GOA UNIVERSITY
P.O TALEIGAO PLATEAU
GOA – 403 206

SYLLABUS FOR M.PHARM. (PHARMACOLOGY)

APPROVED BY THE BOARD OF STUDIES
FOR THE ACADEMIC YEAR

PURPOSE

To produce competent Pharmacologists who on completion of the course, shall possess the adequate knowledge of understanding the concepts of drug action, mechanisms involved, drug therapy of certain disorders, gene therapy, different types of toxicities, process of drug development and estimation of drugs' efficacy using bioassays, apply pharmacokinetics to rational drug therapy and screening of new drugs.

PRE-REQUISITES

A candidate who has passed the B. Pharm. Examination of Goa University or an examination of any other Indian University recognized as equivalent thereto with at least **50%** marks in aggregate in one and the same sitting and with **GPAT** be admitted to the M. Pharm. Course (partly by papers and partly by thesis) in one of the specialisation of Pharmacy mentioned below in which he registers as a post-graduate student. However, if the **GPAT** candidates are not available then the vacant seats shall be filled by admitting the candidates without **GPAT** but who have passed the **B. Pharm**. Examination with at least **50%** marks in aggregate in one and the same sitting.

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M.PHARM (PHARMACOLOGY)

(SEMESTER – I)

(SEMESTER – II)

(SEMESTER –III & IV)

(SEMESTER – I)

Code - 21T1 Pharmaceutical Analysis (Theory) (35 Hrs.) 2hrs/week

1. **UV-Visible spectroscopy:** Absorption spectra of organic compounds and complexes illustrating the phenomenon and its utilization in qualitative and quantitative studies of drugs, Beer-Lambert's law, Shifts and their interpretation (including solvent effects). Multicomponent analysis, derivative spectroscopy. **3hrs**.

2. **Spectrofluorimerty:** Fluorescence, Phosphorescence, Chemiluminescence-Theory, instrumentation and applications. **2hrs.**

3. **a) Infra-Red Spectroscopy:** Qualitative interpretation of IR Spectra, Influence of substituents, ring size, hydrogen bonding vibrational coupling and field effect on frequency, Quantitative methods, FT-NIR and applications. Recent advances in IR Spectroscopy.

   b) Raman Spectroscopy- Introduction & Principle. **3hrs.**

4. **Laser Spectroscopy:** Introduction, principle,. **1hr.**

5. **Nuclear Magnetic Resonance Spectroscopy:** Quantitative NMR. Brief outline of principles of 13C NMR. Introduction to 2-D NMR Techniques. Applications of NMR technique in Pharmaceutical science and biotechnology. **3hrs.**

6. **Mass Spectroscopy -** Principle, Instrumentation, applications, interpretation. **3hrs.**

7. **Chromatographic Techniques:** Introduction and classification

   a) High performance TLC –Detection methods, qualitative and quantitative HPTLC. **2hrs.**

   b) Gas Chromatography: Resolution, Applications of GC in Pharmaceutical science. **2hrs.**

   c) Liquid Chromatography: Instrumentation, columns, packing materials, column selection, mobile phase selection, efficiency parameters, resolution and optimization of chromatographic parameters. Detectors in HPLC: Comparison of sensitivity selectivity and field of applications of these detectors. Modes of HPLC- Ion-pair, Ion-exchange, Size exclusion, Supercritical, Chiral, Gel-permeation, Flash chromatography. Applications of liquid chromatography **5hrs.**

8. **Electrophoresis:** Principle, techniques, instrumentation including detection strategies and applications. **2hrs**

9. Radio Immuno Assay and ELISA at least three drugs. **2hrs**

10. Therapeutic drug monitoring /Analytical Techniques. **3hrs**

11. Polymorphisim, Different polymorph are identified / XRD. **2hrs**

12. Dissolution test, critical factors IV/IV Correlation. **2hrs**

Code - 21P1 <u>Pharmaceutical Analysis (Practical)</u> (64Hrs.) 4hrs/week

1. Extraction and fractionation of some herbs.
2. Preliminary chemical investigation of some extracts.
3. Chemical characterisation of some known drug through UV and IR.
4. Estimation of concentration of a known drug in a solution using UV/visible. spectrophotometric methods.
5. Chromatographic evaluation of extracts. Separation and characterization of selected molecules through HPLC/HPTLC.
6. Immuno Assay and ELISA some drugs.

