| | T-4 | Tutorial/Seminar | | | | | 25 | | |
| | | Total for 4th semester | 420 | 180 | 600 | | 25 | | 25 |
| | | | | | | | | | |
| | | Total | | | 2500 | | | | 100 |

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

Nature of Examination:

Each semester will have theory external examination of four papers of 70 marks each (2.5 hrs. duration). The practical examination of Semesters I to IV will be conducted at the end of the each Semester. Duly certified copy of laboratory record must be produced at the time of examination.

Practical Examination of M. Sc. II

The practical examination will be of 3 days for each semester.

Practical experiments: 60 marks

Oral: 05 marks

Journal: 05 marks

Project work / In-plant training Report:

60**+10 marks for presentation

** The valuation of project/ In plant training report to be done by both external and internal examiners at the time of examination. Valuation of Tutorials is to be done in each semester by the teaching faculty involved in organic chemistry course.

Nature of question paper (M. Sc. II):

Time: 2.5 hours Max. Marks 70

Instructions

1. Attempt 05 questions.
2. All questions carry equal marks.
3. Figures to the right indicate full marks.
4. Use of log tables and calculators is allowed.

Question Paper Pattern

Q 1. Answer the following (14 sub-questions) Marks 14 (1 x 14) Multiple choice questions, predict the product, provide the reagent and conditions etc.

Sub-questions (i) to (xiv)

Q 2. a) -----Marks 08

b) -----Marks 06

Q 3. a) -----Marks 08

b) -----Marks 06

Q 4. a) -----Marks 10

b) -----Marks 04

Q 5. -----Marks 14

At least 40 % questions should be problem oriented, where-ever possible, in view to train students for the SET/NET/GATE and other competitive examinations. These 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.

M. Sc. II (Pharmaceutical Chemistry)

SEMESTER-III

PAPER NO. HCT-301

BASICS IN PHARMACEUTICAL CHEMISTRY

Credits: 04

60 Hrs.

Unit – 1:

[20]

Drug Design

Development of new drugs, procedures followed in drug design, concept of lead identification and lead modification, structure-activity relationship (SAR), factors affecting bioactivity, resonance, inductive effect, isosterism, bioisosterism and spatial consideration. History and development of QSAR, Physiochemical parameters, Lipophilicity, electronic parameters, steric parameters, Shelton and surface activity parameters and redox potentials, Free Wilson and Hantzsch analysis, other statistical methods

Unit – 2:

A] Pharmacokinetics

[10]

Introduction to drug absorption, disposition, drug metabolism, elimination, important pharmacokinetic parameters in defining drug disposition and in therapeutics, importance of pharmacokinetics in drug development process, concept of pro drug and soft drug

B] Pharmacodynamics

[10]

Introduction, principles of drug action, mechanisms of drug action, introduction to the concept of receptors and drug receptor interactions, dose-response relationships, drug potency and efficacy, combined effect of drugs, introduction to relative terminology like LD50, ED50, MIC, MEC etc.

Unit – 3:

Microbiology:

[10]

Microbial Drug Development - Introduction to Microbiology and classification of Microbes. Characterization and Screening of Microbes, Isolation and Improvement of Individual micro-organism, Microbial growth, Kinetics, Fermentation process, Fermenter designing, Media

designing, Down Stream process and effluent treatment (Microbial and Chemical),
Antimicrobial assays

Unit – 4

Immunology:

[10]

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

Reference Books:

1. Grigauge A, Introduction to Medicinal Chemistry; Wiley-VCH
2. Pandey S S, Dimmock J R, An Introduction to Drug Design; New Age International
3. Wolff Ed M EV, Burger's Medicinal Chemistry and Drug Discovery (6th Edition); John Wiley
4. Silverman R B, The Organic Chemistry of Drug Design and Drug Action; Academic Press
5. William Foye, Lippicott, Principles of Medicinal Chemistry (4th Edition); William and Wilkins
6. Kadam S S, Mahadik, Bothera, Principles of Medicinal Chemistry (11th Edition); Nirali Publication
7. Satoskar R S, Bhandarkar, Pharmacology and Pharmacotherapeutics; PopularPrakashan
8. KarAshutosh, Medicinal Chemistry

PAPER NO. HCT-302
ORGANIC SPECTROSCOPY

Credits: 04

60 Hrs.

Unit-1:

[16]

Nuclear Magnetic Resonance Spectroscopy:

