

Syllabus
Degree of
Master of Pharmacy
(Pharmacology)

Year- I
Session 2015-16

Syllabus Prescribed for Degree of Master of Pharmacy (Pharmacology)

Year- I

Subject Code: MPCL 101

Subject: MODERN ANALYTICAL TECHNIQUES (THEORY) (4hr/week)

- 1. UV-Visible Spectroscopy:** Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy, Choice of solvents and solvent effect, Spectrophotometric titrations, Wood ward – Fiesure rule, Applications of UVVisible spectroscopy.
 - a. Spectrofluorimetry:** Theory of Fluorescence, Factors affecting fluorescence, Quenchers, Instrumentation and Applications of fluorescence spectrophotometer.
 - b. Flame emission spectroscopy and Atomic absorption spectroscopy:** Principle, Instrumentation, Interferences and Applications.
- 2. IR Spectroscopy:** Theory, Modes of Molecular vibrations, Sample handling, Instrumentation of Dispersive and Fourier - Transform IR Spectrometer, Factors affecting vibrational frequencies, ATR-IR, Interpretation and Applications of IR spectroscopy
- 3. NMR Spectroscopy:** Quantum numbers and their role in NMR, Principle, Instrumentation, Solvent requirement in NMR, Relaxation process, NMR signals in various compounds, Chemical shift, Factors influencing chemical shift, Spin-Spin coupling, Coupling constant, Nuclear magnetic double resonance, Brief outline of principles of FT-NMR with reference to ¹³CNMR: Spin spin and spin lattice relaxation phenomenon. ¹³C NMR, 1-D and 2-D NMR, NOESY and COSY techniques, Interpretation and Applications of NMR spectroscopy.
- 4. Mass Spectroscopy:** Principle, Theory, Instrumentation of Mass Spectroscopy, Different types of ionization like electron impact, chemical, field, FAB and MALDI, Analyzers of Quadrupole and Time of Flight, Mass fragmentation and its rules, Fragmentation of important functional groups like alcohols, amines, carbonyl groups and alkanes, Meta stable ions, Mc Lafferty rearrangement, Ring

rule, Isotopic peaks, Tandem Mass Instruments, Interpretation and Applications of Mass spectroscopy.

5 Chromatography & Electrophoresis

A- Chromatography: Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution and applications of the following:

- a. Paper chromatography b) Thin Layer chromatography
- b. Ion exchange chromatography d) Column chromatography
- c. Gas chromatography f) GC-MS
- d. High Performance Liquid chromatography h) LC-MS
- e. High Performance Thin Layer chromatography
- f. Super critical fluid chromatography l) Affinity chromatography

B- Electrophoresis: Principle, Instrumentation, Working conditions, factors affecting separation and applications of the following:

- a. Paper electrophoresis
- b. Gel electrophoresis
- c. Capillary electrophoresis
- d. Zone electrophoresis
- e. Moving boundary electrophoresis
- f. Iso electric focusing

6 Other analytic Techniques

- a. **X ray Crystallography:** Production of X rays, Different X ray methods, Bragg's law, Rotating crystal technique, X ray powder technique, Types of crystals, Interpretation of diffraction patterns and applications of X-ray diffraction.
- b. **Optical Rotatory Dispersion:** Principle, Plain curves, Cotton effect, Circular Dichroism, Measurement of rotation angle in ORD and applications
- c. **Radioimmunoassay:** Importance, various components, Principle, Different methods, Limitation and Applications of Radio immuno assay.

7 Statistical Analysis: Introduction, Significance of statistical methods, normal distribution, probability, degree of freedom, standard deviation, correlation, variance, accuracy, precision, classification of errors, reliability of

results, confidence interval, test for statistical significance – Students T test, F test, Chi-square test, Correlation and regression.

Reference Books

1. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.
2. Fundamentals of Statistics – Elhance, Kitab Mahal.
3. Principles of Instrumental Analysis - Douglas A Skoog, F. James Holler, Timothy A. Nieman, 5th edition, Eastern press, Bangalore, 1998.
4. Vogel's Text book of quantitative chemical analysis - Jeffery, Basset, Mendham, Denney, 5th edition, ELDS, 1991.
5. Instrumental methods of analysis – Willards, 7th edition, CBS publishers.
6. Practical Pharmaceutical Chemistry – Beckett and Stenlake, Vol II, 4th edition, CBS Publishers, New Delhi, 1997.
7. Organic Spectroscopy - William Kemp, 3rd edition, ELBS, 1991.
8. Quantitative analysis of Pharmaceutical formulations by HPTLC - P D Sethi, CBS Publishers, New Delhi.
9. Pharmaceutical Analysis - Higuchi, Brochmman and Hassen, 2nd Edition, Wiley – Interscience Publications, 1961.
10. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3rd Edition, CBS Publishers, New Delhi, 1997.
11. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series
12. Analytical Profiles of Drug substances – Klaus Florey, Volume 1 – 20, Elsevier, 2005
13. Analytical Profiles of Drug substances and Excipients – Harry G Brittain, Volume 21 – 30, Elsevier, 2005.

