

**SYLLABUS COPY FOR FINAL YEAR B. PHARM
SEMSETER VII**

PHARMACEUTICAL MEDICINAL CHEMISTRY – III

3 hrs/ week

S. No.	Topic	Hours
	Discussion of the following classes of drugs including classification, chemical nomenclature, structure including stereochemistry, generic names, chemistry, physicochemical properties, SAR, metabolism, molecular mechanism of action and synthesis, introduction to rational development if any of the class of drugs.	
1.	<p>Cholinergic Drugs:</p> <p>(i) cholinergic agonists (methocholine, carbochol*, bethanechol, pilocarpine)</p> <p>(ii) Ach esterase inhibitors (physostigmine, neostigmine*, tacrine*, ambenonium chloride, isofluorphate, pralidoxime)</p> <p>(iii) Cholinergic antagonists (atropine, scopolamine, homatropine hydrobromide, ipratropium bromide); synthetic cholinergic antagonists (cyclopentolate*, dicyclomine*, ben/otropine mesylate, procyclidine hydrochloride, isopropamide iodide, tropicamide)</p> <p>(iv) Ganglion blocking agents (trimethaphan, camsylate, mecamlamine)</p> <p>(v) Neuromuscular blocking agents (tubocurarine, gallamine, triethiodide, succinyl choline chloride)</p>	9
2.	<p>Adrenergic Drugs:</p> <p>(i) α-adrenergic agonists (phenylephrine, naphazoline, xylometazoline, oxymetazoline, methyldopa, clonidine*, guanabenz, guanfacine)</p> <p>(ii) β-adrenergic agonists (isoproterenol, terbutaline*, albuterol, salmeterol, isoxsuprine, ritodrine)</p> <p>(iii) α-adrenergic antagonists (tolazine, phentolamine, phenoxybenzamine, prazosin, doxazosin)</p> <p>(iv) β-adrenergic antagonists (propranolol*, atenolol, metoprolol, acebutalol, alprenolol, timolol, labetalol*)</p> <p>other adrenergic agents (amphetamine, pseudophedrine, ephedrine, guanethidine*, propylhexedrine, reserpine).</p>	9
3.	<p>CVS Drugs:</p> <p>(i) antianginal agents (amyl nitrite, isosorbide dinitrate, pentaerythritol tetranitrate, verapamil, bepridil, diltiazem, nifendipine*, amlodipine, nimodipine, dipyridamole)</p> <p>(ii) antiarrhythmic agents (quinidine, procainamide*, disopyramide, lidocaine, tocainide, mexilitine, encainide, amiodarone, propafenone, verapamil, diltiazem, propranolol, sotalol*).</p> <p>(iii) Antihypertensive agents (a) review of adrenergic agents (b) review of Ca channel blockers (c) ACE inhibitors (captopril*, enalapril, benazepril, ramipril) (d) angiotensin II receptor antagonists (losartan, valsartan*, candersartan)</p> <p>(iv) Vasodilators and K-channel agonists (diazoxide, minoxidil)</p> <p>(v) Antihyperlipidemic agents (clofibrate*, gemfibrozil, niacin, lovastatin,</p>	4 4 6 1

	atorvastatin)	3
	* Indicates synthesis to be discussed	

Reference Books:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 11th Ed. Eds. John H. Block and John M. Beale, Lippincott Williams & Wilkins, 2004
2. Foye's Principals of Medicinal Chemistry, Eds. T. L. Lemke and D. A. Williams. Williams & Wilkins, Baltimore, 2002.
3. Medicinal Chemistry, Ashutosh Kar, 4th Edition, New Age International Publishers, 2007.
4. The Art of Drug Synthesis, Eds. Douglas S. Johnson and Jie Jack Li, Wiley Interscience, 2007.
5. Pharmaceutical Chemistry, Vol. E Drug Synthesis Eds. H. J. Roth, A. Kleeman and T. Beissewenger, Ellis Horwood Ltd. 1988.
6. The Organic Chemistry of Drug Synthesis, Daniel Lednicer, Vols 1 to 7, Wiley.