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehyde and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides and mercapto), chemical exchange, effect of deuteration, complex spin-spin interaction between 2,3,4 and 5 nuclei (first order spectra), virtual coupling. Stereochemistry, Hindered rotation, Fourier transforms technique, Nuclear Overhauser Effect (NOE) with examples

Unit-2:

[15]

^{13}C -NMR spectroscopy: Introduction, ^{13}C - chemical shifts, calculation of ^{13}C - chemical shifts of aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons, factors affecting chemical shifts, proton coupled ^{13}C - spectra, proton decoupled ^{13}C - spectra. Off-resonance decoupling

Unit-3:

[12]

Two-dimensional (2D) NMR spectroscopy: Introduction, DEPT, COSY and HETCOR techniques, (including interpretation of COSY and HETCOR spectra). NOESY, ROESY and 2D-INADEQUATE techniques

Unit -4:

[09]

Mass Spectrometry:

Principle and theory, instrumentation, different ionization techniques (EI, CI, FAB, FD), general modes of fragmentation, fragmentation patterns of various classes of compounds, Mac Laffarty rearrangement with representative compounds, applications

Problems based on combined use of spectroscopic techniques/ advanced techniques **[08]**

Reference Books:

1. Sharma B K: Instrumental methods of Chemical Analysis, Goel Publishing House
2. Silverstein R M, Bassler G C: Spectrometric Identification of Organic Compounds, John Wiley
3. Sharma Y R: Elementary Organic Spectroscopy, Jalandhar
4. Kalsi P S: Spectroscopy of Organic Compounds, New Age International Ltd.
5. D. L. Pavia, G.M. Lamp man, G. S. Kriz, 3rdEd. Introduction to Spectroscopy, Harcourt College publishers
6. V. M. Parikh: Absorption spectroscopy of organic molecules
7. D. H. Williams and I. Fleming: Spectroscopic methods in organic chemistry, McGraw Hill
8. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer- Verlag(1986)
9. Atta-Ur-Rehman: One and Two dimensional NMR Spectroscopy- Elsevier (1989)
10. Joseph B. Lambert, Shurvell, Lightner: Organic structural spectroscopy- Cooks, Prentice-Hall (1998)
11. Field L. D., Kalman J.R. and Sternhell S: Organic structures from spectra- 4thEd. JohnWiley and sons Ltd.
12. Jackmann and Sternhell S: NMR spectroscopy of Organic compounds

PAPER NO. SCT - 303A

BIOACTIVE HETEROCYCLES AND NATURAL PRODUCTS

Credits: 04

60 Hrs.

A] Heterocyclic compounds - Synthesis, reactivity, aromatic character and medicinal importance of following heterocycles:

Unit – 1:

[15]

Three and four membered heterocycles: Aziridines, Oxiranes, Thiranes, Azetidines, Oxitanes and Thietanes

Five and six membered heterocycles with one and two hetero atoms: Pyrazole, Imidazole, Oxazole, Thiazole, Pyrimidine, Pyrazine

Unit – 2:

[20]

Five and six membered heterocycles with more than two hetero atoms:

1, 2, 3-Triazole, 1, 2, 4-Oxadiazole, Tetrazole, 1, 3, 5-Triazine, Tetrazine

Condensed heterocycles:

Benzofuran, Indole, Benzothiophene, Benzoxazole, benzthiazole, Benzimidazole, Coumarins and Chromones, Purines and Pteridines

B] Natural Products

Unit – 3:

[12]

Classification, methods of isolation, synthesis and methods of structure determination of

Alkaloids: Cinchonine and atropine, morphine, nicotine

Terpenoids: Introduction, biological importance and synthesis of Farnesol, Zingiberine, Santonine, Phytol and Abietic Acid

Unit – 4:

[13]

Steroids: Constitution of cholesterol (with synthesis), chemistry of Progesterone, Estrone, Testosterone, PGE and Bile acids

Harmones: Introduction, biological importance and synthesis of Hexosterol, stilbosterol and ACTH.

