KUVEMPU UNIVERSITY

Department of Pharmaceutical Chemistry
Post -Graduate Center, Kadur
M.Sc. Pharmaceutical Chemistry Syllabus (CBCS Scheme w. e. f. 2016-2017)

Courses(i.e., Papers) Offered (Structure of the Programme): M. Sc., Pharmaceutical Chemistry					
Paper Code	**Paper Type**	**Title of the Paper**	**Hrs.**	**Credits**	**Total Credit points/semester**
		SEMESTER-I			
PC.HC. 1.01	**Hardcore**	Inorganic Chemistry	**4**	**4**	**22**
PC.HC.1.02	**Hardcore**	Organic Chemistry	**4**	**4**	
PC.HC. 1.03	**Hardcore**	Physical Chemistry	**4**	**4**	
PC.HC. 1.04	**Hardcore**	Analytical Chemistry	**4**	**4**	
PC.1.05	**Practical-I**	Inorganic Chemistry	**4**	**2**	
PC.1.06	**Practical-II**	Organic Chemistry	**4**	**2**	
PC.1.07	**Practical-III**	Physical Chemistry	**4**	**2**	
SEMESTER-II					
PC.HC. 2.01	**Hardcore**	Advanced Inorganic Chemistry	**4**	**4**	**24**
PC.HC.2.02	**Hardcore**	Advanced Organic Chemistry	**4**	**4**	
PC.HC. 2.03	**Hardcore**	Advanced Physical Chemistry	**4**	**4**	
PC.HC. 2.04	**Hardcore**	Spectroscopy Techniques and Nano Chemistry	**4**	**4**	
PC.2.05	**Elective**	Drug Discovery and Dosage Forms	**2**	**2**	
PC.2.06	**Practical-I**	Inorganic Chemistry	**4**	**2**	
PC.2.07	**Practical-II**	Advanced Organic Chemistry	**4**	**2**	
PC.2.08	**Practical-III**	Bioanalytical Chemistry	**4**	**2**	
Total Credit points					**46**

KUVEMPU UNIVERSITY

Syllabus of M.Sc. Pharmaceutical Chemistry
Department of Pharmaceutical Chemistry
Kuvempu University, Post -Graduate Center, Kadur- 577 548

Courses(i.e., Papers) Offered (Structure of the Programme): M. Sc. Pharmaceutical Chemistry					
THIRD SEMESTER			**Hrs.**	**Credits**	**Total Credit**
PC.HC. 3.01	**Hardcore**	**Spectroscopy Techniques**	**4**	**4**	**22**
PC.SC.3.21	**Softcore**	Separation Techniques	**3**	**3**	
PC.SC.3.22	**Softcore**	Pharmaceutical Analysis	**3**	**3**	
PC.HC. 3.02	**Hardcore**	Bioorganic Chemistry	**4**	**4**	
PC.SC.3.23	**Softcore**	Drug discovery and Development	**3**	**3**	
PC.3.03	**Elective**	Drug Design and Metabolism	**2**	**2**	
PRACTICALS					
PC. 3.04	**Practical-I**	Synthesis of Drugs and Drug intermediates-I	**4**	**2**	
PC.3.05	**Practical-II**	Separation Techniques	**4**	**2**	
PC.3.06	**Practical-III**	Assay of Drugs by titrimetric and instrumental methods-I	**4**	**2**	
FOURTH SEMESTER					**22**
PC.HC. 4.01	**Hardcore**	Medicinal Chemistry-I	**4**	**4**	
PC.HC.4.02	**Hardcore**	Medicinal Chemistry-II	**4**	**4**	
PC.SC.4.21	**Softcore**	General Pharmacology	**3**	**3**	
PC.SC. 4.22	**Softcore**	Dosage forms and regulatory aspects	**3**	**3**	
PC.SC. 4.23	**Softcore**	Biopharmaceutics	**3**	**3**	
PRACTICALS					
PC.4.03	**Practical-I**	**Synthesis of Drugs and Drug intermediates-II**	**4**	**2**	
PC. 4.04	**Practical-II**	**Assay of Drugs by titrimetric and instrumental methods-II**	**4**	**2**	
PC.4.05	**Practical-III**	**Project work**	**4**	**4**	
Soft skills				**3**	**3**
				Total Credit points	**47**