PHARMACEUTICAL ANALYSIS IV

3 hrs/ week

S. No.	Topic	Hours
1.	Chromatography Principal's, terminology-stationery phase, mobile phase, classification of chromatography methods, migration rate of species (partition coefficient, retention time, adjusted retention time), Rate of solute migration (capacity factor, selectivity factor), Column efficiency and band broadening (shape of peak-Gausssian, plate height, number of theoretical plates, van Deemeter equation), Optimisation of column performance (Column resolution, capacity factor, selective factor, tailing factor, peak width), Qualitative analysis, Quantitative analysis (Peak height, peak areas, calibration and internal standard, external standard, area normalization).	3
2.	Gas chromatography (GSC & GLC) Introduction, Principal, Instrumentation-carrier, columns, injection system, detectors (advantage, disadvantage, applications of Thermal conductivity, electron capture, thermionic, flame ionization, nitrogen phosphorus, photoionisation), head space analysis, applications.	5
3.	HPLC Introduction, Principal, Instrumentation-mobile phase reservoir, pumps (reciprocating, displacement, pneumatic, isocratic elution, gradient elution), solvent treatment system, Injection systems (Rheodyne injector in detail, direct sample introduction, sampling loops), columns and fittings (for reverse and normal phase, analytical and guard columns. Thermostats, column packing), detectors advantages, disadvantages, (UV-single wavelength, variable wavelength, phtodiode array), fluorescence, refractive index, electrochemical.	
4.	Ion exchange chromatography Principal, ion exchange resins, mobile phases, applications.	2

5.	Ion pair chromatography Principal, applications	1
6.	Size exclusion chromatography Principal for gel permeation and gel filtration method, support media, mobile phases, applications	1
7.	Paper chromatography Introduction, choice of filter papers, solvents, chromatographic chambers, development techniques (descending, ascending, radial multiple chromatography, two-dimensional chromatography), qualitative analysis-location of spots, Quantitative analysis (direct and elution method), factors affecting retention factor, applications.	3
8.	Thin layer chromatography Introduction, Principal, different absorbents different methods for preparation of plates, solvents, development techniques cascending, descending, horizontal, multiple development two dimensional development, preparative TLC, Qualitative evaluation visualization of spots, Quantitative evaluation (Area, weight, densitometry elution factors affecting RF, applications)	3
9.	High performance thin layer chromatography Introduction, Principal, preparation of plates, development techniques Qualitative evaluation, Quantitative evaluation Instrumentation (adsorbents, solvents, sample application, scanning and documentation), applications.	
10.	Validation of analytical methods as per U.S.P.	1
11.	Statistics & Statistical Quality control Normal distribution, t-test, F-test, linear regression correlation coefficient, confidence limits.	3
12.	Sampling procedures Objectives, different kinds of samples, sampling plan, sampling schemes, sampling equipments, methods of statistical analysts as applied to sampling and interpretation of results.	3
13.	Thermal methods of analysis Theory, introduction, instrumentation, factors affecting analysis, pharmaceutical applications of: Thermogravimetry (TG), Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC).	5

Reference Books:

1. Skoogh-Principals of Instrumental Analysis, 4th edition, Saunders College Publishing, 1992, USA.
2. Browning Chromatography, 1969, Mc Graw Hill, London.
3. Willard H. H., L. L. Merrit & John A. Dean-Instrumental Method of Analysis 6th edition, 1986, CBS Publishers & Distributors, New Delhi.
4. Beckett & Stenlake-Practical Pharmaceutical Chemistry, 4th edition, 1988, CBS Publishers & Distributors, India.
5. I.P., U.S.P., B.P. European Pharmacopeia.