Code - 21T2 <u>Pharmacology- I (Drug Development) (Theory)</u> (35 hr) 2 hr/week

I. Introduction: 2hrs

a. Drug developmental program – in general
b. Guidelines to introduce a new drug in US (IND, NDA and FDA requirements) and India (Schedule Y and its amendments)

II. Drug design: 2hrs

a. Methods, advantages and disadvantages of different conventional drug designs.
b. Modern methods of drug discovery (Introduction, Target identification, Target validation, Lead compound identification and Optimization).
c. High through put (HTP) screening.

III. Data analysis (Bio-statistics): 6hrs

a. Descriptive statistics: Central tendency and their measures (mean, mode and median), Measures of variability (SD, SE, and CV)
Inferential statistics: Probability, Distributions (Binomial and Normal), Confidential intervals, Tests of significance, Null hypothesis, Parametric tests and their application (Chi-square test, Paired and unpaired Student's 't' test, One-way ANOVA and Post-hoc tests), and Non-parametric tests (Wilcoxon tests and Mann-Whitney U test).Data Processing- System analysis and design ,development and creation of databases useful in Pharmacy practice.
Data acquisition ,processing and retrieval systems, Drug information systems(DIS),hospital information systems, Statistical data analysis,Quality control charts using computers.
Introduction to expert systems-Medical diagnosis aid systems
Computer modeling and simulation, application in drug design and Quantitative structure activity relationships.Statistics analysis, modeling, and algorithm development with MATLAB.
Biostatistics, Computerised. Various statistics softwares like SPSS, etc.
Interpretation of research studies, different types of studies-eg. peer reviewed, journals, meta-analysis, etc.
b. Stability studies (Including photo stability and qualification of packaging material) and shelf life estimation. (Guidelines in force)

IV. Pre-clinical trials: 12hrs

a. CPCSEA guidelines to conduct experiments on animals. Study in detail various aspects. Prevention to Cruelty Act in brief. ICMR Guidelines on Research – Animal, Human.
b. Animal house: Design and facilities to maintain the animals.
c. Animal feed and water used in pharma Industry.
d. Common lab animals: Description, handling and applications.
e. Transgenic animals: Production, maintenance and applications.
f. Anaesthetics for animals.
g. GLP (good laboratory practice/ (As per practice and law inforce).
h. Preclinical screening: General screening, and the specific screening procedures for local anaesthetics, antihypertensives, Antianginals; Antiarrythmics; Antiatherosclerotic drugs; Drugs for myocardial infarction; analgesics, anti-inflammatory, antipyretic, Anti-depressants, antianxiety, antiparkinsonian and, Antipsychotic agent; Antidiabetics; Nootropic drugs; Antiepileptics and models for status epilepticus, antifertility agents and drugs for peptic ulcers and diabetes Antimalarials; antimicrobial agents, anthelmintics, anticancer drugs.
i. **Toxicity studies**: **10 hrs**

   Acute, subacute and chronic studies: Protocols, objectives, methods of execution and regulatory requirements. 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 Mutagenicity: In vitro tests for gene mutations in bacteria, chromosome damage, gene mutations in vivo (micronucleus tests and metaphase analysis) in rodents. Carcinogenicity studies: In vivo and In vitro studies Toxicological requirements for biological and bio-tech products: Safety analysis, secondary Pharmacology, antibodies, transmission of viral infections, residual DNA.
j. Limitations of animal experimentation
k. Extrapolation of preclinical data to humans.