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 **64Hrs**

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, Lamberts law, Chromophores, auxochromes, Shift and their interpretation (including solvent effect). Colorimetry, Effect of solvent and structure on λ_{max}, prediction of λ_{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.
B] Optical Rotatory Dispersion: Fundamental principles of ORD. Cotton effect curves, their characteristics and interpretation. Octant rule and its application with examples. Circular dichroism and its relation to ORD. **16Hrs**

UNIT II: IR-Spectroscopy: Introduction, principle and Instrumentation, Types of vibrations, interaction of I.R radiation with organic molecules, selection rules, functional group frequencies and their dependence on chemical environment (bond order, conjugation, hydrogen bonding, ring size, overtones, Fermi resonance). Interpretation of IR spectrum. Practical details of obtaining spectra, including sample preparation for spectroscopy (nujol mull and KBr disc method), qualitative interpretation of I.R spectra, FT-IR and instrumentation. **16Hrs**

UNIT III: NMR Spectroscopy: Principles of NMR, theory: Types of nuclei (classical and quantum), Magnetic properties of nuclei; Excitation of spin ½ nuclei, relaxation process, Instrumentation and its working principle: sensitivity, solvent selection, Chemical shift, factors influencing chemical shift, mechanism of shielding, spin-spin coupling, First order spin systems, coupling constant, Application of signal split and coupling constant data for interpretation of spectra. Brief outline of principles of FT-NMR with reference to C^{13} nucleus. Spin-spin lattice relaxation phenomenon. Free induction decay (FID) proton noise decoupling signal. Nuclear overhauster enhancement C^{13} NMR spectra, their presentation, characteristics, interpretation, examples and applications. Introduction to 2DNMR techniques. **16Hrs**

UNIT IV: Mass Spectrometry: Basic principles and brief outline of instrumentation. Ion formation and types, molecular ion, Meta stable ions, molecular ion peak, base peak, Meta stable ion peak, Mass analyzers, fragmentation processes. FAB, MALDI, Fragmentation patterns and fragmentation characteristics in relation to parent structure and functional groups. McLafferty rearrangement, Retro Diels alder reaction, ortho effect, structural elucidation of some organic compounds, Relative abundance of isotopes and their contribution of characteristic peaks. Mass spectrum, its characteristics. Presentation and interpretation. Application of mass spectrometry in quantitative and qualitative analysis. Determination of molecular formula and molecular weight.
16Hrs

References:

1. Spectrometric identification of Organic compounds, R. M. Silverstein and F. X. Webster, John Wiley & Sons, New York. (Latest edition).
2. Organic Spectroscopy,William kemp, ELBS Mac millan, Hampshire, (U.K).
3. Introduction to spectroscopy- A guide for students of Organic chemistry,D. L. Pavia, G. M. Lampman and G. S. Kriz, Harcourt college publishers. (Latest edition).
4. Spectroscopic methods in Organic chemistry,D. H. Williams and I. Fleming, Tata Mc Graw Hill publishing company Ltd, New Delhi, India. (Latest edition).
5. Organic Spectroscopy -Kalsi.
6. Spectroscopy-Kaur.

PC. SC. 3.21: SEPARATION TECHNIQUES **48 Hrs**

UNIT I: Paper, Thin layer chromatography and Column chromatography: Introduction, Terminology, Classification of chromatographic methods. Paper chromatography:Introduction, principle, methods: ascending, descending, ascending-descending,2D, radial and applications. **Thin Layer chromatography**: Introduction, principle, types of adsorption, preparation techniques and applications, Types of adsorbent for TLC, mobile phase selection, reversed phase TLC, 2D-TLC, quantitative methods in TLC. Detection methods, comparison of paper chromatography and TLC. **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 vandeemeter 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.
4. Quantitative analysis of drugs in pharmaceutical formulations, third edition – P.D. Sethi.
5. Analytical Chemistry by Skoogh and West.
6. Analytical Chemistry by Gary D Christian.

