DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY,
UTTAR PRADESH, LUCKNOW

Syllabus

For

M.Pharm. (Pharmacology)

(Effective from the Session: 2016-17)

Course Structure and Evaluation Scheme for M. Pharm. Courses (All Subjects/ Specialization) (Effective from Session 2016-17)

PHARMACOLOGY

Semester-I

S.N.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
1	*MPA101*	Modern Pharmaceutical Analytical Techniques	3	0	0	3	20	10	70	--	--	100
2	*MPL101*	Advanced Pharmacology-I	3	0	0	3	20	10	70	--	--	100
3	*MPL102/ MPL203*	Pharmacological Screening Methods/ Principles of Drug Discovery	3	0	0	3	20	10	70	--	--	100
4	*MPL103/ MPL204*	Cellular & Molecular Pharmacology/ Clinical Research & Pharmacovigilance	3	0	0	3	20	10	70	--	--	100
5	*RPM101*	Research Process & Methodology	3	0	0	3	20	10	70	--	--	100
6	*MPA105*	Modern Pharmaceutical Analytical Techniques Practical	-	-	2	1	--	--	--	20	30	50
7	*MPL104*	Pharmacology Practical-I	-	-	3	2	--	--	--	20	30	50
Total						**18**						**600**

Semester-II

S.N.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
1	*MPL201*	Advanced Pharmacology-II	3	0	0	3	20	10	70	--	--	100
2	*MPL202*	Toxicological Screening Methods	3	0	0	3	20	10	70	--	--	100
3	*MPL203/ MPL102*	Principles of Drug Discovery/ Pharmacological Screening Methods	3	0	0	3	20	10	70	--	--	100
4	*MPL204/ MPL103*	Clinical Research & Pharmacovigilance/ Cellular & Molecular Pharmacology	3	0	0	3	20	10	70	--	--	100
5	*MPL205*	Clinical Pharmacology & Biopharmaceutics	3	0	0	3	20	10	70	--	--	100
6	*MPL206*	Pharmacology Practical-II	-	-	2	1	--	--	--	20	30	50
7	*MPL207*	Seminar-I (Synopsis)	-	-	3	2	--	--	--	50	--	50
Total						**18**						**600**

Semester-III

S.N.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
1	*MPL301*	Seminar-II	0	0	6	3	--	--	--	100	--	100
2	*MPL302*	Dissertation (Research Project Audit)	0	0	30	15	--	--	--	200	300	500
Total						**18**						**600**

Semester-IV

S.N.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
1	*MPL401*	Dissertation (Final)	0	0	36	18	--	--	--	200	400	600
Total						**18**						**600**

M. Pharm. (Pharmacology)

First Semester

MODERN PHARMACEUTICAL ANALYTICAL TECHNIQUES (*MPA101*)

Unit-I

UV-Visible spectroscopy: Introduction, theory and laws associated with UV-visible spectroscopy, chromophores, auxochromes and their interaction with UV-Vis radiations, choice of solvents and solvent effect. Woodward- Fieser rule and applications of UV-visible spectroscopy.

IR Spectroscopy: Theory, modes of molecular vibrations, factors affecting vibrational frequencies and applications of IR spectroscopy. FT-IR. Interpretation of IR spectra of organic compounds.

Unit-II

Mass spectrometry: Different ionization methods (EI, CI, FAB, ESI, MALDI), analyzers of quadrupole and time of flight. Fragmentation patterns and its rules, relative abundance of ions, molecular ion peak, meta stable ions, isotopic peaks, Mc-Lafferty rearrangement, ring rule. Applications of mass spectrometry.

Flame emission spectroscopy and atomic absorption spectroscopy*:* Principle, interferences and applications of flame emission spectroscopy and atomic absorption spectroscopy.

Unit-III

NMR Spectroscopy: Principle, chemical shift, factors influencing chemical shift, spin-spin coupling, coupling constant, solvent requirement in NMR, NMR active compounds, free induction decay, relaxation process and NMR signals in various compounds. Applications of NMR spectroscopy.

Unit-IV

Chromatography: Principle, chromatographic parameters, factors affecting and applications of: Thin Layer chromatography, column chromatography, gas chromatography, affinity chromatography, ion exchange chromatography, size exclusion chromatography, high performance liquid chromatography, high performance thin layer chromatography.

Unit-V

Miscellaneous techniques:

Thermal methods of analysis: Introduction, principle, instrumentation and application of TGA, DTA and DSC.

Electron microscopy: Principle, instrumentation and applications of scanning electron microscopy (SEM), transmission electron, microscopy (TEM).

Radioimmuno assay: ELISA.