Reference Books:

1. Bansal R K, Heterocyclic Chemistry
2. Acheson R H, An introduction to the chemistry of Heterocyclic compounds (Interscience)
3. Trivedi J J, Chemistry of Heterocyclic Compounds
4. Gupta R R, Kumar M and Gupta V, Heterocyclic Chemistry, Springer
5. Eicher T and Hauptmann S, the Chemistry of Heterocycles
6. Joule J A, Mills K and Smith G F, Heterocyclic chemistry (Van Nossstrand)
7. Paquette L.A., Principals of modern heterocyclic chemistry
8. Palamer M.H., The structure and reactions of heterocyclic compounds.
9. KatrtzhyA.R. and BoottonA.V., Advances in Heterocyclic chemistry (A.P.)
10. Finar, Organic chemistry (Vol. 1 and 2)
11. Joule J. A., Mills K. and Smith G. F., Chapman and Hall. Heterocyclic Chemistry,
12. Heterocyclic Chemistry, Gilchrist T. L., Longman Scientific Technical
13. Newkome G. R. and Poudler W. W., Contemporary Heterocyclic Chemistry, Wiley
14. Katritzky A. R. and Rees C. W., Comprehensive Heterocyclic Chemistry, eds, Pergamum Press
15. Mann J, Davidson R S, Hobbs J B, Natural Products: Chemistry and Biological significance
16. Finar I L, Organic Chemistry; Vol 2
17. Alta-Ur-Rehman and Chaudhary M I, New trends in Natural Product Chemistry
18. Bhat Sujata, Chemistry of Natural Products; Springer-Narosa
19. Singh Ayodhya, Chemistry of Natural Products Vol 1 and 2

PAPER NO. SCT – 303B

BIOCHEMISTRY, BIOMOLECULES AND BIOINORGANIC CHEMISTRY

Credits: 04

60 Hrs.

Basic Biochemistry: Carbohydrates, Lipids and Vitamins

[30]

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, stereoisomerism, anomers and epimers. Reducing properties of monosaccharides, disaccharides, oligosaccharides, polysaccharides, structural studies methylation and periodate oxidation. Polysaccharides structure and function of complex carbohydrates, proteoglycans, glycoproteins, Glycolipids, mucopolysaccharides

Lipids: Classification, structure and function of major lipid subclasses-acylglycerols, circulating lipids: lipoproteins, chylomicrons, LDL, HDL, and VLDL. Pathological changes in lipid levels. Formation of micelles, monolayers, bilayer, liposomes

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

Biomolecules II: Amino acids, Proteins and Nucleic Acids

[15]

1. **Amino acids:** Classification, Properties, reactions of amino acids

2. **Proteins:** Peptide bond, properties, functions

(a) Protein structure: Primary structure, Secondary structure; alpha-helix and beta-pleated sheets, beta-turns, super secondary structure, and Tertiary structure: forces stabilizing and prediction of tertiary structure, fibrous and globular proteins, and Quaternary structure – hemoglobin

(b) Working with proteins: Fractionation and purification by gel filtration and chromatographic techniques. Characterization by gel electrophoresis and isoelectric focusing

(c) Protein sequencing: end group analysis, Sanger's method and Edman degradation method

(d) Solid phase peptide synthesis

3. Nucleic acids

- (a) Molecules of Heredity: Structure of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), DNA double helix, major groove and minor groove, A, B, and Z forms of DNA
- (b) DNA as genetic material, genetic code, flow of genetic information, DNA replication, transcription and translation
- (c) Drugs acting on DNA: nucleoside analogues, Intercalating agents, Alkylating agents, UV radiations and thymine dimers, Drugs acting by chain' cutting

Bioinorganic Chemistry

[15]

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

Reference Books:

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

Text Books:

1. Ligand field theory & its application: B.N. Figgis & M.A. Hitchman (2000) Wiley VCH publ. Chapters 5, 6, 8, 9, 11
2. 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

3. Inorganic Chemistry: Shriver & Atkins (1999) Oxford
4. Inorganic Electronic spectroscopy: A.B.P. Lever, 2nd 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)

(OPEN ELECTIVE)
PAPER NO. OET-304A
MEDICINAL CHEMISTRY-I

Credits: 04

60 Hrs.

Unit-1: Basic principles of medicinal chemistry:

[15]

Basic consideration, historical evolution, fundamental aspects of drugs: forms, application, biological action, metabolism, drug interaction, adverse effects. Classification of drugs, nomenclature of drugs, drug combination, Selection of essential drugs, physicochemical properties of drug: solubility, partition coefficient, hydrogen bonding. Prodrugs: utility of prodrugs, types of prodrugs, mechanism of drug activation- carrier linked prodrugs, carrier linkages for various functional groups, bio precursor

Unit-2: Analgesics and Anti-inflammatory agents:

[15]