V. Alternatives to animal experiments. 3 hrs

Code - 21P2 <u>Pharmacology- I (Practical)</u> 64Hrs. 4Hrs/week

1. Study of common Laboratory animals, breeding, maintenance, handling and CPCSEA regulations various Strains, routes of administration, dose calculation
2. Analgesic activity by hot plate, tail flick, tail dip and writhing methods.
3. To study the effect of hepatic microsomal enzyme induction and inhibition by recording the duration of pentobarbital sleeping time
4. To study the apomorphine-induced compulsive behavior (stereotype) in mice.
5. To study the antianxiety effect of diazepam in mice using elevated plus-maze apparatus.
6. To study the phenothiazine-induced catatonia in rats.
7. To study the antisecretory and ulcer-protective effect of drug like ranitidine in pylorus ligated rats.
8. Screening of antidepressant drugs.
9. Anti microbial screening
10. Experiments based on rota rode, pole climbing apparatus, anxiometer NIBP Autotrack activity meter etc.

Code - 21T3 Pharmacology-II (Theory) (35 hr) 2 hr / week

Definition and Scope of Pharmacokinetics. 5 Hours

Physiological concepts and kinetics, Movement of the drugs through biological membranes, Absorption, Distribution, Metabolism / Biotransformation, Elimination.

1. Integration with kinetics, Variability, genetics, age and weight, disease, interacting drugs, and monitoring of the same. Compartmental models, noncompartmental models and physiologic model Nonlinear pharmacokinetics, multiple dosing and dosage regimen. **:**

a. Clinical Pharmacokinetics: Clinical Pharmacokinetic parameters and their implications in therapeutics (Details on bio-availability, volume of distribution, clearance, half life, zero and first order kinetics, steady states, loading and maintenance doses.)
b. Therapeutic Drug monitoring: Objectives, Strategies for target concentration interventions and applications of TDM.
c. ADR to drugs: Definition and classification, Mechanisms, Detections and monitoring of ADR.
d. Pharmacovigilance ; Concepts, role and applications in relation with guidelines in force.
PDUFA III, Identifying and describing safety signals.
Investigating signals through observational studies.
e. Drug interactions: Definition and Mechanisms (Pharmacokinetic and dynamic) of drug interactions.
f. Intra cerebro-ventricular and other newer techniques of drug administration

2. Pharmacotherapy: The student is expected to apprise himself of with Pathophysiology, Pharmacotherapy and critical analysis of rational use of drugs in the following disorders.

a. CVS: Hypertension, Ischaemic heart disease, CCF, Cardiac arrhythmias, Thrombosis, and Hyperlipidaemia. **5hrs**
b. Respiratory: Asthma and COPD **2hrs**
c. CNS: Parkinson's disease, Alzheimer's disease, Schizophrenia, Affective disorders, Epilepsy, Migraine. **6hrs**
d. Musculoskeletal: Rheumatoid & Osteoarthritis, Gout and hyperuricaemia, Myasthenia gravis. **2hrs**
e. Renal: Acute and chronic renal failure. **1hr**
f. GIT: Peptic ulcer, inflammatory bowel diseases, constipation & diarrhoea. **1hr**
g. Hepatic: Drug induced hepatotoxicity and hepatic diseases. **1hr**
h. Blood: Drug induced blood disorders, and anaemia. **1hr**
i. Endocrine: Diabetes, Thyroid and parathyroid disorders,

Menstrual cycle disorders, Menopause and HRT, Osteoporosis. **4hrs**

j. Eye: Glaucoma. **1hr**

k. Infectious: Respiratory (upper and lower) and UT infections, GI infections (Bacterial and protozoal), Infective meningitis, Tuberculosis, Malaria, AIDS, Malignant: Leukaemia, Lymphomas and solid tumours. **6hrs**

l. Miscellaneous: Drugs in pregnancy and lactation, Paediatrics and Geriatrics therapy. **1hr**

Code - 21T4 Pharmacogenomics (Theory) (35 hr) 2 hrs/week

1. **Introduction to Pharmacogenomics** : **3hrs**

Pharmacogenomics: Historical perspectives and current status, Human Genome and Genomic Applications, Genetic Polymorphism of Metabolic Reactions, SNPs, Association Studies in Pharmacogenomics, Study on industries developing pharmacogenomic research.