6. James W. Munson-Pharmaceutical Analysis, Modern methods, Marcel Dekker Inc. 1981, USA.

PHARMACOGNOSY III

3 hrs/week

Drug mentioned in bold are or detailed study

S. No.	Topic	Hours
1.	Alkaloids: Chemistry, Classification and occurrence of alkaloid in general. Detailed study of the following plants containing alkaloids Ephedra , Colchicum, cocoa, & tea , coffee, lobelia, tobacco, belladonna, datura stramonium, hyoscyamus, cinchona , opium , ashwagandha, ipecac , rauwolfia , vinca, nux vomica , vasaka , aconite, kurchi , pilocarpus, cola, coca, pepper, curare, alkaloids, ergot. Biosynthesis of lysergic acid, opium alkaloids, tropane, alkaloids, colchicines, emethine, quinine.	12
2.	Occurrence structure and applications of following Glycosides a) Anthroquinone - Rubia, cochineal, aloes , hypericum, cascara, andira, senna , rhubarb . b) Isothiocyanate - Brassica c) Cyanogenetic - Almonds, wild cherry d) Napthoquinone - Plumbago, alkanna, henna , walnut Biosynthesis of aloe emodin, amygdaline, juglone.	6 2
3.	Brief introduction to Plant allergens Definition, classification (inhalant, injectant, infestants etc.) with example. Plants causing hay fever & dermatitis, mould causing allergy.	2
4.	Sources, preparation and uses of following enzymes: Papain, bromelain, malt extract, serratiopeptidase, urokinase, streptokinase, pepsin. Study of lectins and snake venom, Preparation of polyvalent antivenins	3
5.	Study of following herbs as health food (Neutraceuticals): Alfaalfa, arnica, apricot, pits, bran, chamomic, chicory, cucumber, fenugreek, onion, garlic, gentian, hydrocotyle, hibiscus, hops, honey, marigold, amla. Ginseng, ashwagandha, ginko biloba, spirulina, gymnema, momordica, tinospora.	3
6.	Occurrence, composition, preparation and uses of following drugs of mineral origin: Diatomic, chalk, bentonite, talc. Study of sulphur containing naturally occurring compounds (sulphide, thiophenes).	2

Reference Books:

1. Trease D. & Evans W.C; Textbook of Pharmacognosy; W. B. Saunders.
2. Tyler V. E. Brady L. R. & Robbers J. E.; Pharmcognosy; Lea Feibger, USA.

3. Wallis I. E. Textbook of Pharmacognosy; CBS Publishers, Delhi.
4. Kokate C. K. Purohit A. P. & Gokhale S. B. Pharmacognosy: Nirali Publications, Pune.
5. Harbone J. B. Phytochemical Methods: A guide to modern techniques of Plant Analysis Chapman & Hall, London.
6. Brunton J. Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
7. Vasudevan I. N. & Buddha K. S. A textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
8. The Indian Pharmacopeia. The Controller of Publication Delhi.
9. Brain K. R. & Fumer L. D. The Practical Evaluation of Phytopharmaceuticals Wright Sceintica, Bristol.
10. Lyenger M. A. & Nayak S. G. Anatomy of Crude Drugs: Manipal Power Press, Manipal.
11. Lyenger M. A. Pharmacognosy of Powdered Drugs: Manipal Power Press, Manipal.
12. Kokate C. K. Practical Pharmacognosy, Vallabh Prakashan.
13. Wagner, Bladi & zagainskit: Plant Drug Analysis: Springer Verlag.
14. Khandelwal K. R.: Practical Pharmacognosy Techniques and Experiments: Nirali Prakashan, Pune.
15. Vasudevan L. N. Laddha K. S.: Practical Pharmacognosy: New Vrinda Publishing House, Jalgaon.