SUGGESTED BOOKS:

1. Pharmacopoeia of India, Ministry of Health, Govt. of India.
2. Skoog D.A., Holler F.J., Crouch S. R., Instrumental Analysis, Indian Edition, Brooks/Cole, Boston.
3. Willard H.H., Merrit L.L., Dean J.A., Settle P.A., Instrumental Methods of analysis, 7th Edition, CBS Publishers & Distributors New Delhi.
4. Kemp W., Organic Spectroscopy, 3rd Edition, Palgrave, New York.
5. Becket A.H. and Stenlake J.B., Practical Pharmaceutical Chemistry Vol. I and II, The Athlone Press of the University of London.
6. Pavia D.L., Lampman G.M., and Kriz G.S., Introduction to Spectroscopy, 3rd Edition, Harcourt College Publishers, Philadelphia.
7. Kalsi P.S., Spectroscopy of Organic Compounds, New Age International Publishers, New Delhi.
8. Florey K., Analytical Profile of Drug Substance (All volume), Academic Press, Elsevier, Massachusetts.
9. Chatten L.G., A Text Book of Pharmaceutical Chemistry, Vol. I & II, Marcel Dekker, New

York.
10. Silverstein R.M., Spectrometric Identification of Organic compounds, 6th Edition, John Wiley & Sons, New Jersey.
11. Obonson J.W.R., Undergraduate Instrumental Analysis, Marcel Dekker Inc, New York.
12. Parikh V.H., Absorption Spectroscopy of Organic Molecules, Addison-Wesley Publishing Co., London.
13. Stahl E., Thin Layer Chromatography: A Laboratory Handbook, Springer, Berlin.

ADVANCED PHARMACOLOGY-I (*MPL101*)

Unit-I

General pharmacology:
Pharmacokinetics: The kinetics of drug absorption, distribution, biotransformation and elimination. Concepts of linear and non-linear compartment models. Significance of Protein binding.
Pharmacodynamics: Mechanism of drug action and the relationship between drug concentration and effect. Receptors, structural and functional families of receptors.

Unit-II

Neurotransmission:
a) General aspects and steps involved in neurotransmission.
b) Neurohumoral transmission in autonomic nervous system (Detailed study about neurotransmitters- Adrenaline and Acetyl choline).
c) Neurohumoral transmission in central nervous system (Detailed study about neurotransmitters- histamine, serotonin, dopamine, GABA, glutamate and glycine).
d) Non adrenergic non cholinergic transmission (NANC). Co-transmission.
Detailed study on pathophysiology of diseases, mechanism of action, pharmacology and toxicology of existing as well as novel drugs used in the following systems: Autonomic pharmacology, parasympathomimetics and lytics, sympathomimetics and lytics, agents affecting neuromuscular junction.

Unit-III

CNS pharmacology:
Local and General anesthetics, sedatives and hypnotics, drugs used to treat anxiety, depression, psychosis, mania, epilepsy and neurodegenerative diseases,.
Narcotic and non-narcotic analgesics, anti-inflammatory agents.

Unit-IV

Cardiovascular pharmacology: Diuretics, antihypertensives, anti-ischemics, anti- arrhythmics, drugs for heart failure and hyperlipidemia. Hematinics, coagulants, anticoagulants, fibrinolytics and anti-platelet drugs.

Unit-V

Autocoid pharmacology: The physiological and pathological role of histamine, serotonin, kinins, prostaglandins, opioid autocoids. Pharmacology of antihistamines, 5HT antagonists.

SUGGESTED BOOKS:

1. Hardman J.G., Le L., Molinoss P.B., Ruddon R.W. and Gil A.G., Goodman and Gilman, The Pharmacological Basis of Therapeutics, Pergamon Press, Oxford.
2. Golan D.E., Armstrong E.J., Armstrong A.W., Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy, Wolters Kluwer, Alphen aan den Rijn.
3. Katzung, B.G. Basic and Clinical Pharmacology, Prentice Hall International, New Delhi.
4. Rang M.P., Dale MM, Riter J.M, Pharmacology, Churchill Livingstone, London.

5. Gibaldi, M., Biopharmaceutics & Clinical Pharmacokinetics, Pharma Book Syndicate, Hyderabad.
6. Herfindal E.T. and Hirashman J.L., Clinical Pharmacy and Therapeutics Lippincott Williams and Wilkins, Philadelphia.
7. Kwon Y., Handbook of Essential Pharmacokinetics, Pharmacodynamics and Drug Metabolism for Industrial Scientists, Springer, New York.

PHARMACOLOGICAL SCREENING METHODS-I (*MPL102/MPL203*)

Unit-I

Laboratory Animals: Common lab animals: Description, handling and applications of different species and strains of animals, transgenic animals. Anaesthesia and euthanasia of experimental animals. Maintenance and breeding of laboratory animals. Limitations of animal experimentation and alternate animal experiments. Extrapolation of *in vitro* data to preclinical and preclinical to humans.

