## FIRST SEMESTER

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## SECOND SEMESTER

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## THIRD AND FOURTH SEMESTER

Research Work for one year
The thesis shall be presented by the candidate at the end of record academic year. The thesis shall be evaluated as under:

- Evaluation of written thesis : MM 200
- Presentation of seminar on thesis : MM 100
- and viva-voce

Total : 300 marks

[Note : Credit System : 1 credit = 20 marks, L- Lecture – Tutorial, P – Practical]
Module 01
**Basic Principles of Pharmacology:**

**Pharmacology of the Autonomic Nervous System:**
- Physiology of autonomic nervous system
- Muscarinic receptor agonists and antagonists
- Anticholinesterase agents
- Agents acting at neuromuscular junction and autonomic ganglia
- Adrenergic agonists and antagonists
- 5-Hydroxytryptamine receptor agonists and antagonists

Module 02
**Pharmacology of Autacoids:**
- Histamine, bradykinin, and their antagonists
- Lipid derived autacoids: Eicosanoids and platelet activating factor

**Drugs Acting on the Central Nervous System:**
- Neurotransmission in central nervous system
- General anesthetics
- Local anesthetics
- Hypnotics and sedatives
- Opioid analgesics
- Pharmacology of ethanol
- Drug addiction and drug abuse

Module 03
**Analgesic, Antipyretic, and Anti-inflammatory Agents**

**Drugs Affecting Renal and Cardiovascular Function:**
- Diuretics
- Vasopressin and other agents affecting the renal conservation of water
- Renin, angiotensin, and their modulators
- Calcium channel blockers

Module 04
**Pharmacology of Chemotherapeutic and Antimicrobial Agents:**
- General considerations of antimicrobial therapy
- Sulfonamides, trimethoprim, quinolones, other related agents
- Penicillins, cephalosporins, and other beta-lactam antibiotics
- Aminoglycosides
- Protein synthesis inhibitors and miscellaneous antibacterial agents
• Antifungal agents
• Antiviral agents (Non-retroviral)

Antineoplastic Agents

Module 05
Hormones and Their Antagonists:
• Pituitary hormones and their hypothalamic releasing factors
• Thyroid and antithyroid drugs
• Estrogens and progestins
• Androgens
• Adrenocortical steroids and their synthetic analogs, inhibitors of synthesis and actions of adrenocortical hormones
• Agents affecting mineral ion homeostasis and bone turnover

Module 06
Drugs Acting on the Blood and Blood-Forming Organs:
• Hematopoietic agents: Growth factors, minerals, and vitamins
• Blood coagulation and anticoagulant, thrombolytic, and antiplatelet drugs

Pharmacology of Dermatological Agents
Ocular Pharmacology
Immunosuppressants, Tolerogens, and Immunostimulants

Reading Material Recommended

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Module 01

**Basic Principles of Clinical Pharmacology:** Monitoring of drug therapy, patient compliance, principles of pediatric and geriatric pharmacology, drug therapy in pregnant and lactating mothers.

Module 02

**Drug Therapy of Cardiovascular Disorders:** Pathophysiology and drug therapy of congestive cardiac failure, hypertension, cardiac arrhythmias, ischemic heart disease, hyperlipidemia, and atherosclerosis.

Module 03

**Drug Therapy of Neurological Disorders:** Pathophysiology and drug therapy of epilepsy, Parkinson's disease, migraine, and myasthenia gravis.

**Drug Therapy of Psychiatric Disorders:** Pathophysiology and drug therapy of anxiety, schizophrenia, Alzheimer’s disease, mood and sleep disorders.

Module 04

**Drug Therapy of Endocrine Disorders:** Pathophysiology and drug therapy of diabetes mellitus, contraception, and infertility.

**Drug Therapy of Inflammatory Disorders:** Biology of inflammation, pathophysiology and drug therapy of osteoarthritis, rheumatoid arthritis, and gout.

Module 05

**Drug Therapy of Respiratory Diseases:** Pathophysiology and drug therapy of asthma.

**Drug Therapy of Gastrointestinal Diseases:** Pathophysiology and drug therapy of peptic ulcers, emesis, irritable bowel syndrome, and inflammatory bowel disease.