2. **Functional Analysis Of Gene Variation** : **5hrs**

Transfection Assays With Allele-Specific Constructs: Functional Analysis of UDP-Glucuronosyltransferase Variants, CYP 2D6, CYP2C19 in drug metabolism, Snapshot of the Allele-Specific Variation in Human Gene Expression, Genome-Wide Analysis of Allele-Specific Gene Expression Using Oligo Microarrays, Roche Ampli Chip, HaploChIP: An In Vivo Assay.

3. **Genotyping Techniques** : **5 hrs**

Aspects Influencing Genotyping Method Selection, Denaturing HPLC for Mutation Detection and Genotyping, Pyrosequencing of Clinically Relevant Polymorphisms, Kinetic Fluorescence-Quenching Detection Assay for Allele Frequency Estimation, MALDI–TOF Mass Spectrometry, Fluorescence-Based Fragment Size Analysis, SNP Genotyping in DNA Pools, Genotyping of InDel Polymorphisms

4. **Pharmacogenomics In Personalized Medicine** : **8 hrs**

Pharmacogenomics of Cardiovascular Diseases, Pharmacogenomics of Cancer treatment(Herceptin as model),
Pharmacogenomics of Neurodegenerative Diseases, Pharmacogenomics in Depression, Pharmacogenomics and Respiratory diseases, Pharmacogenoomics in AIDS, Pharmacogenomics in Antibiotics.

5. **Management of Pharmacogenomic Information** : **5hrs**

The Pharmacogenetics and Pharmacogenomics knowledge Base, Systems for the Management of Pharmacogenomic Information.

6. **Bio-tech products:** **5 hrs**

1. Biotechnology and Related Techniques: Protein engineering, peptide chemistry and peptidomimetics, nucleic acid technology, catalytic antibodies and glycobiology
2. Present products in medicine: Insulin, GH, Vaccines, Monoclonal antibodies, FSH, Tissue plasminogen activator (t-PA)
3. Pharmacokinetics and dynamics of the peptide and protein drugs.

7. **Transgenic animals** and other genetically prone animal models (Nude Mice, SH rats). **2hrs**

8. **Cell line cultures and its application**. **2hrs**

(SEMESTER – II)

Code - 21T5 Drug Development & Regulatory Aspects (Theory) (35hrs) 2 hrs/week)

1. Clinical Trials: 20 hrs

CLINICAL TRIALS – Phase 0–III, Post marketing surveillance. GCP – Good Clinical Practices – Schedule Y. – For new drugs. . Composition, responsibilities, procedures of IRB / IEC

Clinical Trials – CROs, Protocol Development, Feasiblity Studies, Case Report form review and designing, Report writing, monitoring, QA and data management, Bioavailability studies, Role and responsibilities of clinical trial personnel as per ICH GCP.

a. Sponsor
b. Investigators
c. Clinical research associate
d. Auditors
e. Contract research coordinators
f. Regulatory authority

International guidelines (ICH recommendations) GCP. ICMR guidelines.

Fundamentals of clinical trials: Protocols, volunteers, informed consent, ethical committee, designs (single blind, double blind, cross over, randomization, placeboes, controlled studies)

Phased trials: Objectives, design, organization and execution of phase I, Phase II, Phase III and Phase IV clinical trials.

Orphan drugs.

2. NDA/ANDA (Product Registration) 15hrs

1.As per current applicable rules and guidelines
2. New Drug Application (NDA) and Abbreviated New Drug Application (ANDA).
3. Biological products and biotechnology:
4. Clinical aspect of recombinant DNA products,
5. Preclinical pharmacological and
6. toxicological requirement for biological and
7. biotechnological products.
8. New Drug Application, content and format, guideline for filling NDA.
9. New Drug Approval, exclusivities, Orangebook.
10. ANDA, Contents and format, guidelines for filling ANDAs.
11. Bio-waver requirements in ANDA, Para I, II, III and IV approvals.
12. DMFs and their importance
13. Patents; Introduction to IPR and briefly procedure for patenting as per the prevailing laws.