Unit-II

Preclinical screening of new substances for the pharmacological activity using *in-vivo,in-vitro*, and other possible animal alternative models. General principles of preclinical screening: CNS Pharmacology (Behavioral and muscle coordination, CNS stimulants and depressants, anxiolytics, anti-psychotics, antiepileptics and nootropics). Drugs acting on autonomic nervous system.

Unit-III

Preclinical screening of new substances for the pharmacological activity using *in-vivo, in-vitro* and other possible animal alternative models: Gastro-intestinal drugs (Antiulcer, anti-emetic, anti-diarrheal and laxatives), respiratory pharmacology (Anti-asthmatics and drugs for COPD), reproductive pharmacology (Anti-fertility agents), antioxidants, analgesics, anti-inflammatory and antipyretic agents, antimicrobial agents, immunoassay for digoxin and insulin,

Unit-IV

Preclinical screening of new substances for the pharmacological activity using *in-vivo, in-vitro* and other possible animal alternative models: Cardiovascular pharmacology (Antihypertensive and antiarrhythmic), drugs for metabolic disorders such as- anti-diabetic, antihyperlipidemic agents. Anticancer agents.

Unit-V

Principles of biological standardization:
a) Principles and methods of biological assay.
b) Development of new bioassay methods.
c) Statistical treatment of model problems in evaluation of drugs.

SUGGESTED BOOKS:

1. *Turner R.A., Hebborn P.,* Screening Methods in Pharmacology, Academic Press, Cambridge.
2. *Laurence D.R., Bacharach A.L.,* Evaluation of drugs activities, Academic Press, Cambridge.
3. Arnold S., Methods in Pharmacology, Springer, New York.
4. Ghosh M.N. Fundamentals of Experimental Pharmacology, Scientific Book Agency, Calcutta.
5. Mcleod, L.J., Pharmacological Experiment on Intact Preparations, Churchill Livingstone, London.
6. Vogel H.G., Drug discovery and Evaluation, Springer-Verlag, Heidelberg.
7. Goyal R.K., Practicals in Pharmacology, B.S. Shah Prakashan, Ahmadabad.
8. Gupta S.K., Preclinical Evaluation of New Drugs, Jaypee Brothers Medical Publishers Private Limited, New Delhi.
9. CPCSEA, OECD, ICH, USFDA, Schedule Y, EPA Guidelines.

CELLULAR AND MOLECULAR PHARMACOLOGY (*MPL103/MPL204*)

Unit-I

Cell biology: Structure and functions of cell and its organelles. Genome organization, gene expression and its regulation, importance of siRNA and micro RNA, gene mapping and gene sequencing

Unit-II

Cell signaling: Classification of receptor family and molecular structure- Ligand gated ion channels, G-protein coupled receptors, tyrosine kinase receptors and nuclear receptors.
Secondary messengers: cyclic AMP, cyclic GMP, calcium ion, inositol-1,4,5-trisphosphate, (IP3), NO and diacyl glycerol (DAG).
Detailed study of following intracellular signaling pathways: cyclic AMP signaling pathway, mitogen-activated protein kinase (MAPK) signaling.

Unit-III

Principles and applications of genomic and proteomic tools: DNA electrophoresis, PCR (reverse transcription and real time), ELISA and western blotting.
Recombinant DNA technology and gene therapy: Basic principles of recombinant DNA technology, restriction nenzymes, various types of vectors. Applications of recombinant DNA technology. Gene therapy: Various types of gene transfer techniques, clinical applications and recent advances in gene therapy

Unit IV

Pharmacogenomics: Gene mapping and cloning of disease gene. Genetic variation and its role in health/pharmacology. Applications of proteomics science: Genomics, proteomics, metabolomics, nutrigenomics.

Unit V

Cell culture techniques: Basic equipments used in cell culture lab. Cell culture media, various types of cell culture, general procedure for cell cultures; Isolation of cells, sub-culture, cryopreservation, characterization of cells and their application. Principles and applications of cell viability assays, glucose uptake assay. Principles and applications of flow cytometry.

SUGGESTED BOOKS:

1. Cooper G.M., Hausman R.E., The Cell: A Molecular Approach, Sinauer Publisher, USA.
2. Licinio J., Mali W., Pharmacogenomics: The Search for Individualized Therapies, Wiley-VCH, Weinheim.
3. Bradshaw R.A., Denis E.A., Handbook of Cell Signaling, Academic Press, Cambridge.
4. Dickenson J., Freeman F., Molecular Pharmacology: From DNA to Drug Discovery, Wiley, Colorado.
5. Helgason C.D., Miller C.L., Basic Cell Culture protocols, Springer, New York.
6. Davis J.M., Basic Cell Culture (Practical Approach), Oxford University Press, Oxford.
7. Masters J.R., Animal Cell Culture: A Practical Approach, Oxford University Press, Oxford.
8. Ausubel F.M., Current Protocols in Molecular Biology, Vol-I toVI, Wiley, New Jersey.

