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Total Credit points 46
### Courses (i.e., Papers) Offered (Structure of the Programme): M. Sc. Pharmaceutical Chemistry

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Note: Among three soft core papers students have a choice to opt any two.
III SEMESTER, M. Sc. Pharmaceutical Chemistry

PC.HC. 3.01: SPECTROSCOPY TECHNIQUES

UNIT I: A] UV-Spectroscopy: Brief review of electromagnetic spectrum, Interaction of electromagnetic radiation (UV-Visible) with matter and its effects. UV-Visible range, energy, wavelength, frequency and color relationships. The Nature of electronic excitations, Modern Instrumentation and its working principle, Beer’s Law, Lambert’s law, Chromophores, auxochromes, Shift and their interpretation (including solvent effect). Colorimetry, Effect of solvent and structure on $\lambda_{\text{max}}$, prediction of $\lambda_{\text{max}}$ for polyenes, alpha, beta unsaturated aldehydes and ketones, aromatic systems and their derivatives. (Woodward's-Fieser’s rule). Absorption spectra of organic compounds and illustrating the phenomenon and its utilization in qualitative and quantitative studies of drugs.


References:

5. Organic Spectroscopy -Kalsi.

PC. SC. 3.21: SEPARATION TECHNIQUES 48 Hrs


12 Hrs

UNIT II: Column chromatography and HPTLC: Introduction, adsorption phenomenon, differential migration, types of adsorbents, such as nature of adsorption forces: Vander Waals forces, inductive (dipole) forces, hydrogen bonding forces, solvent system (mobile phase solvent system-elutotropic series, choice of solvents as eluents for column chromatography), Packing techniques (wet packing techniques and dry packing techniques). HPTLC: Introduction, Instrumentation and applications. 

12 Hrs

UNIT III: Gas chromatography 
Principle and Instrumentation, types of column, packed and capillary column. Column efficiency parameters, the van Deemeter equation. Resolution, liquid stationary phases, derivatization methods of GC including Acylation, Perfluoroacylation, Alkylation and Esterfication. Detectors (TCD-thermal conductivity detector, FID-flame ionization detector and ECD-electron capture detector, examples of GC applications in pharmaceutical analysis. Interfacing gas chromatography with mass spectrometry. 

12 Hrs

UNIT IV: High Performance Liquid Chromatography (HPLC)
Principle, instrumentation in HPLC, Reverse phase HPLC, packing materials (normal and reversed phase), column selection (standard column (analytical, preparative), narrow bore, micro bore columns, short column, guard columns), mobile phase selection, efficiency, retention, resolution and selectivity parameters, detectors in HPLC (UV-visible absorbance detector, refractive index detector, electrochemical detector, optical activity detector, mass detector). Comparison of GC and HPLC.

12 Hrs

Books:
1. Practical pharmaceutical chemistry, Part I and Part II - Becket and Stanlake.
2. Text book of pharmaceutical analysis - K. A. Conners
3. Pharmaceutical Analysis – Higuchi, Bechmann and Hassan.
5. Analytical Chemistry by Skoogh and West.

PC. SC. 3.22: PHARMACEUTICAL ANALYSIS 48 Hrs

12Hrs

UNIT II: High Performance Liquid Chromatography (HPLC)
Principle, instrumentation in HPLC, Reverse phase HPLC, packing materials (normal and reversed phase), column selection (standard column (analytical, preparative), narrow bore, micro bore columns, short column, guard columns). mobile phase selection, efficiency, retention, resolution and selectivity parameters, detectors in HPLC (UV-visible absorbance detector, refractive index detector, electrochemical detector, optical activity detector, mass detector). Comparison of GC and HPLC. Applications and limitations with examples. 12 Hrs

UNIT III: Definition, principle, and application of the following techniques: Ion-exchange chromatography (IEC) Ion-Exchange chromatography (IEC): Ion-exchangers, cation-exchange resins, anion-exchange resins, ion-exchange mechanism, factors affecting ion-exchange equilibrium, ion-exchange capacity, affinity scale, instrumentation, techniques for ion-exchange, liquid ion-exchanger, applications of IEC, experimental IEC, Supercritical fluid chromatography: Affinity chromatography: Introduction, classification, Selection of matrix, role of spacer, affinity ligands, applications of affinity chromatography in the separation of biomolecules. Exclusion chromatography Size exclusion (Gel) chromatography: Introduction,
theory and principles of size exclusion process, materials for size exclusion process, application.