Code - 21T6 Pharmacology III (Hospital & Clinical Pharmacology) (Theory)

(35 hr) 2 hr / week

1. Concept of clinical pharmacy & Global scenario Competencies in clinical pharmacy **1hr**
2. Interpreting laboratory data. Common biochemical & hematological data and their implications in therapeutics **3hrs**
3. Ward round participation (Basic Types) **4hrs**
4. Rational use of the drug and ESSENTIAL drug concepts Pharmacoeconomics **2hrs**
5. Medication adherence and compliance **2hrs**
6. Drug therapy review and enveloping therapeutic guidelines **4hrs**
7. Medication errors **2hrs**
8. Patient psychology and patient handling **2hrs**
9. Patient counseling **2hrs**
10. Management of Hospital pharmacy **4hrs**
11. Pharmacoepidemiology **2hrs**
12. ADR monitoring and reporting **2hrs**
13. Pharmainformatics, Introduction to validation of computer assisted process. Information resources available , Telemedicine. **1hr**
14. OTC medicines **1hr**
15. Poisonings **:** General principles of management of acute poisoning cases **2hrs**

Code - 21P3 <u>Pharmacology III (Practical)</u> (64 hrs.) 2 hr / week

1. To generate Pharmacokinetic parameters to a drug based on hypothetical model/methods.
2. Problem solving exercises on calculation of doses (maintenance and loading etc) in different cases.
3. Exercises on evidence-based medicine: SOAP to hypothetical/real cases.
4. Identify the poisons/drugs present in the biological fluids/solutions based on the leads obtain from the case histories

Code - 21T7 Pharmacology IV (Theory) (35 hr) 3 hr/week

1. Neurotransmitter receptor mechanisms, ion channel and G-protein linked receptors, second messenger systems. 8hrs

Receptor expression and regulation with specific emphasis on adrenergic, dopaminergic, cholinergic, serotoninergic, histaminergic, GABA/BZ and excitatory aminoacid receptors, opioid receptors, purinoceptors, Cannabinoid receptors and their subtypes with agonists and antagonists. Isolation and characterization of receptors. Neuro transmission in CNS (NA, Ach, 5-HT, Dopamine etc.)

2. Mediators of inflammation and allergy Autocoids 4hrs

(Histamine, Bradykinins, PAF, Eicosanoids: prostaglandins, thromboxanes, leukotrienes and related compounds), nitric oxide / EDRF, Endothelin receptors: and vascular substances, oxygen free radicals and their scavengers. Cytokines and their actions, Cox- l, Cox-2 inhibitors and their role in inflammatory process, anti-inflammatory agents, asthma and COPD.

3. Immunomodulators, AIDS & Rheumatoid arthritis. 4hrs.

The molecular and cellular mechanisms of immunomodulators, Free fatty acid receptors.

4. Drug dependence and substance of abuse. 4hrs

Study of biological test kits for substance of abuse and other products available in market and their application.

5. Recent developments in chemotherapeutic agents. 4Hrs

Cellular and molecular mechanisms of actions and resistance of antimicrobial and anticancer drugs. Mechanism of multidrug resistance (MDR), antibacterial, antiviral, antiprotozoal and anthelmintics, Cancer chemotherapy.

6. Biological assays: 4hrs

Types of Bioassays, Their application Immunoassays: General principles and procedures of immunoassays. Immunoassay for digoxin and insulin.

Code - 21P4 Pharmacology IV (Practicals) 64 Hrs (4 Hrs/wk)

1. Bioassay of acetylcholine/histamine using guinea pig ileum preparation.
2. Bioassay of oxytocin using rat uterine preparation.
3. Bioassay of 5-HT using rat fundus preparation.
4. PA2 values of various antagonists using suitable isolated tissue preparations.
5. Screening of anxiolytic drugs
6. . Effect of various autonomic drugs on rat phrenic nerve diaphragm preparation.
7. Anti-dysrrhythmic activity in rats using ECG
8. Effect of various autonomic drugs on rat blood pressure.
9. Effect of various drugs on rabbit jejunum preparation.
10. Detection of a drugs using biological test kits.