PHARMACEUTICS VI

3 hrs/ week

S. No.	Topic	Hours
1.	Introduction to sterile dosage forms Parental products <ul style="list-style-type: none"> • Various routes of parental administration, pyogens, vehicle,- WFI preparation, purity, storage and distribution, vehicles other than WFI, additives in parental products, types of formulations, freeze drying , containers- glass and plastics- types and evaluation, concept of FFS, rubber closures and testing, personnel, facilities- layout, environmental control cleanliness classes, air handling (HVAC systems), HEPA filters, laminar flow, production procedures, QA & QC- sterility test, pyrogen/ endotoxin test, particulate evaluation, leaker test. 	12
2.	Ophthalmic products <ul style="list-style-type: none"> • Anatomy and physiology of eye – lachrymal system, tears, precorneal tear film, cornea, ocular bioavailability, types of ophthalmic products- solutions, suspension, ophthalmic ointments and gels, preservatives and efficacy test, additives, QA and QC sterility test, clarity, particle size for suspension, tests on ointments and collapsible tubes, packaging. • Contact lens solutions: types of lenses-cleaning solution, disinfection solution, lubricants, multipurpose solutions and packages. 	8
3.	Oral sustained and controlled release systems <ul style="list-style-type: none"> • Advantages of SR systems, biopharmaceutical consideration and 	8

	dose calculation of drug, properties of drug with reference to the design of oral SR systems, matrix and reservoir type of systems, dissolution controlled systems, diffusion controlled systems, ion exchange controlled systems.	
4.	Stability studies <ul style="list-style-type: none"> Kinetic principles, Arrhenius equation and derivation of shelf life based on Arrhenius equation, limitations and advantages equation, degradation pathways- hydrolysis, oxidation, photolytic degradation, methods to enhance stability studies, introduction to ICH guidelines. 	8

Reference Books:

1. Pharmaceutical dosage forms: Parental medications, Vol. I, II, III, ed. by Kenneth A. Avis, Leon Lachman and H. A. Liberman, Marcel Dekker Inc., 1986.
2. Pharmaceutics The Science of dosage form design ed. by M. E. Aulton, 2nd ed., Churchill Livingstone, 2002.
3. Modern Pharmaceutics, 4th ed. Revised and Expanded ed. by Gilbert S. Banker and Christopher T. Rhodes, Marcel Dekker INC., 2002.
4. The theory and practice of industrial pharmacy, ed. by Leon Lachman, H. A. Liberman, J. I. Kanig, 3rd ed., Verghese Publishing house, 1987.
5. Remington, The science and practice of Pharmacy, 21st ed., Vol. I and II, B. L. Publications Pvt. Ltd., 2005.
6. Ophthalmic drug delivery, ed. by Ashim K. Mitra, 1993, Marcel Dekker INC.
7. Turco and Kings, Sterile Dosage forms, 3rd Edn., Lea & Febiger, Philadelphia, 1985.
8. Michael J. Akers, Quality Control of Parenterals, Marcel Dekker
9. "Controlled drug delivery – Fundamentals and Applications", Robinson Joseph R., Lee Vincent H., Vol. 29, Marcel Dekker Inc.

BIOPHARMACEUTICS AND PHARMACOKINETICS

3 hrs/ week

Topic	Hours
Introduction to the subject of biopharmaceutics and Pharmacokinetics. Emphasis on the importance in drug discovery, development and clinical pharmacy.	1
Definitions, different mechanisms of drug transport, physiology of cell membrane and passage of drugs across cell membrane.	2
Modified pH partition theory and its limitations. Zero v/s first order transport.	2
Rate limiting steps in drug absorption, Theories of dissolution, Physicochemical factors affecting the bioavailability of drugs.	2
Physiology of GH and oral bioavailability Formulation, dosage form related factors and physiological factors affecting oral bioavailability	2
Different routes of drug administration as alternative to oral route Factors affecting bioavailability of drugs from parental routes e.g. insulin zinc suspension	2
Dissolution rate and methods of enhancing dissolution rate. Official and unofficial methods of dissolution. Application to different dosage forms	2