Books:
1. Practical pharmaceutical chemistry, Part I and Part II- Becket and Stanlake.
2. Text book of pharmaceutical analysis- K. A. Conners
3. Pharmaceutical Analysis – Higuchi, Bechmann and Hassan.
5. Analytical Chemistry by Skoogh and West.

PC.HC. 3.31: BIOORGANIC CHEMISTRY 64 Hrs


chemical constituents and uses of Clove oil, Cinnamon oil, Sandalwood oil, Methods of production and analysis. B) Terpenoids: General introduction, classification, isolation, purification and structural elucidation of Menthol and Camphor. Biological importance of terpenoids.


16Hrs

Books
1. Harpers review of biochemistry- Martin
2. Text book of Biochemistry-Lehninger
3. Outlines of Biochemistry- Conn and stump
4. Natural Products-Gurdeep and Chatwal
5. A text book of organic chemistry-I. L. Finar
6. Fundamentals of Enzymology-Price and Stevens
7. Enzymes-Dixon and Webb
8. Isoenzymes-D. W. Moss

PC.SC. 3.23: DRUG DISCOVERY AND DEVELOPMENT 48 Hrs

UNIT I: Drug discovery from natural products and through enzyme inhibition: Introduction, drug discovery and design a historical outline, Sources of drugs and lead compounds, Classification of drugs, Route of administration, the pharmaceutical phase, Introduction to drug action: ADME process. Bioavailability of drug, the pharmacodynamic phase. Introduction to medicinal plants: preparation of initial extracts and preliminary biological screening, methods for compound structure elucidation and identification, compound development, a brief explanation on the development of natural product drugs.

12 Hrs


12Hrs
UNIT III: Drug Design and relationship of functional groups to Pharmacologic activity:

Introduction to drug discovery: Introduction, stereochemistry and drug design: structurally rigid groups, confirmation, configuration. Solubility and drug design: The importance of water solubility, solubility and drug structure, salt formation. The incorporation of water solubilizing groups in structure: The type of group. Reversibility and irreversibility attached groups, the position of water solubilizing group, methods of introduction of solubilizing groups.


UNIT IV: Vitamins: Introduction, classification, Properties, biological significance of vitamins. Synthesis and Biological importance (Occurrence, Chemical properties, Deficiency and Excess defect), of following Vitamins: Retinal, Thiamine (B1), Ascorbic acid, Pantathionic acid, Vitamin K.

Lipids: nomenclature, classification, purification, structure and synthesis of lipids, phospholipids, sphingolipids. Biological importance of lipids: Lecithin, sphingolipids, oils and fats.

Books

2. Text Book of Medicinal Chemistry-Wilson and Gisvold’s.
4. Fundamentals of medicinal chemistry-Gareth Thomas John Wiley & Sons Ltd.
5. Organic Synthesis, The disconnection approach, Stuart Warren and Paul Wyatt, 2nd edition,
7. Terpenoids-V. K. Ahluwalia
8. Biochemistry-Jain
ELECTIVE PC. 3.03. DRUG DESIGN AND METABOLISM 32Hrs

UNIT-I: Drug Discovery design and Development: principles of drug design, Drug discovery without lead (Pencillins) lead discovery (random screening, non-random screening), drug metabolism studies, clinical observation, rational approach to lead discovery.