Note: Virtual / Simulated experiments are permitted.

Code - 21T8 <u>Pharmacology V (Theory)</u> 35hrs 2hrs /Week

Study of following receptors their types, agonist antagonist, pathophysiology, Molecular biology, pharmacology etc .)

Advances in receptor identification and classification IPHAAR Adenosine receptors, called a_1, a_{2a}, a_{2b} and a_3, binding sites, **Angiotensin receptors,** the classification of the angiotensin receptors, **Apelin receptor** apelin peptides, functions, **Bile acid receptor** receptor structure receptor distribution physiology , **Bombesin receptors,** GRP, NMB peptide Types of BB receptor Physiological and pathophysiological roles, **Calcitonin receptors**, **Adrenomedullins receptor** , Chemokine receptors:, Viral anti-chemokines and chemokine receptors, **KiSS1-derived peptide receptor**, **Melanocortin receptors, Melatonin receptors**, **Neurotensin receptors**, **Relaxin family peptide receptors**, **Urotensin receptor**, **VIP and PACAP receptors** **(25 hrs)**

Endocrine Pharmacology: Molecular and cellular basis of mechanisms of actions of hormones (growth hormone, prolactin, thyroid, Glycoprotein hormone receptors, insulin, Glucagon receptor family and oral hypoglycaemic agents, sex hormones and oral contraceptives, corticosteroids, Corticotropin-releasing factor receptors, and drugs affecting calcium regulation) and their antagonists. Ghrelin receptor **(10 hrs)**

Recent developments reported from time to time.

SEMESTER III & IV

Code 21T9 Soft Skills & Scientific presentation

1. REFERENCE & BIBLIOGRAPHY

Styles of referencing Vancouver style/Harvard style etc.

2. SCIENTIFIC WRITING, FORMAL WRITING

Resume Writing, Formal Letter Writing, understanding e-communication.

Types of information, databases, known publishers, Journals, Types of articles (Letters, short communication, research , reviews,) the importance of publishing research results How to organise your time to write a paper the components of writing that make up a paper.

4. ETIQUETTE & ETHICS ON THE JOB

Understanding Body Language, Social & Business Etiquette, Netiquette
Communication Ethics, Telephone/Mobile Etiquette

5. GROUP DISCUSSION SKILLS

Interacting and working in a group Analyzing a case study Working in a Group &
Presenting a Case Study

6. SPOKEN ENGLISH

Essentials of pronunciation in Spoken English, Essentials of Grammar Vocabulary Development.

7. PRESENTATION SKILLS

Essentials of Effective Presentation Oral skills in Presentation, Putting together PowerPoint Presentations use of LAP Tops LCD, Multimedia.

8. PERSONAL INTERVIEW TECHNIQUES

Building on the Resume, Interview Coaching, Mock Interviews

9. INTRODUCTION TO THE CORPORATE CULTURE

Exposure to Corporate Culture Govt. procedures
Leadership Qualities, labour psychology

10. Fund raising /Application for grants/ Project submission Indian funding agencies

11. Application to foreign Universities / references do' & Don'ts

Code 21P5 Field work & Industrial Training

(Three months one month each in filed - Evaluation at the end of third semester - 100 Marks)

1. Industrial (35 Marks) 2. Hospital (35 Marks) 3. Community Pharmacy (30 Marks)

Code 21P6 Dissertation

Total Marks 400

The examiners will jointly assign the mark for & Viva -voce.

The allotment of marks shall be as under:

1. Scientific Contents - 80
2. Presentation / Communication - 80
3. Discussion - 80
4. Report - 160

Scheme Evaluation for Practical Examination:

Synopsis	Major Experiment	Minor Experiment	Viva - Voce	Total
10	30	15	15	70

Books :