Subject Code: MPCL 101

Subject: MODERN ANALYTICAL TECHNIQUES (PRACTICAL)

(6hr/week)

Minimum 15 experiments to be conducted

1. Use of UV Vis spectrophotometer for analysis of pharmacopoeial compounds and their formulations **(4 Experiments)**.
2. Simultaneous estimation of multi component containing formulations by UV spectrophotometry. **(4 Experiments)**.
3. Effect of pH and solvent on UV spectrum of certain drugs.
4. Experiments based on HPLC and Gas Chromatography (2 Experiments)
5. Experiments on factors affecting the absorbance/fluorescence in UV spectroscopy/Fluorimetry.
6. Separation and quantitative analysis of various components by TLC and HPTLC techniques (1Experiment in each technique)
7. Interpretation of IR, NMR and MASS spectra (2 compound each)
8. Gradient elution and other technique in column Chromatography (Minor Experiment)
9. Separation by electrophoresis

Subject Code: MPCL 102

Subject: ADVANCED PHARMACOLOGY AND TOXICOLOGY (THEORY)

(4hr/week)

1. General Pharmacology;

a. Pharmacokinetics: The dynamics of drug absorption, distribution, biotransformation and elimination

b. Pharmacodynamics: Mechanism of drug action and the relationship between drug concentration and effect. Receptors, structural and functional families of receptors, classification of receptors. Quantitation of drug receptors interaction and elicited effects

2. Molecular Mechanisms in Cell regulation ;

a. **Signaling Molecules:** Nitric oxide, carbon monoxide, neurotransmitters, cytokines, peptide hormones, growth factors and eicosanoids.

b. **Signaling Receptors:**

1. **Cell surface Receptors:** Ion channels, G-protein coupled receptors, tyrosine kinase receptors, cytokine receptors, non-receptor protein tyrosine kinases

2. **Nuclear receptors:** Steroid hormone receptors, thyroxine receptors, other nuclear receptor families

3. Signal transduction:

a. **Intracellular signal transduction:** cAMP, cGMP, IP3-DAG, calcium pathway, PI3K/Akt, m-TOR, MAPK, JAK/STAT, TGF β /Smad, NF κ B signaling, Hedgehog-Wnt, Notch pathways including

b. **Adrenergic and cholinergic transmissions & Other peripheral mediators:** 5-HT and Purines, Cannabinoids, Peptides and proteins

c. **Cytoskeleton signal transduction:** Integrins and signal transduction, regulation of actin cytoskeleton

4. Chemical Mediators ;

Biosynthesis, pathophysiological roles, receptors and drugs affecting the receptors for following mediators of inflammation and allergy: Histamine, Bradykinin, PAF, Eicosanoids:

prostaglandins, thromboxanes, leukotrienes and related compounds, EDRF and vascular substances, oxygen free radicals, Cytokines, Cox-1 and Cox-2.

5. Pharmacotherapeutics

The student is expected to understand Pathophysiology, Pharmacotherapy and critical analysis of rational use of drugs in the following disorders.

a. Introduction to Pharmacotherapeutics

b. **CVS:** Hypertension, Ischaemic heart disease, CCF, Cardiac arrhythmias and dyslipidaemia.

c. **Respiratory:** Asthma and COPD

CNS: Parkinson's disease, Alzheimer's disease, Schizophrenia, Affective disorders, Epilepsy, insomnia, anxiety and pain management

d. **Musculoskeletal:** Rheumatoid & Osteoarthritis, hyperuricaemia, Myasthenia gravis.

e. **GIT:** Peptic ulcer, GERD, Inflammatory bowel diseases, constipation, diarrhoea.

f. **Endocrine:** Obesity, Diabetes mellitus, Osteoporosis, Thyroid and parathyroid disorders,

g. **Infectious:** UT infections, RT infections, GI infections (Bacterial and protozoal), Malaria, Tuberculosis, AIDS, Malignant: Leukaemia, Lymphomas and solid tumours.