Lead modification: identification of the active part (pharmacophore), functional group modification, SAR, structural modification to improve potency and TI (homologation, chain branching, ring chain transformation, bioisosterism).

16Hrs

UNIT-II: Physicochemical Properties of Drugs and Drug Metabolism

Physicochemical properties of drug molecules in relation to biological activity- solubility, partition coefficient, hydrogen bonding, protein binding, chelation, pKa values, isosterism, geometrical and optical isomerism, steric effect and ionization.

Drug metabolism: Introduction, sites of drug biotransformation, General Pathways of drug metabolism Phase-I metabolism Oxidation, Reduction, Hydrolysis

Phase–II metabolism Glucouranic acid conjugation, amino acid conjugation, sulphate conjugation, methylated conjugation and acetylated conjugation, role of Cytochrome P-450 in drug metabolism, factors affecting drug metabolism. 16Hrs

References

III Semester:

Practical-I, PC: 3.04: Synthesis of drugs and drug intermediates-I

A] Synthesis:
1. Aspirin
2. Paracetamol
3. Iodoform
4. Coumarin derivative
5. Benzinmidazole
6. Benzotriazole
7. Synthesis of pharmaceutically important molecules

B] Identification of pharmaceuticals by the analysis of their spectral data:

Give the photocopies of UV, IR, NMR and Mass data of standard compounds for the elucidation of structure.

Books Recommended:
1. Practical organic chemistry – A.I. Vogel
2. Practical organic chemistry – Ahluwalia
4. Practical organic chemistry – Vishnohi
5. Reactions, rearrangement and reagents – S.N. Sanyal.
7. Advanced organic chemistry – reactions, mechanism and structure – Jerry March

Practical-II, PC: 3.05: Separation techniques:

1. Analytical thin layer chromatography: Qualitative separation of given mixture containing following compounds.
   a) Phenol and Resorcinol
   b) O-nitro aniline and p-nitro aniline.
   c) Aspirin and acetaminophen and
   d) Sulphaisoxazole and Sulphamethoxazole.
2. Preparative thin layer chromatography- Quantitative separation of given mixture of compounds.
3. Paper chromatography: Qualitative separation of given mixture containing amino acids Glycine, Tyrosine, Tryptophan and Histidine.
4. Column chromatography- Separation of given mixture and quantification of the compounds.

Books Recommended:
1. Practical pharmaceutical chemistry, part-I and II – Becket and Stenlaker.
2. Instrumental methods of chemical analysis – Gurudeep R Chatwal and Sham K Anand
4. Text book of chromatography – Gurudeep R Chatwal

Practical- III, PC: 3.06: Assay of drugs by titrimetric and instrumental methods - I

1. Assay of Aspirin
2. Assay of Analgin
3. Assay of Ibuprofen
4. Assay of Paracetamol
5. Calcium gluconate
6. Assays of new biologically important molecules

Books Recommended:
3. Practical Chemistry – Dr. O.P. Pandey, D.N. Bajpai and Dr. S. Giri
4. Lab manual- selected experiments of pharmaceutical analysis – Anees A. Siddique.

IV SEMESTER, M. Sc. Pharmaceutical Chemistry

PC.HC. 4.01: MEDICINAL CHEMISTRY-I 64Hrs

UNIT –I:Local Anti-infective agents: Introduction, classification, mechanism of action, Synthesis and SAR of nitrofurazone and furazolidos
Sulfonamides: Introduction, classification, mechanism of action, Synthesis and SAR of sulisoxoxazole and sulfamethoxazole
Antibiotics: Introduction, classification, mechanism of action, Synthesis and SAR of Penicillin G, cephalosporins, and tetracyclins. 16Hrs

UNIT II
Anticancer/antiviral, hypoglycemic agents: Introduction, classification, mode of action, Synthesis of 5-flourouracil, azidothymadine, Tolbutamide and tolastamide 16Hrs