In vitro in view correction and its significance	1
Distribution Definition relationship of drug transport to distribution process, perfusion limitation permeability limitation. Plasma protein and tissue protein binding, introduction to the concept of volume of distribution and factors affecting distribution.	3
Elimination, Definition, introduction to elimination via metabolism and excretion Hepatic clearance drugs, first pass effect and dependence of hepatic extraction ratio. Introduction to renal clearance and factors affecting renal clearance.	3
Pharmacokinetics: Introduction to compartmental and physiological models. Introduction to the compartmental open model and its assumptions.	1
Mathematical treatment of Pharmacokinetics upon IV bolus dosing and extravascular dosing. Importance of volume of distribution. Clearance, elimination rate constant, half life, absorption rate constant, bioavailability. Introduction of the concept of area under the curve, the trapezoidal rule and the method residuals Introduction to the rate method and sigma minus method for urine analysis for IV.	9
Introduction to method for estimating bioavailability and bioequivalence.	2
Discussion of linear and nonlinear kinetics and description of factors resulting in non linear kinetics.	2
Application of PK principles through simple problems.	2

Reference Books:

1. Brahmankar, D. M. Jaiswal, Sunil B., "Biopharmaceutics and Pharmacokinetics: a treatise", 1st Edition, 1995, Vallabh Prakashan, Delhi.
2. Banakar, Umesh, "Pharmaceutical Dissolution Testing", Volume 49, Marcel Dekker Inc., New York, 1992.
3. Malcom Rowland, Thomas Tozer, "Clinical Pharmacokinetics: Concept and Application", 3rd Edition, 1996. A Lea-Febiger book, B. L. Baverly Books Pvt. Ltd. USA.
4. Robert E. Notari, "Biopharmaceutics and Pharmacokinetics An Introduction", 1971, 4th Edition, Marcel Dekker Inc., New York.
5. Leon Shargel, Susanna Wu-Pong, Andrew B. C. Yu. "Applied Biopharmaceutics & Pharmacokinetics" 5th Edition, 2005, Singapore.
6. Milo Gibaldi, "Biopharmaceutics Clinical Pharmacokinetics" 4th Edition, 1991, USA.

PHARMACOLOGY IV

3 hrs/ week

S. No.	Topic	Hours
1.	Drugs acting on central nervous system <ul style="list-style-type: none"> • Aliphatic alcohols • General anaesthetics • Local anaesthetics • Sedative-hypnotics & anxiolytic agents • Antidepressants • Antipsychotics 	18

	<ul style="list-style-type: none"> • Drugs used in Neurodegenerative disorders <ul style="list-style-type: none"> - Antiparkinsons - Drugs used in Alzheimer's disease • Analgesics, antipyretic and anti-inflammatory drugs • CNS stimulants & Psychotomimetic drugs (Convulsions and respiratory stimulants, Psychomotor stimulants and Psychotomimetic drugs) 	
2.	Autocoids <ul style="list-style-type: none"> - Histamine, Antithistaminics - 5 HT and Antagonists - Kinins, Ecosonides, Cytokines, PAF 	6
3.	Pharmacotherapy of Bronchial asthma	2
4.	Immunology – Regulation of Immune system physiological and pathological states, Signaling Pathways for activation and inhibition, Immunology of diseases like HIV and Cancer and their modulation & Immunomodulators.	6
5.	Principals of toxicology <ul style="list-style-type: none"> - Heavy metal poisoning and its treatment - Pesticide poisoning and its treatment - Opium alkaloid poisoning and its treatment 	4

Reference Books:

1. Goodman & Gilman's Pharmacological Basis of Therapeutics – Joel G. Hardman, Lee E, Limbird, Alfred Goodman Gillman 11th Edition, The McGraw Hill Companies Inc., 2001.
2. Satoskar, R. S. Bhandarkar S. D. & Rege N. N. Pharmacology & Therapeutics 20th Edition, Popular Prakashan, 2007.
3. Rang & Dale Pharmacology – 5th Edition, Churchill Livingstone, 2003.
4. Lippincott's Illustrated Reviews: Pharmacology – Lippincott Raven 3rd Edition Howland & Nycets Publishers N Y, 2006.
5. Lewis Pharmacology – By Crossland – 5th Edition, Churchill Livingstone.
6. Laurence D. R. & Bennet Clinical Pharmacology – 9th Edition, Elsevier, N Y, 2006.
7. Kulkarni, S. K. Handbook of Experimental Pharmacology, 3rd Edition, Vallabh Prakashan, New Delhi, 2005.
8. B. G. Katzung - Basic and Clinical Pharmacology 9th Edition Appleton and Lange publication, 2004.
9. Gosh M. N. – Fundamentals of Experimental Pharmacology, 3rd Edition, Hilton & Company, Calcutta, 2005.