PC. SC. 3.22: PHARMACEUTICAL ANALYSIS 48 Hrs

UNIT I: Gas chromatography: General introduction, types and terminology, Instrumentation, types of column, packed and capillary column. Column efficiency parameters, the vandeemeter 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-electon capture detector, Examples of GC applications in pharmaceutical analysis. Interfacing gas chromatography with mass spectrometry: Applications and limitations.
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 spacerseg. 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.

12Hrs

UNIT IV: **Electrophoresis**: Overview, basis for electrophoretic separations, Moving boundary electrophoresis, Zone electrophoresis, isotachophoresis, isoelectric focusing and immunoelectrophores, and Continuous electrophoresis (preparative), applications. Capillary electrophoresis: Introduction, Principle, Instrumentation and applications. **12Hrs**

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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.
4. Quantitative analysis of drugs in pharmaceutical formulations, third edition – P.D. Sethi.
5. Analytical Chemistry by Skoogh and West.
6. Analytical Chemistry by Gary D Christian.

PC.HC. 3.31: BIOORGANIC CHEMISTRY 64 Hrs

UNIT I: Chemistry of amino acids and peptides: *Amino acids:* Introduction, classification, isoelectric point. Synthesis of amino acids-Streckers synthesis, Gabriel pthalamide synthesis. Erlynmeyers synthesis, Knoop synthesis. Chemical reaction of alpha amino acids: reactions involving a) amino group b) carboxylic acid and c) both carboxylic and amino group. *Peptides:* Introduction, peptide linkage, Major methods of peptide synthesis: synthesis of following di and tri peptides by using Merrifield resin. a) gly-gly b) gly-ala c) gly-val d) gly-gly-gly e) gly- ala-ala f) ala-ala-gly. stereochemistry features and confirmation features. Determination of primary structure of protein. Blocking agents and deblocking agents used in amino group protection and de protection. Reagents and reaction used in activation of carboxylic group of amino protected amino acids. **16Hrs**

UNIT II: Alkaloids: Introduction, Occurrence, Structure elucidation and synthesis of following Alkaloids: Morphine, Nicotine, papaverine. Phytochemical tests for alkaloids.

Glycosides: Introduction, General characters and classification of glycosides. Study of general methods of isolation and uses of the following: Cardiac glycosides, Anthracene glycosides and Cyanogenetic glycosides.

Anthocyanins: Introduction, general nature of anthocyanin. Occurrence, structure and synthesis of anthocyanidinsand Flavones. Phytochemical tests for flavonoids.

16 Hrs

UNIT III: Steroid Hormones: Introduction,nomenclature**,** Structure and biosynthesis of cholesterol, Female and male sex hormones- structures, their significance, development of antifertility agent. Biological importance of bile acids, estrone, progesterone, testosterone, androsterone and carticosterone.

Prostaglandins: Introduction, Occurrence, Nomenclature, classification, synthesis and structure elucidation of PGE1, Synthesis of PGE series. Biological significance of prostaglandin.**Essential Oils:A]** Introduction, Definition, chemical nature, Classification, General methods of extraction,

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

UNIT IV: Enzymes: Classification, Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. *Enzyme Kinetics:*Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions.

Enzyme inhibition-Overview of enzymes as catalytic receptors, types of inhibitors - competitive, noncompetitive and uncompetitive, their mode of action. Isoenzymes,

*G*eneral concept of enzyme inhibition-reversible enzyme inhibition eg. Azidothymadine, physostigmine and 5-flurouracil, Irreversible enzyme inhibition- Affinity labels and active site directed irreversible enzyme inhibitors-TPCK, mechanism based irreversible enzyme inactivators - clavulanic acid and gabaculin. **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**

UNIT II:Drug design: General approach to discovery of new drugs - lead discovery – lead modification –physiochemical principles of drug action – drug stereo chemistry –drug action - 3Ddatabase search – computer aided drug design – docking - molecular modeling indrug design – structure based drug design – pharmacophores - QSAR.

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.