UNIT III
Antihistamine: Introduction, classification, mode of action, Synthesis of Phenarimine maleate, pyrilamine, ranitidine, cimetidine
Cardiovascular Agents: Introduction, classification, mechanism of action, Synthesis of Antiarrythmicagents verapamil, Antihypertensive agent clonidine and hydralazine derivatives
Psychopharmacological agents Introduction, classification, mechanism of action, Synthesis of Benzodiazepines: diazepam, Phenothiazines: chlorpromazine, Amitryptyline. 16Hrs

UNIT IV
**Antiamoebic agents** Introduction, classification, mechanism of action, Synthesis of Metronidazole and iodoquinol

**Anticonvulsant** Introduction, classification, mechanism of action, Synthesis of Phenytoin sodium, carbamazepine.

**Sedatives and hypnotics** Introduction, classification, mechanism of action, Synthesis of Phenobarbital, Chlordiazepoxide

**General anesthetics** Introduction, classification, mechanism of action, Synthesis of Halothane, Methahexital sodium

64 Hrs

Books

1. Principles of Medicinal chemistry-Foye, Vargheese and Co.
3. Wilson and Gisvold’s: Text Book of Medicinal Chemistry
5. Burgers Medicinal Chemistry Volume-1 to Volume 6

PC.HC: 4.02: MEDICINAL CHEMISTRY-II

**UNIT 1: A**  a) Basic considerations, historical evolution b) Fundamental aspects of drugs: Forms, application, biological action, placebo effect, metabolism, drug interactions, adverse effects, c) classification of drugs d) nomenclature of drugs e) drug combinations f) the selection of essential drugs. Physicochemical properties of drug molecules in relation to biological activity; solubility, partition coefficient, hydrogen bonding, protein binding, chelation, p^ka^ values, isomerism, Geometrical and optical isomers, steric effect, ionization. **B** SAR and QSAR: SARs, Changing size and shape, introduction of new substituents-the introduction of a group in an unsubstituted position, the introduction of a group by replacing the existing group. QSAR- Lipophilicity, partition coefficient (log P), lipophilic substitution constants(π). Electronic effect (Hammet constant σ), steric effect, Taft’s steric parameter (Es), Hansch analysis and application, craigs plot, Free-Wilson analysis and application.

16 Hrs

**UNIT II: Prodrugs:** Enzyme activation of drugs. Utility of prodrugs, types of prodrugs, mechanism of drug activation- Carrier linked prodrugs, carrier linkages for various functional groups, carrier linked bipartite prodrugs. Bioprecursor prodrugs(Proton activation, hydrolytic activation, elimination activation, oxidative activation, reductive activation, nucleotide activation, phosphorylation activation, sulfation activation, decorboxylation activation.

16 Hrs

**UNIT III: Selective examples of drug action at some common target areas:** Introduction, Examples of drugs that disrupt cell membranes and walls-Antifungal agents, Azoles, Allylamines, Phenols, Antibacterial agents- Ionophoric antibiotic action, Cell wall synthesis inhibition. Drugs that target enzymes- Reversible inhibitors, Irreversible inhibition, Transition state inhibitors,
Drugs that target receptors- Agonists, Antagonists, Partial agonists. Drugs that target nucleic acids-Antimetabolites, Enzyme inhibitors, Intercalation agents, Alkylating agents, Antisense drugs, Chain cleaving agents, Antiviral drugs-Nucleic acid synthesis inhibitors, Host cell penetration inhibitors, Inhibitors of viral protein synthesis.  

UNIT IV: Combinatorial Chemistry and Drug metabolism: A] Introduction, the design of combinatorial synthesis, the general techniques used in combinatorial synthesis, the solid support method, parallel synthesis, Furka’s mix and split techniques, Encoding methods-Sequential chemical tagging method, stills binary core tag system, computerized tagging, combinatorial synthesis in solution, screening and deconvolution. B] Drug metabolism: Introduction, sites of drug biotransformation, phase-I and phase-II reactions, role of Cytochrome P-450, Factors affecting drug metabolism.  