**Drug Therapy of Metabolic and Sexual Disorders:** Pathophysiology and drug therapy of obesity and erectile dysfunction.

Module 06

**Drug Therapy of Infectious Diseases:** Pathophysiology and drug therapy of tuberculosis, leprosy, HIV and related opportunistic infections, malaria, amoebiasis, and helminth infections.

**Reading Material Recommended**


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**Module 01**

**Principles of Experimental Pharmacology :**
Common laboratory animals in pharmacological research, limitations of animal tests, alternatives to animal use, anesthetics used in laboratory animals, some standard techniques used in laboratory animals, euthanasia of experimental animals. Regulations for the care and use of laboratory animals.

**Module 02**

**Drug Discovery :**
Strategies and approaches employed in drug discovery. Basic concept of combinatorial chemistry, high throughput screening, cell lines, and their application in drug discovery. Transgenic animal models in the development of new drugs.

**Receptor-Radioligand Binding Assays**
General principles and techniques of radioligand binding assays. Specific assay design for adrenoceptors, dopamine receptors, histamine receptors, GABA and benzodiazepine receptors.

**Pharmacological Techniques to Evaluate the following Class of Drugs:**

**Module 03**
- Antihypertensive agents
- Antianginal agents
- Antiarrhythmic agents and agents used in sudden cardiac death
- Drugs used in cardiac failure and cardiomyopathies
- Drugs used in hyperlipidemia and atherosclerosis
- Anti-infarct agents
- Antiplatelet and thrombolytic agents

**Module 04**
- Antiepileptics
- Antiparkinsonian agents
- Antimigraine agents
- Antianxiety agents and drugs used in mood and sleep disorders
- Antipsychotics
- Drugs used in Alzheimer’s disease
- Local anesthetics

**Module 05**
- Skeletal muscle relaxants and neuromuscular blockers
- Antidiabetic agents
- Antifertility agents
• Analgesics and drugs used in arthritis and neuropathic pain
• Anti-inflammatory agents

Module 06

• Antiasthmatic agents
• Antiulcer agents
• Antiemetics
• Hepatoprotective agents
• Antiobesity agents
• Drugs used in erectile dysfunction
• Dermatological agents and experiment models in skin pharmacology

Reading Material Recommended

1. Experiments to study pharmacology of receptors (competitive and non-competitive antagonists). Experiments to calculate $\text{pA}_2$ and $\text{pA}_{10}$ using isolated rectus abdominus muscle of rat, vas deferens, muscle of rat, rat colon, and rat fundus preparations.

2. Experiments in intact animals to evaluate local anesthetics, mydriatics, miotics, analgesics, anti-inflammatory agents, hypnotics, antianxiety agents, antiepileptic agents, antidepressants, antipsychotics, antiparkinsonian agents, nootropics, and antiulcer agents.

3. Design and statistical analysis of experimental data using student t-test, One way ANOVA etc.

Reading Material Recommended

Module 01

New Drug Development Process: Stages of drug discovery, pre-clinical and safety evaluation, acute, sub-acute, chronic studies, in-vivo and in-vitro studies (behavioral, biochemical, neurochemical models) and special studies including carcinogenicity, mutagenicity, teratogenicity.

Module 02 -03

Clinical trials: Design (placebo, multicentre clinical trials, randomization, blinding) and different phases of clinical trials (1 to 4), principles of controlled clinical trials, protocol designing, patient informed consent, patient enrolment, inclusion and exclusion criteria, withdrawals and dropout, run in period. Clinical trial team, monitoring of clinical trial, report preparation, deviations in clinical trials. Clinical data management. Contract Research Organization (CRO) and relationship of marketing to clinical research. Clinical research in children, women, and elderly patients. IND, NDA, and ANDA applications

Module 04


Module 05

Intellectual property
Concepts and fundamentals regarding intellectual property (IP), intellectual property protection (IPP) and intellectual property rights (IPR); mechanism for protection of intellectual property - patents, copyright, trademarks; brief introduction of WTO, WIPO, GATT, GATS, TRIPs and TRIMS.