6. Toxicity studies:

a. Acute, sub-acute and chronic studies: Protocols, objectives, methods of execution and regulatory requirements.

b. Reproductive toxicology assessment: Male reproductive toxicity, spermatogenesis, risk assessment in male reproductive toxicity, female reproductive toxicology, oocyte toxicity, alterations in reproductive endocrinology, relationship between maternal and developmental toxicity

c. Mutagenicity: In vitro tests for gene mutations in bacteria, chromosome damage, gene mutations in vivo (micronucleus tests and metaphase analysis) in rodents.

7. Carcinogenicity Studies & other Toxicological Requirements :

a. Carcinogenicity studies: In vivo and In vitro studies

b Toxicological requirements for biological and bio-tech products: Safety analysis, concept of safety Pharmacology, antibodies, transmission of viral infections, residual DNA

Reference Books

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics. (International Edition) McGraw Hill, New York (2001), 10th Edition.
2. Pharmacology by Rang HP, Dale MM and Ritter JM. Churchill Livingstone, London, 6th Edition, 1999.
3. Basic and Clinical Pharmacology by Bertram G Katzung (International Edition) Lange Medical Book/McGraw-Hill, U.S.A. (2001) 8th Edition.
4. Clinical Pharmacy by D.R. Laurence, P.N. Bennett & Mi. Brown, 8th Edition Churchill Livingstone 1997.
5. Clinical pharmacy and therapeutics –Eric T, Herfindal, Williams and Wilkins Publications
6. Clinical pharmacy and therapeutics –Roger and Walker, Churchill Livingstone Publication
7. Experimental and surgical techniques in the rat, 2nd edition H.B. Waynforth and P.A Flecknell.
8. Harrison's Principles of Internal Medicine. (2 Volumes 2001) by Braunwald, Fauci, Kasper, Hauser, Longo Jameson, McGraw Hill, New York, 15th Edition.
9. Pharmacotherapy: A pathophysiologic approach-Joseph T. Dipiro et.al Appleton and Lange
10. General and applied toxicology by B. Ballantyne, T. Marris, P. Turner (Eds) The Macmillan Press Ltd, London.
11. Harrison's Principles of Internal Medicine. (2 Volumes 2001) by Braunwald, Fauci, Kasper, Hauser, Longo Jameson, McGraw Hill, New York, 15th Edition.

Subject Code: MPCL 102

Subject: ADVANCED PHARMACOLOGY AND TOXICOLOGY (PRACTICAL)

(6hr/week)

1. Animal house: Design and facilities to maintain the animals
2. Routes of administration of drugs like oral, intravenous, intraperitoneal, intramuscular, subcutaneous including conversion of human dose to animal
3. Anaesthetics for animals (isoflurane by inhalation, ketamine+xylazine by intraperitoneal)
4. Blood sampling methods in experimental animals (cardiac puncture, retroorbital, tail vein, cephanous, marginal ear vein)
5. To identify the cholinergic, adrenergic, serotonergic, vasodilator and cardiotoxic drug /blockers using isolated mammalian heart preparation in Langendorff's setup.
6. To assess the effect of drugs on angiogenesis using chorio- allantoic membrane (CAM) assay
7. To identify the Anti-dysrhythmic activity in rats using ECG
8. To identify the effect of various autonomic drugs on rat blood pressure (carotid and jugular cannulation).
9. To identify the effect of various drugs on rabbit/rat/chick jejunum preparation.
10. To identify the Acetylcholine, noradrenaline, adenosine and serotonin like drug /blockers using rat anococcygeus muscle preparation.
11. To identify the following receptors by using suitable tissue preparations:
 - i. the alpha action of a drug
 - ii. the beta action of a drug
 - iii. the muscarinic action of a drug
 - iv. the nicotinic action of drug
 - v. the 5 HT action of a drug

Subject Code: MPCL 103

**Subject: PHARMACOLOGICAL SCREENING METHODS AND CLINICAL
EVALUATION (THEORY (4hr/week)**

1. Drug Design:

- a. Drug discovery and development – introduction
- b. Modern methods of drug discovery (Introduction, Target identification, Target validation, Lead compound identification and Optimization).
- c. Study of laboratory animals including physiological parameters Regulations and ethics requirements. Transgenic animals and other genetically prone animal models (Viz Nude Mice, SH rats and humanized mice).

2. Preclinical models employed in the screening of new drugs belonging to following categories: Antipsychotic agent; Antianxiety agents; Nootropic drugs; Antidepressant drugs; Antiparkinsonian agents; Analgesics; Antiepileptics; Antiinflammatory agents; Antiulcer agents; Antianginals and myocardial infarction; Antiarrhythmics; Antiatherosclerotic drugs; Antimalarials; Antidiabetics; Antihypertensives; Anticancer.