BOOKS

1. Introduction to quantitative Drug Design-Y.C.Martin.  
2. Comprehensive Medicinal chemistry-Crowin and Hansch.  
6. Drug design volumes-Ariens.  
7. Strategy of drug design-Brucell.  
8. The Organic Chemistry of drug design and drug action-Richard. B. Silverman.  

PC.SC.4-21: GENERAL PHARMACOLOGY  


UNIT III: Drug receptor Interaction and Adverse Drug receptor: Introduction, history, affinity - the role of chemical bonding, conformation, stereochemistry of labetalol. Drug receptors, Drug action, sites of drug action, Mechanism of drug action, drug receptors, types of receptors-ligand gated ion channels, voltage gated ion channels, G-protein coupled receptors, intracellular receptors, dose response relationship, adverse drug relationship. Drug allergy. 12 Hrs

UNIT IV: Immunology and Microbiology

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) 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, Autoimmuninity, Immunization, Immunosuppressants, Immunomodulators, Immunological techniques. 12 Hrs

Books

1. Pharmacology and Pharmacotherapeutics - Satoshkar et al.
2. Basic Pharmacology – M. N. Ghosh
4. Biopharmaceutics and clinical pharmacokinetics IV-Eddition - Gibaldi
5. Biopharmaceutics and pharmacokinetics G.R. Chatwal
6. Biopharmaceuticals S.N. Jogdand

PC.SC.4.22: DOSAGE FORMS AND REGULATORY ASPECTS 48 hrs

Unit I: Dosage forms and regulations


Unit II: Stability of medicinal products: Chemical stability: Hydrolysis, dehydration, oxidation, isomerisation, racemisation, polymerization, photochemical reactions, factors affecting chemical stability. Physical stability: Volatility, change in the water content of solids, changes in
the crystal properties, physical changes in emulsions and suspensions. Stability of medicines in pharmaceutical practice, e.g. glycerol trinitrate tablets.

**Physical characteristics:** Particle size, shape, surface area, Solubilization, surfactants and its importance, temperature, pH, co-solvency; Techniques for the study of crystal properties and polymorphism.

**Chemical characteristics:** Degradation, Hydrolytic, oxidative, reductive, photolytic degradations;

**Biopharmaceutics characteristics:** Solubility, dissociation, Dissolution rate, diffusibility, and drug stability in GI tract. Physicochemical characteristics of new drug molecules with respect to different dosage forms.


Books Recommended

3. Novel drug delivery systems and regulatory affairs-Dr. Yajaman Sudhakar and Dr. K. N. Jayaveera, S. Chand publications.

PC.SC. 4.23: BIOPHARMACEUTICS

UNIT-I Preformulation

**Absorption of Drugs:** Structure of Cell membrane, Gastro-intestinal absorption of drugs, mechanisms of drug absorption, Factors affecting drug absorption: Biological, Physiological,
Physico-chemical, pharmaceutical. Absorption of drugs from non-per oral routes, Methods of determining absorption: In-vitro, in-situ and In-vivo methods.

**Bioavailability:** Objectives and considerations in bioavailability studies, Concept of equivalents, measurement of bioavailability, Determination of the rate of absorption, Bioequivalence and its importance, bioequivalence studies.

**Dosage Regimen:** Multiple dosing with respect to IV and oral route, Concept of loading dose, maintenance dose, Accumulation index, Adjustment of dosage in renal and hepatic impairment, Individualization of therapy, Therapeutic Drug Monitoring.

12 Hrs

**UNIT-II Scale up**

**Pilot Plant** Scale up Techniques, Pharmaceutical Production Planning and Control: Significance of pilot plant scale up study, Large scale manufacturing techniques (formula, equipment, process, stability and quality control) of solids, liquids, semisolid and parental dosage forms, General principles, Types of production systems, calculation of standard costs, production or process planning, Routing, Loading, Scheduling, Dispatching of records, Production control.