Analgesic drugs: Introduction, Classification, Mechanism of action, Synthesis and SAR of Ibuprofen, Paracetamol, Phenylbutazone, Acetaminophen, Diclofenac sodium, Dichlorophenac, Indomethacin, Rofecoxib, Celecoxib

Antitubercular and antileprotic agents: Introduction, Classification, Mechanism of action, Synthesis and SAR of Isoniazid, Ethambutal, Clofazimine, Dapsone

Unit-3: Sulfonamide, Antiamoebic and Anti-infective agents:

[15]

Sulfonamides: Introduction, Nomenclature, Synergism of Sulfonamides, SAR studies and Synthesis of Sulfisoxazole, Sulfapyridine, Sulfacetamide and Sulfamethoxazole

Antiamoebic agents: Introduction, Classification, and Mechanism of action and Synthesis of Metronidazole, Iodoquinol and Dimercaprol

Anti-infective agents: Introduction, Classification, Mechanism of action, Synthesis and SAR of Nitrofurazone and Furazolidos

Unit-4: Anti-malarials, CNS depressants agents:

[15]

Antimalarials: Etiology of malaria. Mechanism of action and SAR of Quinolone antimalarials, Synthesis of Chloroquin, Primaquin and Quinacrine

CNS depressants: Introduction, Classification, Mechanism of action, Synthesis and SAR of -

- a) Anaesthetics – Halothane, Lidocaine and Thiopental

- b) Sedative and hypnotics: Chlorodiazepoxide and Diazepam
- c) Anticonvulsant: Phenytoin Sodium, Carbamazepine

References:

1. Comprehensive medicinal chemistry- corwin and Hansch
2. Medicinal chemistry-Burgers (Vol-I-VI)
3. Principles of medicinal chemistry-William O Foye
4. Text book 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`sText 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

(OPEN ELECTIVE)
PAPER NO. OET-304B
DRUG REGULATORY AFFAIRS

Credits: 04

60 Hrs.

Unit-1:

[12]

Drug Regulatory Aspects (India) -

Indian drug regulatory authorities, Central and State regulatory bodies (State FDA, DCGI, CDSO); Drugs and Cosmetics Act and Rules with latest Amendments (Special emphasis - Schedule M and Y); New Drugs - (Importation, Registration, Development, Clinical Trials, B.E. studies); Various licenses - (Test license, Import license for testing of drugs and API's, Mfg., Contract and Loan license manufacturing)

Good Manufacturing Practices (GMP) - Indian GMP certification, WHO GMP certification; ICH guidelines for stability testing and other relevant ones (Q1 - Q10); Export permissions and manufacturing for semi-regulated countries; Understanding of the plant lay-outs with special emphasis on the environment & safety (HVAC, Water systems, Stores management, Effluent etc.); Quality Assurance and Quality Control - Basic understanding for in-built quality

Unit-2:

[12]

Drug Regulatory Aspects (International & highly regulated markets) - US Requirements - (for Generic Drugs especially formulations); CDER, INDA, NDA, ANDA's (types), CTD Formats of dossiers, E-submission, US DMF (various types), IIG Limits, Orphan Drugs, Exhibit/Pivotal batches, Validation batches, Various Guidance issued by CDER, OGD, Orange Book (and patents), RLD (Reference listed drug) for BE studies and the norms for US submission, Bioequivalence and dissolution recommendations, Packaging, Stability studies and the Product Information Leaflet, US FDA Inspection (audits), Pre-approval Inspections and approvals; A brief introduction to the guidelines for Europe, Japan, Australia, South Africa, Rest of the World (ROW) and South & Latin American countries; GMP audits, role of Quality Assurance, product approvals and supplies

Introduction to IPR & Patents - Development of IP law in India, IPR regime, Introduction to IP laws in India, Role of IP in Pharma industry growth.