3. Modern techniques to elucidate the mechanisms of drug actions:

- a. Cell culture and maintenance: Concepts of in-vitro screening, Different cell lines (animal & human) used in screening techniques. Primary and secondary cultures, Principles of techniques involved in cell culture and its maintenance.
- b. Introduction and applications of Biomarker analysis
- c. Introduction to Translational pharmacology
 - a. Alternatives to animal screening procedures, cell-line, patch-clamp technique, in-vitro models.
 - b. High throughput screening (HTS): Introduction, Basic principles involved in cell based assays, receptor binding assays and ultra high through put screening.

4. Pharmacokinetics:

- a. Definition and Scope of Pharmacokinetics.
- b. Absorption, Distribution, Metabolism, Elimination and transporters
- c. Individualization: variability, genetics, age and weight, disease, interacting drugs, and monitoring of the same.
- d. Pharmacokinetic models: compartmental models, non-compartmental models and

physiologic model. Nonlinear pharmacokinetics, multiple dosing and dosage regimen.

5. Clinical Research: Introduction and Ethics

- a. Definition and scope of clinical research. Role of sponsor, study director or principal investigator; Clinical Research Associate in conduct of Clinical Research
- b. Study design, ethics in patient selection and preserving their rights. Institutional Ethics Review committee its constituent members and its role in clinical research. Introduction to informed consent and its importance.

6. Phases of Clinical Trial and Clinical Trial Design

- a. Calculation of Human Equivalent Dose; Phase 0, Phase I, Phase II, Phase III, Phase IV and Phase V Clinical trial.
- b. Randomized Clinical Trial, Uncontrolled Trials, Protocol Development, End points, Patient Selection and blinding, special designs like cross over design, factorial design, Equivalence design, confounding in clinical trials and ways to minimize it, Missing data and its management, occurrence of ADRs, interim monitoring and stopping of trials,

7. Regulatory Affairs in Clinical Research

- a. Pharmacovigilance
- b. Laws governing Clinical Research: preparation of Drug master files (IND, NDA and ANDA) Schedule Y, Code of Federal Regulations (CFR-USFDA) CDSCO (ICMR), EMEA
- c. International Guidelines to meet the standards in Clinical Research: ICH guidelines for efficacy testing of drugs: clinical aspects and data management strategies (E1 – E14]

Reference Books:

1. Drug Discovery and Evaluation Pharmacological Assay by Vogel H G and Vogel W H (Springer publication)
2. Evaluation of drug activities Pharmacometrics by D R Laurence and A L Bacharach Vol. 1 and 2.
3. Drug Screening Methods by SK Gupta, Jaypee Brothers, New Delhi.
4. Alternatives to animals in toxicity testing. Scientific American 26 :(1989), 16-22.
5. Remington's Pharmaceutical Sciences 24th edn.
6. Methods of clinical trials by Alan Spreit and Simon.
7. Clinical Pharmacology by P N Bennett and Brown
8. The Oxford textbook of Clinical Pharmacology and drug therapy by D.G. Graham-Smith and J.K.Aronson.
9. Modern Methods of Drug Discovery by Hillisch, A and Hilgenfeld, R
10. Short Protocols in Pharmacology and Drug Discovery edited by Enna SJ, et al., John Wiley & Sons Inc.
11. Modern drug research- Paths to better and safe drugs (Medicinal Chemistry vol. 9) by Y C Martin, E. Kutter and V. Austel
12. Practical approaches in toxicity studies by Poole and Leslie
13. Pharmacological Experiments in Intact preparations, Edinburgh University Pharmacology staff, Livingstone, (1968)
14. Pharmacological Experiments on Isolated preparations, Edinburgh University Pharmacology staff, Livingstone, E & S Livingstone Edinburgh & London (1970).
15. Screening Methods in Pharmacology, Academic Press, New York and London (1965).
16. Biopharmaceutics and Clinical Pharmacokinetics by Milo Gibaldi, Lea and Febiger Book. 3rd Edition (1984).