RESEARCH PROCESS & METHODOLOGY (*RPM101*)

Unit-I

Fundamentals of research: Meaning, objective and importance of research methodology, types of research (basic, applied and patent oriented), defining research problem, research design including various methods, research process and steps involved. Literature survey and documentation.

Unit-II

Data collection, analysis and hypothesis testing: Classification of data, methods of data collection, sample size, sampling procedure and methods. Data processing and graphical representation of data. Statistical inference and hypothesis: Types of hypothesis (experimental and non-experimental), hypothesis testing (Parametric and non-parametric tests), generalization and interpretation of results. Use of statistical softwares/ packages in data analysis (SPSS, Graph Pad Prism).

Unit-III

Multivariate analysis: Introduction to multivariate analysis (Linear and non linear methods) and their validation methods (Statistical parameters).

Research ethics, plagiarism and impact of research: Research ethics, responsibility and accountability of the researchers, ethical consideration during animal experimentation including CPCSEA guidelines. Plagiarism and use of plagiarism detection softwares such as-VIPER. Impact of research on environment and society, commercialization of research, intellectual ownership.

Unit-IV

Technical writing and reporting of research: Types of research report: Dissertation and thesis, research paper, review article, short communication, conference presentation, meeting report etc. Structure and organization of research reports: Title, abstract, key words, introduction, methodology, results, discussion, conclusion, acknowledgement, references, footnotes, tables and illustrations. Impact factor, rating, indexing and citation of journals. Detailed study of 'Instruction to Authors' of any research journal, a thorough understanding of steps involved in submitting articles electronically to any research journal (Registration, new article submission, tracking process, submitting revised articles).

Unit-V

Funding agencies and research grants: Introduction to various research funding agencies such as-DST, DBT, AICTE, UGC, CSIR, ICMR, AAYUSH, and DRDO along with their function in India. Writing a research project and procurement of research grant. Project cost analysis.

SUGGESTED BOOKS:

1. Kothari C.R., Research Methodology Methods and Techniques, Wishwa Prakashan, New Delhi.
2. Lokesh K., Methodology of Educational research, Vikash Publishing House Pvt. Ltd., New Delhi.
3. Kumar R., Research Methodology, Dorling Kindersley (India) Pvt. Ltd., New Delhi.
4. Rao G.N., Research Methodology and Qualitative Methods, B.S. Publications, Hyderabad.
5. Saunders M., Lewis P. and Thornhill A., Research Methods for Business Students, Dorling Kindersley (India) Pvt. Ltd., New Delhi.
6. Bolton S. and Bon C., Pharmaceutical Statistics: Practical and Clinical Applications, Marcel Dekker, New York.
7. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, An introduction to Research Methodology, RBSA Publishers, Jaipur.
8. Fisher R.A. Statistical Methods for Research Works, Oliver and Boyd, Edinburgh.
9. Chow S.S. and Liu J.P., Statistical Design and Analysis in Pharmaceutical Sciences, Marcel Dekker, New York.
10. Buncher C.R., Statistics in the Pharmaceutical Industry, Marcel Dekker, New York.

MODERN PHARMACEUTICAL ANALYTICAL TECHNIQUES PRACTICAL (*MPA105*)

1. Determination of the wavelength of maximum absorbance (λ max) of given compounds by UV-Visible spectrophotometry.
2. Quantitative estimation of Pharmacopoeial compounds by UV-Visible spectrophotometry.
3. UV-Vis spectrophotometric assay of pharmaceutical formulations containing Pharmacopoeial compounds as active ingredients.
4. Simultaneous estimation of multi component containing formulations by UV-Visible spectrophotometry.
5. Quantitative estimation of caffeine in beverages using UV-Vis spectrophotometer.
6. Study and interpretation of the FT-IR/IR spectra of given compounds.
7. Separation of the organic compounds from given mixture by thin layer chromatography (TLC).
8. Isolation of the organic compounds from given mixture by two-dimensional thin layer chromatography (2D-TLC).
9. Separation and quantitative estimation of organic compounds in the given mixture by thin layer chromatography (Preparative TLC).
10. Column packing and separation of organic compounds with the help of column chromatography.
11. Simultaneous estimation of any marketed formulation using RP-HPLC method.
12. Stability studies of marketed formulation by RP-HPLC method as per ICH guidelines.
13. Estimation of Sodium/ Potassium by flame photometry.