1. Principles of Instrumental Analysis, 5th Edition, D.A. Skoog, F.J. Holler and T. A. Nieman.
2. "Spectrometric Identification of Organic Compounds" Silverstein, R.M., Bassler & Morril Fifth Edition (1991)
3. Instrumental Methods of Analysis,H.H.Willard, L.L.Merritt, J.A. Dean, F.A.Settle, 7th Ed.
4. Pharma Analysis, Modern Methods - (Ed) James W Munson Part-B, Vol -2.
5. Drugs & Pharma, Sciences Series, Marcel Dekker Inc.
6. "Applications of absorption spectroscopy of organic compounds" by John R. Dyer.
7. "Contemporary practice of chromatography" by Poole, Colin F. and Sheila A. Schuette.
8. Ewing's Analytical Instrumentation handbook, edited by Jack Cazes, CRC press.
9. "Practical HPLC method development" by L. R. Snyder Willey Interscience, Second Ed.
10. Aldrich FT-IR spectral library.
11. "Pharmaceutical Analysis" by David C. Lee Blackwell publisher.
12. Remington's Pharmaceutical Sciences 20th edn.
13. Evaluation of drug activities Pharmacometrics by D R Laurence and A L Bacharach.
14. Drug Discovery and Evaluation Pharmacological Assay by Vogel H G and Vogel W H (Springer publication)
15. Modern drug research- Paths to better and safe drugs (Medicinal Chemistry vol 9) by Y C Martin, E. Kutter and V. Austel
16. Practical approaches in toxicity studies by Poole and Leslie
17. Alternatives to animals in toxicity testing. Scientific American 26:(1989), 16-22.
18. Methods of clinical trials by Alan Spreit and Simon.
19. Modern Methods of Drug Discovery by Hillisch, A and Hilgenfeld, R.
20. Clinical Pharmacy and Therapeutics by Roger Walker and Clive Edward 3rd edn

21. Text Book of Therapeutics, Drug and Disease Management by Herfindal E T and Gourley D R .

22. Basic and Clinical Pharmacology by B G Katzung .

23. Molecular Biology of the Cell by Alberts B., Bray, D., Lewis, J., Raff M., Roberts, K and Watson, JD, 3rd edition.

24. Molecular Cell Biology By Lodish, H., Baltimore, D., Berk, A et al.,

25. Molecular Biology by Turner, PC., McLennan, AG., Bates, AD and White MRH .

26. Genes VIII by Lewin, B.,

27. Pharmaceutical Biotechnology, by Crommelin, DJA and Sindelar RD

28. Recombinant DNA by Watson, JD., Gilman, Metal.

29. Fundamentals of Experimental Pharmacology by M N Ghosh.

30. Hand book of Experimental Pharmacology by S K Kulkarni.

31. Practical in Pharmacology by R K Goyal,

32. Pharmacology Rang HE Dale MM and Ritter JM Churchill Livingstone, London,

33. Pharmacological Basis of Therapeutics. Goodman and Gilman's (International Edition) McGraw Hill, New York

34. General and applied toxicology B.B allantyne, T. Man-s, P. Turner (Eds) The Macmillan Press Ltd.London.

35. Clinical Pharmacy D.R. Laurence, P.N. Bennett & M.J. Brown, 8th Edition Churchill Livingstone

36. Harrison's Principles of Internal Medicine. Braunwald, Fauci, Kasper, Hauser, Longo Jameson, McGraw Hill, New York.

37. Applicable Guideline, rules and manuals in force.

TEXT BOOKS:

1. Pharmacogenomics: Methods and Protocols (Methods in Molecular Biology) First Edition
   (2005) Federico Innocenti, Humana Press Inc, New Jersey, USA.
2. Pharmacogenomics and Personalized Medicine (Methods in Pharmacology and Toxicology)
   First Edition (2005) Nadine Cohen, Humana Press Inc, New Jersey, USA.

REFERENCES:

1. An A-Z Guide to Pharmacogenomics, First Edition (2006) M.C. Catania, Published by American Association for Clinical Chemistry.
2. Pharmacogenomics: Social, Ethical, and Clinical Dimensions, First Edition (2003) Mark A.
   Rothstein, Wiley-Liss Publications.

JOURNALS :

1. Indian Journal of Pharmacology [Essential]
2. Journal of Pharmacy & Pharmacology
3. Some of Online Journals and Data Bases.

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18/2/2010.