Subject Code: MPCL 103

**Subject: PHARMACOLOGICAL SCREENING METHODS AND CLINICAL
EVALUATION (PRACTICAL)**

(6hr/week)

1. Bioassay of acetylcholine/histamine using guinea pig/rat ileum preparation.
2. Bioassay of oxytocin using rat uterine preparation.
3. PA₂ values of various antagonists using suitable isolated tissue preparations.
4. *In-vitro* Absorption study using Inverted rat intestine
5. Exercise on determination of pharmacokinetic parameters using UV/visible spectrophotometer/HPLC
6. Screening of anxiolytic drugs
7. Screening of antidepressant drugs
8. Antipyretic activity by yeast induced pyrexia in rats.
9. Anti-inflammatory activity by rat paws oedema method.
10. Analgesic by hot plate, tail flick, tail dip, paw pressure test, plantar test and/or writhing methods.
11. Skeletal muscle relaxant activity by rotarod method.
12. Anticonvulsant
13. Pole climbing
14. Actophotometer
15. Exercise on Biostatistics using software
16. Enzyme based *in vitro* bioassays (5-LO, COX, DPPH, AchE, hyaluronidase inhibition assays)
17. Antioxidant activity of Super oxide dismutase (SOD), Catalase, lipid peroxidation and Reduced glutathione in tissue homogenate

Subject Code: MPCL 104

Subject: MOLECULAR BIOLOGY (THEORY) (4hr/week)

1. Cellular structure and functions:

- a. **Cell structure:** cell wall, cytoplasm and its components, nucleus and its components
- b. **Plasma membrane:** Structure, transport of small molecules and drugs across it, endocytosis, transport proteins and their inhibitors
- c. **Extra cellular matrix, cell signaling and communication** between cells and their environment, ion-channels, Organization of signal transduction pathways, third messengers,
- d. Biosensors-introduction and applications.

2. Mechanisms of Cellular Regulation:

- a. **Excitation, contraction and secretion**
- b. **Cell proliferation:** Phases and checkpoints of Cell cycle, Positive and negative regulators of cell cycle
- c. **Cell renewal:** Stem cells and maintenance of adult tissues, proliferation of different stem cells, medical application of adult stem cells, embryonic stem cells, somatic cell nuclear transfer, induced pluripotent stem cells and their therapeutic applications in medicine.
- d. **Cell death (Apoptosis):** Events of apoptosis, regulators of apoptosis, intrinsic and death pathways of apoptosis.
- e. Animal cell culture

3. Gene manipulation and its applications :

- a. Role of genes within cells, DNA- the primary genetic material.
- b. Elucidation of genetic code,
- c. Gene expression, Genetic elements that control gene expression,
- d. Microarray.

4. Recombinant DNA Technology:

- a. Principles, process and applications.
- b. Gene cloning: Isolation, cloning vectors, enzymes used in molecular cloning,

- c. PCR (Polymerase chain reaction), LCR (Ligation chain reaction) and their applications. The formation and uses of RFLP's (Restriction Fragment Length Polymorphism).
- d. Recombinant DNA / Human Genetics: DNA sequencing, Mapping and cloning of Human disease genes, DNA-Based diagnosis of genetic diseases.

5. Human Genome Project & Gene Therapy :

- a. Human genome project.: Principles, process and applications.
- b. Gene therapy and Antisense technology.

6. Biotechnology related techniques:

Protein engineering, Peptide chemistry and peptidomimetics, Nucleic acid technologies, catalytic antibodies, glycobiology.

7. Principles of cell based assays and their application:

MTT assay, COMET assay, DNA ladder, Radio-ligand binding assay, RT-PCR, Western blotting, Immunoblotting, Immunofluorescence, Flow cytometry. Basic principles of *in vitro* cell culture techniques

Reference Books

1. Molecular biology of the CELL. Alberts B. et.al (Eds). Garland Publishing Inc. New York and London.
2. Pharmaceutical Biotechnology. Crommelin DJA and Sindelar RD. (Eds). Harward Academic Publishers, Australia, UK.
3. Biopharmaceuticals: Biochemistry & Biotechnology. Gary Walsh. (Eds). John Wiley and Sons.
4. Recombinant DNA. James D. Watson, Michael Gilman, Jan Witowski, Mark Zollet (Eds). Scientific American Books, New York
5. The Cell: A Molecular Approach. Geoffrey M Cooper and Robert E Hausman (Eds). 5th ed
6. S P Vyas and D V Kohli, Pharmaceutical Biotechnology

Subject Code: MPCL 104

Subject: MOLECULAR BIOLOGY (PRACTICAL) (6hr/week)

1. Drug mutagenicity study using mice bone-marrow chromosomal aberration test.
2. Drug mutagenicity study using mice bone-marrow micronucleus test.
3. Ame's test (Salmonella typhimurium)
4. Drug cytotoxicity using a cell line (MTT or any other assay)
5. Polyacrylamide Gel Electrophoresis
6. Western Blotting.
7. Isolation and estimation of DNA and RNA.
8. Restriction digestion of DNA.
9. Ligation of DNA.
- 10.** Isolation of plasmids.
- 11.** Estimation of proteins by Bradford /or Lowrays