PHARMACOLOGY PRACTICAL-I (*MPL104*)

The practicals may be chosen from the following suggested list of experiments based on the subjects opted in that particular semester-

1. Handling of laboratory animals.
2. Various routes of drug administration.
3. Techniques of blood sampling, anesthesia and euthanasia of experimental animals.
4. Functional observation battery tests (modified Irwin test).
5. Evaluation of CNS stimulant, depressant, anxiogenics and anxiolytic, anticonvulsant activity.
6. Evaluation of analgesic, anti-inflammatory, local anesthetic, mydriatic and miotic activity.
7. Evaluation of diuretic activity.
8. Evaluation of antiulcer activity by pylorus ligation method.
9. Oral glucose tolerance test.
10. Isolation and identification of DNA from various sources (Bacteria, Cauliflower, onion, Goat liver).
11. Isolation of RNA from yeast.
12. Estimation of proteins by Branford/Lowry's in biological samples.
13. Estimation of RNA/DNA by UV Spectroscopy.
14. Gene amplification by PCR.
15. Protein quantification Western Blotting.
16. Enzyme based in-vitro assays (MPO, AChEs, α-amylase, α-glucosidase).
17. Cell viability assays (MTT/Trypan blue/SRB).
18. DNA fragmentation assay by agarose gel electrophoresis.
19. DNA damage study by Comet assay.
20. Apoptosis determination by fluorescent imaging studies.
21. Pharmacokinetic studies and data analysis of drugs given by different routes of administration using software.
22. Enzyme inhibition and induction activity.
23. Extraction of drug from various biological samples and estimation of drugs in biological fluids using different analytical techniques(UV)

24. Extraction of drug from various biological samples and estimation of drugs in biological fluids using different analytical techniques (HPLC).
25. To record the DRC of agonist using suitable isolated tissues preparation.
26. To study the effects of antagonist/potentiating agents on DRC of agonist using suitable isolated tissue preparation.
27. To determine the strength of unknown sample by matching bioassay by using suitable tissue preparation.
28. To determine the strength of unknown sample by interpolation bioassay by using suitable tissue preparation
29. To determine to the strength of unknown sample by bracketing bioassay by using suitable tissue preparation
30. To determine to the strength of unknown sample by multiple point bioassay by using suitable tissue preparation.
31. Estimation of PA_2 values of various antagonists using suitable isolated tissue preparations.
32. To study the effects of various drugs on isolated heart preparations.
33. Recording of rat BP, heart rate and ECG.
34. Recording of rat ECG.
35. Drug absorption studies by averted rat ileum preparation.
36. Acute oral toxicity studies as per OECD guidelines.
37. Acute dermal toxicity studies as per OECD guidelines.
38. Repeated dose toxicity studies- Serum biochemical, haematological, urine analysis, functional observation tests and histological studies.
39. Drug mutagenicity study using mice bone-marrow chromosomal aberration est.
40. Protocol design for clinical trial.
41. Design of ADR monitoring protocol.

Semester-II

ADVANCED PHARMACOLOGY-II (*MPL201*)

Unit-I

Endocrine pharmacology: Molecular and cellular mechanism of action of hormones such as growth hormone, prolactin, thyroid, insulin and sex hormones Anti-thyroid drugs, oral hypoglycemic agents, oral contraceptives.

Unit-II

Antimicrobials: Cellular and molecular mechanism of actions of antimicrobial agents such as ß-lactams, aminoglycosides, tetracyclines, quinolones, macrolide antibiotics.
Antifungal, antiviral, and anti-TB drugs.

Unit-III

Chemotherapy: Drugs used in protozoal infections, drugs used in the treatment of helminthiasis and chemotherapy of cancer
Immunopharmacology: Cellular and biochemical mediators of inflammation and immune response. Types of allergic or hypersensitivity reactions.

Unit-IV

GIT pharmacology: Antiulcer drugs, prokinetics, antiemetics, anti-diarrheals and drugs for constipation and irritable bowel syndrome.
Chronopharmacology: Biological and circadian rhythms, applications of chronotherapy in various diseases like cardiovascular disease, diabetes, asthma and peptic ulcer.

Unit-V

Free radicals pharmacology: Generation of free radicals, role of free radicals in etiopathology of various diseases such as diabetes, neurodegenerative diseases and cancer. Protective activity of certain important antioxidant.
Recent advances in treatment of: Cancer and diabetes mellitus.

SUGGESTED BOOKS:

1. Hardman J.G., Limbird Le, Molinoss P.B., Ruddon R.W. and Gil A.G., Goodman and Gilman The Pharmacological Basis of Therapeutics, Pergamon Press, Oxford.
2. Golan D.E., Armstrong E.J., Armstrong A.W., Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy, Wolters Kluwer, Alphen aan den Rijn.
3. Katzung, B.G. Basic and Clinical Pharmacology, Prentice Hall International, New Jersey.
4. Rang M.P., Dale MM, Riter JM, Pharmacology Churchill Livingstone, London.
5. Gibaldi, M., Biopharmaceutics and Clinical Pharmacokinetics, Pharma Book Syndicate, Hyderabad.
6. Herfindal E.T. and Hirashman J.L., Clinical Pharmacy and Therapeutics Williams and Wilkins, Philadelphia.
7. Kwon Y., Handbook of Essential Pharmacokinetics, Pharmacodynamics and Drug Metabolism for Industrial Scientists, Springer, New York.