Unit-3: [12]

Patenting in India - Introduction, Patent legislation, Indian Patents Act 1970 and amendments, Procedure for patent application, Grant and opposition proceedings, Patent licensing, Patent infringement proceedings, IPAB - Role and functions (IP Appellate Board)

Patent search, Patent analysis & Patent drafting

Allied Patents Related Issues

Indian IP case studies- The Novartis case, Lipitor case, Natco versus Bayer case of compulsory license, Patenting and traditional knowledge [Neem, Basmati, Haldi patent], Patenting of life forms [Diamond versus Chakravarty case]

Unit-4: [12]

American & European patent system - Requirements for patenting: utility, novelty, non-obviousness. Patent specification & claims, Patent infringement and Doctrine of Equivalents, Federal circuit and Patent system in Europe 2.0 International treaties and conventions on IPR - Paris convention, PCT - an introduction, PCT application & general rules, WTO / GATT system & Uruguay TRIPS, WIPO, Doha declaration

Unit-5: [12]

Hatch Waxman Act and amendments, FDA Medicare Modernization Act, 2003

Introduction to Geographical indication / Trademark/ copyright: Filing Procedures

Exploitation of patent, Abuse of patents, Compulsory licensing, Infringement analysis, Drug-Patent Linkage

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 [PriceControl] Order, 1995

M. Sc. Pharmaceutical Chemistry

Semester IV

PAPER NO. HCT- 401

STEREOCHEMISTRY, PHOTOCHEMISTRY AND PERICYCLIC REACTIONS

Credits: 04

60 Hrs.

Unit-1:

[15]

Fused and bridged rings:

Cis- and trans- decalins and nine methyl decalines and perhydraphenanthrene, perhydroanthracene. Bridged rings, Nomenclature stereo chemical restrictions. The Bredts rule, Reactivities, Stereochemistry of Allenes, spiranes and biphenyls

Unit-2:

[15]

Principles and applications of asymmetric synthesis:

Stereoselectivity in cyclic compounds, enantio-selectivity, diastereo-selectivity, enantiomeric and diastereomeric excess, stereoselective aldol reactions, Cram's rule, Felkin Anh rule, Cram's chelate model, Prochirality, Asymmetric synthesis, use of chiral auxiliaries, chiral reagents and catalysts, asymmetric hydrogenation, asymmetric epoxidation and asymmetric dihydroxylation, Synthetic and Industrial applications

Unit-3: Organic Photochemistry:

[15]

Introduction, Electronic transition, Jablonskii diagram, photosensitizations, photochemistry of carbonyl compounds, unsaturated system and aromatic compounds

Unit-4: Pericyclic Reactions:

[15]

Introduction : Types and stereochemistry, Theoretical basis of Pericyclic reactions, M O Theory and symmetry property reactant and product orbital, Cyclo addition reactions – [2 + 2] and [4 + 2], Electrocyclic reactions, Sigmatropic rearrangement and group transfer reactions

Reference Books:

1. Finar I L, Organic Chemistry
2. Trivedi J P, Stereochemistry
3. Nasipuri D, Stereochemistry
4. P S Kalsi : Stereochemistry of Organic Compounds
5. Nogradi M, Stereoselective synthesis: A practical approach
6. March Jerry: Advanced Organic Chemistry, 4th Ed, Wiley Eastern Ltd., New Delhi (1985)
7. V K Ahluwalia, R K Parasar : Organic Reaction Mechanism, 2nd Ed.
8. S M Mukherjee: Pericyclic Reactions
9. J Coxon and B Halton : Introduction to Photochemistry

PAPER NO. HCT- 402

DRUG DISCOVERY AND DOSAGE FORMS

Credits: 04

60 Hrs.

Unit-1: Introduction to drug discovery and dosage forms:

[15]

Introduction, drug discovery and design: a historical outline, sources of drugs and lead compounds, classification of drugs, brief discussion on methods of drug administration, introduction of drug action and bioavailability

Dosage forms: oral solids, oral liquids, solution properties, suspensions, emulsions, parenteral, aerosols, inhalation products, topical semisolids, topical lipids and powders, ophthalmic products, rectal and vaginal products. Oral solids: tablets, types of tablets, methods of tablet production- wet granulation, coating of tablets. Quality control methods and measurement of tablet properties. Oral liquids: introduction, type, oral suspensions and oral emulsions

Unit-2: Drug screening methods:

[15]

General principles of screening of drugs, general screening methods, clinical trial. Experimental animals used in pharmacological assays, invitro, invivo studies. Tissue experiments and whole animal experiments. Bioassay, scope , principals involved and general methods. Bioassay of acetylcholine, insulin and atropine. Screening method for evaluation of analgesic, anti-inflammatory, antiulcer, anticonvulsants, hepatoprotective, antidiabetic and antifertility activities. Methodology for microbial assay of penicillin and miconazole. Enzyme inhibition studies: inhibition of acetylcholine esterase activity in rat striatum, Cox inhibition studies

Unit-3: GMP and Drug Regulations:

[15]

Introduction, requirements of good manufacturing practice and quality management, guidelines to manufacturing practice for medicinal products, premises and equipments, documentation and production and quality control.