Introduction, relationship between molecular structure and biological activity, selectivity of drug action and drug receptors. Discovery and structural modification of lead compounds. Drug discovery through random screening of synthetic compounds. Refinement of lead structure. Functional group modification. **12Hrs**

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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. **12 Hrs**

Books

1. Principles of medicinal Chemistry-Foye,Vargheese and Co.
2. Text Book of Medicinal Chemistry-Wilson and Gisvold's.
3. Comprehensive Medicinal Chemistry-Series 1-VI , (Academic press)
4. Fundamentals of medicinal chemistry-Gareth Thomas John Wiley & Sons Ltd.
5. Organic Synthesis, The disconnection approach, Stuart Warren and Paul Wyatt,2nd edition,
6. Natural Products-Gurdeep and Chatwal, Himalya Publishers.
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**

UNNIT-II: Physicochemical Properties of Drugs and Drug Metabolism

Physicochemical properties of drug molecules in relation to biological activity- solubility, partion 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

1. Pharmacology and Pharmacotherapeutics-S. D. Satoshkar, Revised 21st Edition, Bhandarkar and Nirmala Rege.
2. Practical Pharmacology-M. N. Ghosh andVallabh Prakash.
3. Drug Discovery and evaluation: Pharmacological assay, Hans Gerhard Vogel, 3rd Edition, Vol-2.
4. Clinical Pharmacology- P. N. Benett and M. J. Brown, Elsevier, 9th Edition.
5. Oxford text book of Clinical Pharmacology and Drug Therapy-D. G. Graham-Smith and J. K. Aronson, 3rd Edition.
6. Principle of Organic Medicinal Chemistry- Rama Rao Nadendla, 1st Edition.

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. Benzimidazole
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
3. Organic chemistry vol-I and vol-Ii – I.L.Finar.
4. Practical organic chemistry – Vishnohi
5. Reactions, rearrangement and reagents – S.N. Sanyal.
6. Spectroscopic identification of organic compounds - Silverstein, sixth edition and Webster.
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
3. Quantitative analysis, sixth edition – R.A.Day. Jr, and A.L.Underwood.
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:

1. Vogel's text book of quantitative chemical analysis– R.C. Denny, J.D. Barnes, M.J.K. Thamas and others, sixth edition.
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.
5. Quantitative analysis of drugs in pharmaceutical formulations, third edition – P.D. Sethi.

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 sulfisooxazoles and sulfamethoxazoles

Antibiotics: Introduction, classification, mechanism of action, Synthesis and SAR of Penicillin G, cephalosporins, and tetracyclins. **16Hrs**

UNIT II

Antitubercular and antileprotic agents: Introduction, classification, mechanism of action, Synthesis of isoniazid, ethambutal, clofazimine, dapsone.

Analgesic and anti-inflammatory agents: Introduction, classification, mechanism of action, Synthesis of Ibuprofen, phenylbutazone, acetaminophen, diclofenac sodium.

Anticancer/antiviral, hypoglycemic agents: Introduction, classification, mode of action, Synthesis of 5-flurouracil, azidothymadine, Tolbutamide and tolazamide **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 ofBenzodiazepines: diazepam, Phenothiazines: chlorpromazine**,** Amitryptyline. **16Hrs**

UNIT IV

Antimalarials Introduction, classification, mechanism of action, Synthesis of Chloroquine, mefloquine, primaquine. SAR of antimalarial agents.

Antiamoebic agents Introduction, classification, mechanism of action, Synthesis ofMetronidazole and iodoquinol
Anticonvulsant Introduction, classification, mechanism of action, Synthesis ofPhenytoin sodium, carbamazepine.
Sedatives and hypnotics Introduction, classification, mechanism of action, Synthesis ofPhenobarbital, Chlordiazepoxide
General anesthetics Introduction, classification, mechanism of action, Synthesis of Halothane, Methahexital sodium **16 Hrs**

Books

1. Principles of Medicinal chemistry-Foye,Vargheese and Co.
2. Drug discovery and development-M. S. Chorgade, Vol -2.
3. Wilson and Gisvold's: Text Book of Medicinal Chemistry
4. Comprehensive Medicinal Chemistry-C. Hansch, Series 1-VI , Academic press.
5. Burgers Medicinal Chemistry Volume-1 to Volume 6