12 Hrs

**Pharmaceutical Pre-approval inspections, Post operational activities**

Evaluation of FDA, Pre-new drug application approval inspection, FDA riskbased approach to inspections, Critical role Pharmaceutical scientist in product development and preparing for pre-approval inspection, Training requirements in product development, System based pre-approval inspection, cGMP risk assessment, and Management strategy, Concepts in quality by design for drug development manufacture, Equipment cleaning during pharmaceutical product development and its importance to pre-approval inspection, Distribution, Recalled products, Returned products, Complaints and adverse effects, Drug product salvaging documents and formats.

12 Hrs

**UNIT-III Pharmaceutical Laws and Acts**

**Laws and Acts:** An introduction of following laws with regard to drug product design, manufacture and distribution in India (with latest amendments):

a. Drugs and Cosmetics Act 1940 and its rules 1945  
b. National Pharmaceutical Pricing Authority (NPPA)  
d. Patent Procedure in India

**Registration Requirements:** Forms, Clinical Trial Registration, Test License, Commercial Import License, Sale License, Manufacture License, Certificate of pharmaceutical Product (CoPP)

**Regulatory requirements:** For import and product registration of New Drugs, DCGI & RCGM requirements, Generics, Medical Devices, Biologics, Herball, Cosmetics & Fixed Dose Combinations, Export of drugs, traditional drugs, narcotics etc.

12 Hrs

**UNIT-IV: Pharmaceutical Regulations:** USA Organization and structure of FDA, Federal register and CFR, History and devolution of FDC act, Hatch Waxman act and Orange book, Regulatory Approval Process for IND, NDA, ANDA. Regulatory requirements for Orphan drugs and Combination Products, SUPAC & PMS. Changes to an approved NDA / ANDA.

**European Union:** Organization of EMA & Marketing Authorization procedures in EU (CP, DCP, MRP, NP). Eudralex directives for human medicines, Variations & extensions, IMPD. Requirements for BA/BE studies, Compliance of European Pharmacopoeia (CEP)/ Certificate of Suitability (CoS)
Emerging Markets: Overview, Regulatory Requirements for generic drug registration, new drugs and post approval requirements in BRICS countries (Brazil, Russia, India, China, South Africa) and Egypt  

Books Recommended

IV- Semester:
Practical –I, PC: 4.03: Synthesis of Drugs and Drug intermediates-II
1. 2-hydroxy naphthaldehyde
2. Schiff base
3. Chalcone
4. 3-acetyl coumarin
5. Sulphonamide drugs
6. Other important compounds.

Books Recommended:
1. Practical organic chemistry – A.I. Vogel
2. Practical organic chemistry – Ahluwalia
4. Practical organic chemistry – Vishnohi
5. Reactions, rearrangement and reagents – S.N. Sanyal.
7. Advanced organic chemistry – reactions, mechanism and structure – Jerry March

Practical-II, PC: 4.04: Assay of drugs by titrimetric and instrumental methods - II
1. Isoniazid
2. Ascorbic acid
3. Hexamine
4. Ampicillin
5. Amoxycillin
6. Aspirin
7. Paracetamol
8. Other drugs of interest.

Books Recommended:
2. Practical pharmaceutical chemistry, fourth edition, part i and II – Beckett and Stenlaker.
3. Practical chemistry – Dr. O.P. Pandey, D.N. Bajpai and Dr. S. Giri
4. Lab manual- selected experiments of pharmaceutical analysis – Anees A. Siddique

**Practical-III, PC: 4.05: Project Work**

Project work Involving appropriate or relevant work in the field of Pharmaceutical Chemistry. Work is assigned to research project and submit the results at the end of the semester in the form of a dissertation which will be valued for 100 marks (75 for dissertation and 25 for Viva voce). Project work involving multistage synthesis or isolation of active molecules present in medicinal plants or pharmacokinetic studies or evaluation of biological activities.