GCP- guidelines and related management. Principles of ICH and GCP, ethical principles related to GCP. Regulations for obtaining permission for clinical trial, application for permission, report: clinical trial report, trial management, data monitoring committee (DMC)

Unit-4: Drug delivery systems:

[15]

Fundamental of novel drug delivery: Rationale of sustained release, controlled release dosage forms. Physicochemical and biological factors influencing design and performance of CR products. Pharmacokinetics and pharmacodynamic basis of NDDS. Bioavailability assessment of CR systems. Regulatory requirements. Theory of mass transfer. Fick's law and its application in NDDS. Polymers in CR- classification, properties biocompatible and biodegradable polymers. Modeling of drug release from porous polymer: drug release from nonporous and hydrophobic polymers. Oral controlled drug delivery systems, mucosal drug delivery system, ocular drug delivery systems, parenteral drug delivery systems, transdermal drug delivery systems

References:

1. Pharmacology and Pharmacotherapeutics – Satoshkaret. Al
2. Basic pharmacology- N M Ghosh
3. Drug discovery and Evaluation. pharmacological assay, III Ed. Vol-2, H G Vogel
4. Biopharmaceutics and clinical pharmacokinetics IV Ed.- Gibaldi
5. Pharmaceutics and Pharmacokinetics – G R chatwal
6. Biopharmaceutics – S N Jogdand
7. Pharmcaeutical codex Principles and practice of pharmaceutics 11 Ed. Waterland

PAPER NO. HCT- 403
MEDICINAL CHEMISTRY - II

Credits: 04

60 Hrs.

Unit- 1: Anti-neoplastic agent

[12]

Introduction, cancer chemotherapy, special problems; Role of alkylating agent and anti-metabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors, synthesis of some antineoplastic agent-e.g. Taxol

(a) Antagonist: Fluorouracil **(b) Alkylating agents:** i) Chlorambucil (ii) Cis-Platin

Unit-2: Antibiotics

[16]

Preparation of semi synthetic penicillin, conversion of penicillin into cephalosporin, general account of tetracycline and macaracyclic antibiotics (no synthesis)

Introduction, Classification, Mechanism of action and Synthesis of the following drug molecules (at least one convenient synthetic route with Possible mechanism) from following classes:

Antibiotics: (a) Chloramphenicol (b) Ampicillin (c) Amoxycillin (d) Cefepime (e) Cefpirome

Antimycobacterial: Ethambutol, **Antiviral:** Acyclovir, **Antimicrobial:** Sulfamethoxazole

Unit-3: Antidiabetics, Antihistamines and Anti-hypertensive drugs

[16]

Introduction, Classification, Mechanism of action and Synthesis of the following drug Molecules (at least one convenient synthetic route with possible mechanism) from following classes:

Anti-hypertensive Drugs: (a) Verapamil (b) Captopril (c) d-sotalol (d) Atenolol (e) Diltiazem (f) Semotiadilfumarate.

Antidiuretics: (a) Troglitazone (b) Chlorpropamide (c) Tolbutamide

Antihistamines; Phenobarbiton, Fenediazole, Diphenylhydramine, mechanism of action

Unit-4: Tranquilizers, Anti AIDS and Cardiovascular Drugs: [16]

Introduction, Classification, Mechanism of action and Synthesis of the following drug molecules (at least one convenient synthetic route with Possible mechanism) from following classes:

Tranquilizers: Diazepam, Trimeprazin

Anti AIDS drugs: Cause, Antimetabodies and Anti-AIDS drugs

Cardiovascular Drugs: Dilliazem, Quindine, Methyldopa, Atenolol, Oxyprenol

Antacids / Antiulcer: Omeprazole, Ranitidine

Reference Books:

1. Synthesis of Essential Drugs- R. S. Vardanyan and V. J. Hruby, *Elsevier*
2. Contemporary Drug Synthesis- J. J. Li, D. S. Johnson, D. R. Sliskovic, B. D. Roth, *John Wiley*
3. Medicinal chemistry (Vol. I and II)-Burger
4. The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press)
5. Strategies for organic drug synthesis and designing - D. Lednicer Wiley
6. Medicinal Chemistry- Ashutosh Kar
7. Medicinal Chemistry- BalkishenRazdan