PC.HC: 4.02: MEDICINAL CHEMISTRY-II 64Hrs

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. Bioprecurssor 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. **16 Hrs**

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. **16 Hrs**

BOOKS

1. Introduction to quantitative Drug Design-Y.C.Martin.
2. Comprehensive Medicinal chemistry-Crowin and Hansch.
3. Medicinal Chemistry-Burger.
4. Principles of Drug Design-Smith.
5. Principles of Medicinal Chemistry- William Foye.
6. Drug design volumes-Ariens.
7. Strategy of drug design-Brucell.
8. The Organic Chemistry of drug design and drug action-Richard. B. Silverman.
9. Fundamentals of medicinal chemistry-Gareth Thomas. John Wiley and sons England.

PC.SC.4-21: GENERAL PHARMACOLOGY 48 Hrs

UNIT I: General pharmacology: Introduction, definition, sources and active ingredients of drugs, routes of drug administration, Drug distribution, fate of drug, drug excretion, plasma half life and its significance, methods of prolonging the duration of action of a drug, special drug delivery system. Factors modifying drug effects, drug toxicity, acute, sub-acute, and chronic toxicity. LD50, ED50, tolerance, habituation, and addiction. Drug response relationship, drug interaction- basic concept of drug interaction (both in vitro and in vivo), preclinical and clinical evaluations. **12 Hrs**

UNIT II: Sterilization and Screening methods: Sterilization, types of sterilization methods General principles of screening of drugs, general screening methods, clinical trials. Experimental animals used in pharmacological assays, *in vitro, in vivo* studies. Bioassay, scope, principles involved in bioassay. Screening for analgesic, antiinflammatory, antiimplantaion, antihelmintic, antidiabetic and antiulcer, Methodology for microbial assay of Penicillin, and Miconazole. Enzyme inhibition studies: DNA gyrase, COX inhibition studies. **12Hrs**

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,Microbia1growth, kinetics, Isolation and Improvement of Individual micro- organism, fermenter designing, Media designing, antimicrobial assays; Down Stream process andeffluent 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, Autoimmunnity, Immunzation, Immunosuppresants, Immunomodulators, Immunological techniques. **12 Hrs**

Books

1. Pharmacology and Pharmacotherapeutics-Satoshkar et al.
2. Basic Pharmacology –M. N. Ghosh
3. Drug Discovery and Evaluation: Pharmacological assays, 3rd edition, Vol 2. H. G. Vogel.
4. Biopharmaqceutics and clinical pharmacokinetics IV-Eddition -Gibaldi
5. Biopharmaceutics and pharmacokinetics G.R. Chatwal
6. Biopharmaqceuticals S.N. Jogdand
7. Pharmaceutical codex- principles and practice of pharmaceutics , XII Edition, Editor Walterland
8. Medicinal Chemistry – Gareth Thomas.

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

Unit I: Dosage forms and regulations

Different dosage forms: Oral solids, oral liquids, solution properties, suspensions, emulsions, parentarals, aerosols, inhalation products, topical semisolids, typical lipids, and powders, ophthalmic products, rectal and vaginal products. Oral solids: Tablets, types of solids, methods of tablet production – wet granulation, coating of tablets. Quality control methods and measurement of tablet properties. Oral liquids: Introduction, types, oral suspensions and oral emulsions.

12Hrs

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 thestudy 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 newdrug molecules with respect to different dosage forms. **12 Hrs**

UNIT III: Current good manufacturing practice, Clinical trials: Introduction, requirements of good manufacturing practice and quality management, guide lines to manufacturing practice for medicinal products, premises and equipments, documentation and production and quality control. Process development: Introduction, solid dosage forms and granulation and safety, plan for, process development – equipments, validation batch record. Regulatory aspects of process development: In process tests, validation of equipments and definition of batch size, packing, clinical trials and SOPs. **12 Hrs**