TOXICOLOGICAL SCREENING METHODS (*MPL202*)

Unit-I

Basic definition and types of toxicology (general, mechanistic, regulatory and descriptive). Regulatory guidelines for conducting toxicity studies OECD, ICH and Schedule Y. OECD Principles of good laboratory practice (GLP)

Unit-II

Acute, sub-acute and chronic- Oral, dermal and inhalational studies as per OECD guidelines (Acute eye irritation, skin sensitization, dermal irritation and dermal toxicity studies).

Unit-III

Reproductive toxicology studies: Male reproductive toxicity studies, female reproductive studies (segment I and segment III), teratogenecity studies (segment II).
Genotoxicity studies: Ames test, *in-vitro* and *in-vivo* micronucleus and chromosomal aberrations studies)
In-vivo carcinogenicity studies.

Unit-IV

IND Enabling studies (IND studies): Definition of IND, importance of IND, industry perspective, list of studies needed for IND submission.
Safety pharmacology studies: Origin, concepts and importance of safety pharmacology. Tier1-CVS, CNS and respiratory safety pharmacology.

Unit-V

Toxicokinetics: Toxicokinetic evaluation in preclinical studies, saturation kinetics, importance and applications of toxicokinetic studies. Alternative methods to animal toxicity testing.

SUGGESTED BOOKS:

1. Schedule Y Guideline: Drugs and Cosmetics (Second Amendment) Rules, 2005, Ministry of Health and Family Welfare, New Delhi.
2. Rick N.G., Drugs from Discovery to Approval, Wiley-Blackwell, New Jersey.
3. Gad S.C., Animal Models in Toxicology, CRC Press, Florida.
4. Stine K.E., Brown T.M., Principles of Toxicology, CRC Press, Florida.
5. OECD Test Guidelines.
6. http://www.fda.gov/downloads/drugs/guidancecomplianceregulatoryinformation/guidances/ucm073246.pdf.
7. http://www.who.int/tdr/publications/documents/glp-handbook.pdf.

PRINCIPLES OF DRUG DISCOVERY (*MPL203/MPL102*)

Unit-I

An overview of modern drug discovery process: Target identification, target validation, lead identification and lead optimization. Economics of drug discovery.

Target discovery and validation- Role of genomics, proteomics and bioinformatics. Role of nucleic acid microarrays, protein microarrays, role of transgenic animals in target validation.

Unit-II

Lead identification: Combinatorial chemistry and high throughput screening, *in silico* lead discovery techniques, assay development for hit identification.
Protein structure levels of protein structure, threading and homology modeling methods. Application of MR and X-ray crystallography in protein structure prediction

Unit-III

Rational drug design: Traditional vs. rational drug design, methods followed in traditional drug design, high throughput screening, concepts of rational drug design.
Rational drug design methods: Structure and pharmacophore based approaches.
Virtual screening techniques: Drug likeness screening, concept of pharmacophore mapping and pharmacophore based screening,

Unit-IV

Molecular docking: Rigid docking, flexible docking, manual docking. Docking based screening and *De novo* drug design.
Quantitative analysis of structure activity relationship.

Unit-V

QSAR Statistical methods: Regression analysis, partial least square analysis (PLS) and other multivariate statistical methods. 3D-QSAR approaches like COMFA and COMSIA.
Prodrug design: Basic concept, prodrugs to improve patient acceptability, rationale of prodrug design and practical consideration of prodrug design.

SUGGESTED BOOKS:

1. Sioud M., Target Discovery and Validation Reviews and Protocols: Emerging Molecular Targets and Treatment Options, Vol.- 2, Humana Press Inc., Totowa.
2. Leon D., Markel S., *In-silico* Technologies in Drug Target Identification and Validation, CRC Press, Florida.
3. DiStefano J.K., Disease Gene Identification Methods and Protocols, Humana Press, Totowa.
4. Kubinyi H., QSAR: Hansch Analysis and Related Approaches- Methods and Principles in Medicinal Chemistry, Wiley-VCH, Weinheim.
5. Gubernator K., Bohm H.J., Structure-Based Ligand Design: Methods and Principles in Medicinal Chemistry, Wiley-VCH, Weinheim.
6. Parrill A.L., Reddy M.R., Rational Drug Design: Novel Methodology and Practical Applications, American Chemical Society, Washington.
7. Turner J. R., New Drug Development: Design, Methodology and Analysis, John Wiley and Sons, New Jersey.

CLINICAL RESEARCH AND PHARMACOVIGILANCE (*MPL204/MPL103*)

Unit-I

Regulatory perspectives of clinical trials: Origin and principles of International conference on harmonization-Good clinical practice (ICH-GCP) guidelines.
Ethical committee, institutional review board, ethical guidelines for biomedical research and human participant, schedule Y, ICMR.