SOFT CORE
PAPER NO. SCT- 404A
ADVANCED ORGANIC SYNTHESIS

Credits: 04

60 Hrs.

Unit – 1: Name reactions

[18]

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

Unit-2: Free radical reactions

[15]

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

Unit-3: 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

Unit-4: Reagents

[12]

Lithium dialkylcuprate, Trimethylsilyl iodide, Peracids, PPA, Ozone, Hoffmann-Löffler Fretag reactions, Ene reaction, Barton reaction, Selenium dioxide, Periodic acid, Iodoisobenzoyldiacetate

References

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

PAPER NO. SCT- 404B

MODERN ORGANIC CHEMISTRY

Credits: 04

60 Hrs.

Unit-1: Protecting Groups

[10]

Protection and deprotection of hydroxyl, carbonyls in aldehydes and ketones, amines, carboxylic acids, alkenes and alkynes

Unit-2: Disconnection Approach

[20]

Introduction to: Grounding of organic chemistry for understanding retrosynthesis; Retrosynthetic analysis and designing of the synthesis; Disconnection approach: An introduction to synthons, synthetic equivalents, disconnection approach, functional group interconversions, importance of order of events in organic synthesis, one and two group C-X disconnections, selective organic transformations: chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity, Reversal of polarity, cyclization reactions, amine synthesis

C-C Disconnections

i) One group C-C Disconnections:

Alcohols (including stereoselectivity), carbonyls (including regioselectivity), Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis

ii) Two group C-C Disconnections:

Diels-Alder reactions, 1,3difunctionalized compounds and α , β -unsaturated compounds, control in carbonyl condensations, 1,5 difunctionalized compounds, Michael addition and Robinson annulation

Unit-3: Transitional metals complexes in organic synthesis

[15]

(A.) Palladium Heck arylation, allylic activation, carbonylation, wacker oxidation, isomerization formation N-aryl and N-alkyl bond transmetalation, allyldeprotection in peptides, coupling reactions: Stille coupling, Sonogashira and Suzuki coupling reactions and their importance

Iron:-Reactions of Iron carbonyls, ferrocenes, Fe-cyclopentadiene complex, protection of dienes, isomerization

Mn & Co:-Manganese and Co-carbonyls in hydroformylation, carboxylations, synthesis of silane complexes and their applications Pausal-khand reactions and its applications protection of alkynes by Co_2CO_8 .

Unit-4: Organoboranes

[15]

Preparation and properties of organoborane reagents e.g. RBH_2 , R_2BH , R_3B , 9-BBN, catechol borane. Thexylborane, cyclohexylborane, ICPBH_2 , $\text{-21-IPC}_2\text{BH}$, Hydroboration-mechanism, stereo and regioselectivity, uses in synthesis of primary, secondary tertiary alcohols, aldehydes, ketones, alkenes. Synthesis of EE, EZ, ZZ dienes and alkynes. Mechanism of addition of IPC_2BH . Allyl boranes- synthesis, mechanism and uses

Reference Books:

1. Organic Synthesis: The Disconnection Approach: Stuart Warren
2. Designing Organic Synthesis: Stuart Warren
3. Organic Synthesis: Strategy and Control: Paul Wyatt and Stuart Warren
4. The Logic of Chemical Synthesis: E. J. Corey and Xue-Min Chelg
5. Classics in Total Synthesis I, II and III: K. C. Nicolaou and others
6. Organic Synthesis Concepts, Methods, Starting Materials: J. Fuhrhop, G. Penzlin
7. Some Modern Methods of Organic Synthesis: W. Carruthers
8. Organic Synthesis: M. B. Smith
9. Principles of Organic Synthesis: R. Norman and J. M. Coxan
10. Advanced Organic Chemistry: Jerry March
11. Organic Chemistry: Clayden, Greeves, Warren and Wo

**M. Sc. II (Pharmaceutical Chemistry) Practicals:
SEMESTER-III**

HCP-V: Drug synthesis (Any five)

Part A: Synthesis of medicinally important compounds:

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

Formation of product should be confirmed by **TLC**
IR spectra are used for functional group identification.