PHARMACOLOGY LABORATORY II

4 hrs/ week

S. No.	Topic
1.	Experiments Bioassay of - Acetylchoine

	- Histamine
2.	Demonstration - bioassay of oxytocin - bioassay of pancuronium (With Graph or Actual)
3.	Demonstration/ Simulated CD's - To study the CNS depressant activity of chlorpromazine on locomotor activity of mice using actophotometer - To study the effect of diazepam on the muscle grip strength of mice using rota-rod apparatus. - Analgesic effect of aspirin using analgesiometer - To study phenothiazine induced catatonia in rats and to study anticatonic (antiparkinsons) effect of scopolamine - To study the anticonvulsant property of diazepam on pentylene tetrazole induced convulsions in mice or anticonvulsant effect of phenytoin against maximal electroshock induced convulsion in mice
4.	Toxicity studies (CPCSEA, OCED guideline) - brief introduction to acute, subacute and chronic toxicity studies.

Reference Books:

1. Kulkarni, S. K. Handbook of Experimental Pharmacology – 3rd Edition Vallabh Prakashan New Delhi, 2005.
2. Gosh M. N. Fundamentals of Experimental Pharmacology, 3rd Edition, Hilton & Company, Calcutta, 2005.
3. S. B. Kasture. A Handbook of Experiments in Pre-Clinical Pharmacology- 1st Edition, Career Publications, 2006.
4. W. L. M. Perry, Pharmacological Experiments On Isolated Preparations, 2nd Edition, E & S Livingstone, Edinburgh & London, 1970.
5. Websites: Indian Journal of Pharmaceutical education and research, Vol. 41 (1) Jan-Mar, 2007; 52-61. (www.ipper.org)

PHARMCEUTICAL CHEMISTRY LABORATORY – II

4 hrs/ week

1. Synthesis of heterocyclics: a) Benzimidazole from O-phenylenediamine, b) 4-methyl carbostyryl from Acetoacetanilide.
2. Perkin reaction: Cinnamic acid from benzaldehyde
3. Claisen/ Aldol Condensation acid from benzaldehyde.
4. Benzilic acid rearrangement: Benzilic acid from benzyl.
5. Hofmann rearrangement: Anthranilic acid from Phthalimide.
6. Reduction reaction: PABA from p nitrobenzoic acid.
7. Esterification: Benzocaine from PABA.
8. Condensation: Phenytoin.
9. Multistep reaction: Sulfanilamide from acetanilide.

PHARMACOGNOSY LABORATORY II**4 hrs/ week**

S. No.	Topic	Hours
1.	Morphology, microscope and chemical test for identification of cinchona, vasaka, ephedra, kurchi, datura, nux, vomica, senna, rauwolfia, ipeca.	8
2.	TLC analysis: 1) Alkaloids of nux vomica cinchona 2) Glycosides of senna/ aloe	2
3.	Morphological identification of drugs covered in theory (alkaloids and glycosides) any 20 samples	2
	Total	12

PHARMACEUTICS LABORATORY IV

1. Preparation and monographic testing WFI (IP)
2. Processing & testing of glass containers & rubber closures (as per IP)
3. Preparation and documentation of following:
 - A) Injections (official)
 - Sodium chloride and Dextrose injection
 - Calcium gluconate injection
 - Ascorbic acid injection
 - One injection with oily vehicle
 - One suspension injection
 - B) Ophthalmic preparations
 - Sulphacetamide eye drops
 - One Antibiotic eye ointment
 - Contact lens solution
4. Calculation of Pharmacokinetic parameters (plasma samples provided)