Unit-II

Clinical trials: Types and design, experimental study- RCT and Non RCT, observation study-Cohort, case control, cross sectional.
Clinical trial study team: Roles and responsibilities of clinical trial personnel: Investigator, study coordinator, sponsor, contract research organization and its management.

Unit-III

Clinical trial documentation- Guidelines to the preparation of documents, preparation of protocol, investigator brochure, clinical study report, clinical trial monitoring- Safety monitoring in CT.

Unit-IV

Basic aspects, terminologies and establishment of pharmacovigilance significance of safety monitoring, pharmacovigilance in India and international aspects, WHO international drug monitoring programme, evaluation of medication safety, establishing pharmacovigilance centres in hospitals, industry and national programmes related to pharmacovigilance. Roles and responsibilities in Pharmacovigilance

Unit-V

Methods, ADR reporting and tools used in pharmacovigilance international classification of diseases, international non-proprietary names for drugs, passive and active surveillance, comparative observational studies, targeted clinical investigations and vaccine safety surveillance. Spontaneous reporting system and reporting to regulatory authorities. Adverse drug reactions: Definition and types, detection of ADR and reporting methods. Pharmacoepidemiology, pharmacoeconomics , safety pharmacology.

SUGGESTED BOOKS:

1. Central Drugs Standard Control Organization - Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India, Ministry of Health, New Delhi.
2. http://www.ich.org/fileadmin/Public_Web_Site/ICH_Products/Guidelines/Efficacy/E6/E6_R2__Addendum_Step2.pdf.
3. Ethical Guidelines for Biomedical Research on Human Subjects, Indian Council of Medical Research, New Delhi.
4. Machin D., Day S.,Green S., Textbook of Clinical Trials, John Wiley and Sons, New Jersey.
5. Rondels R.K., Varley S.A.,Webb C.F., Clinical Data Management, John Wiley and Sons, New Jersey.
6. Lloyd J., Raven A., Handbook of Clinical Research, Churchill Livingstone, London.
7. Hayes G., Principles of Clinical Research, Routledge, Abingdon-on-Thames.

CLINICAL PHARMACOLOGY & BIOPHARMACEUTICS (*MPL205*)

Unit-I

Introduction to clinical Pharmacology Terminology, basic components and scope.
Pharmacotherapeutics of following diseases: Management and clinical Practice Guidelines
Cardio-vascular: Hypertension (HTN) including hypertension in pregnancy, angina pectoris (AP), acute myocardial infarction (AMI), congestive heart failure (CHF), cardiac arrhythmia (CA), atherosclerosis, peripheral vascular disorders (PVD).
Renal Disease: Acute and chronic renal failure (ARF and CRF), end stage renal disease (ESRD), renal dialysis (Heamodialysis and peritoneal dialysis), renal transplantation, clinical alerts associated with drug dose selection in renal impairment.
Hepatic disorders: Hepatitis (A, B, C), jaundice, Fatty liver, liver fibrosis, liver cirrhosis, alcohol and drug induced complications associated with hepatic impairment.
Gastrointestinal diseases: Hyperacidity, nausea and vomiting, peptic ulcer, diarrhea and constipation, hemorrhoids (piles), clots.
Respiratory diseases: Pneumonia, bronchitis, chronic obstructive pulmonary disease (COPD), asthma.
Autoimmune and metabolic disorder: Rheumatic fever, pain management rheumatoid arthritis, gout and hyperuricemia, diabetes mellitus(DM).
Neoplastic disorder: Leukemia; General principal of cancer chemotherapy.

Unit-II

Drug interactions and rationale for drug combination: Drug interactions involving antibiotics, cardiovascular drugs, antihistaminic drugs and analgesic, anti-inflammatory agents. Various mechanisms of drug interactions, food-drug interactions and drug-drug interactions.
Therapeutic Drug Monitoring (TDM):-Clinical significance and its need on patients associated with narrow therapeutic range of drugs eg. Digoxin, Aminoglycosides, Phenytoin.

Unit-III

Infectious Disease: Tuberculosis (TB), chicken pox, syphilis, gonorrhea, urinary tract infection (UTI).
Antibiotic Resistance: Causes of resistance to antibiotic, general guidelines for rational use of antibiotics.
Current concept in theory and research of drugs for AIDS, Vaccines and sera.

Unit-IV

a) Absorption and distribution.
b) Biological half-life, Area under curve, apparent volume of distribution, concept of clearance, Drug Disposition.
c) Compartment models and their limitations- one compartment open model and multi-compartment models.