Unit IV: Novel Drug Delivery Systems: Fundamentals of Novel Drug Delivery: Rationale of sustained/controlled release(CR), physicochemical and biological factors influencing design and performance of CR products. Pharmacokinetic 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 & biodegradable polymers. Modeling of drug release from porous polymer; drug release from non-porous and hydrophobic polymers. Diffusional release and dissolution controlled release from monolithic devices, microporous systems.Oral Controlled Drug Delivery Systems, Mucosal Drug Delivery System, Ocular Drug Delivery Systems, Parenteral Drug Delivery systems, Transdermal Drug Delivery Systems. **12Hrs**

Books Recommended

1. The Science and Practice of Pharmacy,Lippincott Williams & Wilkins, Vol. I & II, 21st edition, Remington, Wolters Kluwer Health (India) Pvt. Ltd., New Delhi (2005).
2. Clinical Trials and Good Clinical Practice in India, Arun Bhatt, 1st edition, D.K. Publications, Mumbai (2006).
3. Novel drug delivery systems and regulatory affairs-Dr. YajamanSudhakar and Dr. K. N.Jayaveera, S. Chand publications.
4. Novel Drug Delivery Systems-Deeraj, NiraliPrakashan.

PC.SC. 4.23: BIOPHARMACEUTICS 48hrs

UNIT-I Preformulation

Absorption of Drugs: Structure of Cell membrane, Gastro-intestinal absorptionof drugs, mechanisms of drug absorption, Factors affecting drug absorption:Biological, Physiological,

Physico-chemical, pharmaceutical. Absorption ofdrugs from non-per oral routes, Methods of determining absorption: In-vitro, in-situand In-vivo methods.

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

Dosage Regimen: Multiple dosing with respect to IV and oral route, Concept ofloading dose, maintenance dose, Accumulation index, Adjustment of dosage inrenal and hepatic impairment, Individualization of therapy, Therapeutic Drug Monitoring. **12 Hrs**

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

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 productdevelopment and preparing for pre-approval inspection, Training requirements inproduct development, System based pre-approval inspection, cGMP riskassessment, and Management strategy, concepts in quality by design for drugdevelopment manufacture, Equipment cleaning during pharmaceutical productdevelopment and its importance to pre-approval inspection, Distribution,Recalled products, Returned products, Complaints and adverse effects, Drugproduct salvaging documents and formats.

12Hrs

UNIT-III Pharmaceutical Laws and Acts

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

a. Drugs and Cosmetics Act 1940 and its rules 1945
b. National Pharmaceutical Pricing Authority (NPPA)
c. Intellectual property rights - Indian patent Act and its rules, Law of Copyrightand Designs, Law of Trademark and Geographical indications
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, Herbals,Cosmetics & Fixed Dose Combinations, Export of drugs, traditional drugs,narcotics etc. **12Hrs**

UNIT-IV: PharmaceuticalRegulations:USAOrganization and structure of FDA. Federal register and CFR, History andevolution of FDC act, Hatch Waxman act and Orange book, Regulatory ApprovalProcess 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 proceduresin EU (CP, DCP, MRP, NP). Eudralex directives for human medicines,Variations & extensions, IMPD. Requirements for BA/BE studies, Compliance ofEuropean 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 **12Hrs**

Books Recommended

1. Clinical Trials and Good Clinical Practice in India, Arun Bhatt, 1st edition, D. K. Publications, Mumbai (2006).
2. The Science and Practice of Pharmacy, Lippincott Williams & Wilkins, Vol. I & II, 21st edition, Remington, Wolters Kluwer Health (India) Pvt. Ltd., New Delhi (2005).

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
3. Organic chemistry vol-I and vol-Ii – I.L.Finar.
4. Practical organic chemistry – Vishnohi
5. Reactions, rearrangement and reagents – S.N. Sanyal.
6. Spectroscopic identification of organic compounds, sixth edition - Silverstein and Webster.
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 intrerst.
9. Demonstration: Estimation of potassium in agricultural water supply by flame photometry.

Books Recommended:

1. Vogel's text book of quantitative chemical analysis, sixth edition – R.C. Denny, J.D. Barnes, M.J.K. Thamas and others.
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

5. Quantitative analysis of drugs in pharmaceutical formulations, third edition – P.D. Sethi.

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.