Part B: Biochemistry Practical's (Estimations) (Any five)

1. Estimation of carbohydrates
2. Estimation of proteins
3. Molar extinction coefficient of molecules
4. Extraction and estimation of lipids
5. Direct microscopic counts
6. Total viable counts
7. Control of microbial growth
8. Determination of MIC (plate method)
9. Isolation of Bacterial, animal, plant and plasmid DNA
10. Agarose gel electrophoresis of DNA

Part C-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 β -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
9. Estimation of sulphur by Messenger method
10. Estimation of nitrogen by Kjeldahl's method
11. Estimation of calcium from chalk powder
12. Estimation of calcium from kidney stone. (By synthesizing Ca-oxalate as a sample)
13. Determination of Chemical Oxygen Demand of water sample

(Other suitable experiments may be added)

Reference Book:

1. Biochemical Methods by Dr. S. Sadasivam and Dr. A. Manikam, 3rd Edition New Age International, 2006
2. Practical Biochemistry, Principles and Techniques (1995). Ed. Kelth Wilson and John Walker
3. Introductory Practical Biochemistry (2001). Ed. S.K. Sawhny and Randhir Singh

SCP-VIA: Drug assay/analysis

Part A- Assay of drugs by instrumental methods (Any three)

1. Paracetamol
2. Aspirin
3. Amoxicillin
4. Ampicillin
5. Hexamine
6. Ascorbic acid

Part B- Assay of drugs by chemical methods (Any three)

1. Assay of Paracetamol
2. Assay of Aspirin
3. Assay of Amoxicillin
4. Assay of Ibuprofen
5. Assay of gluconate

Part C-Separation techniques (Any one)

Qualitative separation of given mixture containing following compounds by TLC and preparative TLC.

1. Phenol and resorcinol
2. P-nitroaniline and o-nitroaniline
3. Aspirin and acetaminophen

(Other suitable experiments may be added)

References:

1. Natural products chemistry-nakanishigolo
2. Organic chemistry of natural products vol-I and II – Gurdeepchatwal
3. Organic chemistry, Vol-I and II –Finar
4. Introduction to quantitative drug design- Y C Martin
5. Comprehensive medicinal chemistry- corwin and Hansch
6. Medicinal chemistry-Burgers (Vol-I-VI)
7. Principles of medicinal chemistry-William O Foye
8. Strategy of drug design- Brucell
9. The organic chemistry of drug design and drug action- Rechar B
10. Pharmaceutical analysis-Higuchi, Bechmann and Hassan
11. Text book of pharmaceutical analysis- K A Connors
12. Vogel's text book of Quantitative chemical analysis, Sixth edition-RC denny, J D Barnes, N J K Thomas and Others
13. Practical pharmaceutical chemistry-IV eedition, Part-I And II- Beckett and Stenlaker
14. Practical chemistry- Dr. O P Pandey, D N Bajpai and Dr. S Giri
15. Pharmaceutical analysis- david G Watson
16. Principles of analytical chemistry-John H kenedy

SCP-VIB: Spectral Problems:

Identification of Pharmaceutically important Intermediates by the analysis of their spectral data:

Photocopies of UV, IR, NMR and Mass spectra of standard compounds are to be interpreted to determine the structure of the compound

M. Sc. II (Pharmaceutical Chemistry) Practical's:

SEMESTER-IV

HCP-VII:

Two stages or Three stages organic preparations starting with 5g or less. (Any six)

(TLC Analysis is recommended)

1. Preparation of Benzanilide by Beckmann rearrangement
2. Preparation of Anthranilic acid
3. Preparation of Phthalimide
4. Preparation of N- Bromosuccinamide
5. Preparation of p- Aminobenzoic acid
6. Preparation of p- chloronitrobenzene by Sandmeyer reaction
7. Preparation of p- Iodonitrobenzene by Sandmeyer reaction
8. Pinacol- Pinacolone rearrangement
9. Preparation of Acetophenones by Fries rearrangement
10. Preparation of aromatic aldehydes by Vilsmer Hack reaction or R. T.
11. Wittig reaction
12. Preparation of Benzopyrazole

(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 ArunSethi. (New Age)

HCMP VIII: Major Project/In Plant training:

Literature survey, Studies of reactions, Synthesis, Mechanism, Isolation of natural products, Standardization of reaction conditions, New methods etc. and Spectral Analysis.

In leave of practical I, II and III, candidates are expected to work on assigned research project and submit the results at the end of the semester in the form a dissertation which will be valued for 70 marks.

Project work involving multistage synthesis of organic compounds or isolation of bioactive molecules from medicinal plants or pharmacokinetic studies or evaluation of biological activities or in-plant training in any of the pharmaceutical or chemical industry for 21 days.

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