Unit-V

Bioavailability: Objectives and consideration in bio-availability studies, Measurements of bio-availability, Determination of the rate of absorption, Bioequivalence and its importance, Study of different in-vitro and in-vivo / biological models for determination of absorption, distribution, metabolism and excretion and permeability of drug. Study of physiological transporter systems and physiological barriers like BBB and blood placental barrier. Drug dissolution: *In-vitro* dissolution testing models.

SUGGESTED BOOKS:

1. Walker R., Clinical Pharmacy and Therapeutics, Churchill, Livingston, London.
2. DiPiro J.T., Talbert R.L., Yee G.C., Matzke G.R., Wells B.G., Posey L.M., Pharmacotherapy: A Pathophysiological Approach, Elsevier, Amsterdam.
3. Russell J.G., Norman D.H., Pathology and Therapeutics for Pharmacists: A Basis for Clinical Pharmacy Practice, Chapman and Hall, New York.
4. Herfindal, E.T. and Hirschman J.L.; Clinical Pharmacy and Therapeutics, Lippincott, Philadelphia.

5. Panda, U.N., Textbook of Medicine, CBS Publishers and Distributors, New Delhi.
6. Jambur A., Psychopharmacology Treatment of Psychiatric Disorders, Jaypee Brothers, New Delhi.
7. Misbahuddin, M., Chaudhari, M.A., Jalil, A Community Pharmacology, Jaypee Brothers, New Delhi.
8. Patten J, Neurological Differential Diagnosis, Springer, New York.
9. Walton J., Diseases of Nervous System, Oxford Uni. Press, Oxford.
10. Gennaro A.R., Remington: The Science and Practice of Pharmacy, Lippincott, New York.
11. Herfindal E.T. and Hirashman J.L., Clinical Pharmacy and Therapeutics Lipincott Williams and Wilkins, Philadelphia.
12. Michael E.W., Basic Clinical Pharmacokinetics, Lipincott Williams and Wilkins, Philadelphia.

PHARMACOLOGY PRACTICAL-II (*MPL206*)

The practicals may be chosen from the following suggested list of experiments based on the subjects opted in that particular semester-

1. Handling of laboratory animals.
2. Various routes of drug administration.
3. Techniques of blood sampling, anesthesia and euthanasia of experimental animals.
4. Functional observation battery tests (modified Irwin test).
5. Evaluation of CNS stimulant, depressant, anxiogenics and anxiolytic, anticonvulsant activity.
6. Evaluation of analgesic, anti-inflammatory, local anesthetic, mydriatic and miotic activity.
7. Evaluation of diuretic activity.
8. Evaluation of antiulcer activity by pylorus ligation method.
9. Oral glucose tolerance test.
10. Isolation and identification of DNA from various sources (Bacteria, Cauliflower, onion, Goat liver).
11. Isolation of RNA from yeast.
12. Estimation of proteins by Branford/Lowry's in biological samples.
13. Estimation of RNA/DNA by UV Spectroscopy.
14. Gene amplification by PCR.
15. Protein quantification Western Blotting.
16. Enzyme based in-vitro assays (MPO, AChEs, α-amylase, α-glucosidase).
17. Cell viability assays (MTT/Trypan blue/SRB).
18. DNA fragmentation assay by agarose gel electrophoresis.
19. DNA damage study by Comet assay.
20. Apoptosis determination by fluorescent imaging studies.
21. Pharmacokinetic studies and data analysis of drugs given by different routes of administration using software.
22. Enzyme inhibition and induction activity.
23. Extraction of drug from various biological samples and estimation of drugs in biological fluids using different analytical techniques(UV)
24. Extraction of drug from various biological samples and estimation of drugs in biological fluids using different analytical techniques (HPLC).
25. To record the DRC of agonist using suitable isolated tissues preparation.
26. To study the effects of antagonist/potentiating agents on DRC of agonist using suitable isolated tissue preparation.
27. To determine the strength of unknown sample by matching bioassay by using suitable tissue preparation.
28. To determine the strength of unknown sample by interpolation bioassay by using suitable tissue preparation
29. To determine to the strength of unknown sample by bracketing bioassay by using suitable tissue preparation

30. To determine to the strength of unknown sample by multiple point bioassay by using suitable tissue preparation.
31. Estimation of PA_2 values of various antagonists using suitable isolated tissue preparations.
32. To study the effects of various drugs on isolated heart preparations.
33. Recording of rat BP, heart rate and ECG.
34. Recording of rat ECG.
35. Drug absorption studies by averted rat ileum preparation.
36. Acute oral toxicity studies as per OECD guidelines.
37. Acute dermal toxicity studies as per OECD guidelines.
38. Repeated dose toxicity studies- Serum biochemical, haematological, urine analysis, functional observation tests and histological studies.
39. Drug mutagenicity study using mice bone-marrow chromosomal aberration est.
40. Protocol design for clinical trial.
41. Design of ADR monitoring protocol.

SYNOPSIS (SEMINAR-I) (*MPL207*)