Module 06

Pharmacovigilance: Definition, scope, and epidemiology of adverse events, product recall and withdrawal of drugs with specific examples.
Pharmcoeconomics: Principles, methods, and applications of pharmcoeconomics to pharmacotherapy and managed health care.
Nutraceuticals: Concept, regulatory requirements, and clinical uses of various nutraceuticals.

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Module 01

1. **Clinical Evaluation**: Clinical evaluation of antihypertensive agents, antianginal agents, antiepileptics, antidepressants, antipsychotics, antiparkinsonian agents, drugs used in Alzheimer’s disease, antiulcer agents, antidiabetics.

2. **Clinical Pharmacokinetics**: Determination and clinical relevance of various pharmacokinetic parameters. Concept and measurement of bioavailability, bioequivalence, renal and hepatic clearances. Calculation of loading and maintenance doses and dose adjustment in renal and hepatic impairments.

Module 02

3. **Recombinant DNA Technology**: DNA structure and functions, restriction endonucleases, plasmid cloning, methods of creating and screening gene library, cloning DNA sequences that encode eukaryotic proteins, vectors for cloning large pieces of DNA, genetic transformation, and selection of prokaryotes.

Module 03

4. **Molecular Diagnostics**: DNA diagnostic systems, hybridization probes, diagnosis of malaria, fluorescent in situ hybridization procedure, molecular diagnosis of genetic diseases – PCR/OLA procedures, ligase chain reaction (LCR).

   **Introduction and application of molecular pharmacological techniques**: Elisa, Western Blotting, SDS-PAGE and electrophoresis, flow cytometry.

Module 04


Module 05


Module 06

7. **Gene and stem cell Therapies**: Basic concepts and clinical potentials of gene therapy and stem cell therapy, Impact of human genome sequence on the discovery of newer pharmacological agents. Ethical issues related to stem cells and human cloning.

8. Applications of cell lines.
Reading Material Recommended

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**Module 01**

**Molecular Pharmacology :**
Receptor occupancy and cellular signaling systems including G proteins, cyclic nucleotides, calcium and calcium binding proteins, phospholipases.

**Pharmacology of receptors :**
Classification, cellular signaling systems, and pharmacology of agonists and antagonists of the following receptor types:
(a) Excitatory Amino Acid receptors
(b) Purinoreceptors
(c) GABA and Benzodiazepine receptors
(d) Neurosteroid receptors
(e) Cannabinoid receptors
(f) Melatonin receptors

**Ion Channels and Their Modulators :**
Classification and biology of potassium ionic channels, and pharmacology of their Modulators

**Module 02**

**Novel Target Sites :**
Physiological functions, pharmacological implications, and therapeutic potential of the following target sites:
(a) Rho kinase (ROCK)
(b) Phosphoinositide 3-kinase (PI3K)
(c) Akt (Protein kinase B)
(d) Caspases
(e) Poly (ADP-ribose) polymerase (PARP)
(f) Peroxisome proliferator activator receptors (PPAR)-α and γ
(g) AMP activated protein kinases
(h) Protein kinases
(i) Phosphodiesterases

**Module 03**

**Neuropeptides :**
Biological functions, pharmacological implications, their agonists and antagonists, and therapeutic potentials of the following neuropeptides:
- Neuropeptide Y
- Calcitonin gene-related peptide (CGRP)
- Substance P
- Cholecystokinin
Module 04

**Transporter Proteins:**
Classification and biology of ATP binding cassette (ABC) transporter super family.
Multidrug resistance (MDR) proteins
Cystic fibrosis transmembrane regulator (CFTR)

**Programmed Cell Death (Apoptosis):**
Molecular biology, physiological and pharmacological implications and therapeutic potentials of apoptosis.

Module 05

**Cytokines and Chemokines:**
Classification, physiology, pharmacology, pathological, and therapeutic implications of various cytokines and chemokines.

**Cell Adhesion Molecules and Matrix Proteins:**
Biology of cell adhesion molecules and matrix proteins, their role in various disease processes, and potential target sites to develop newer agents. Glycoprotein IIb/IIIa receptor antagonists and anti-integrin therapy.

Module 06

**Growth Factors:**
Biology and therapeutic potentials of various growth factors. Pharmacology of Erb B receptors, cardiac and vascular remodeling.

**Biology of Vascular Endothelium:**
Biology of EDRF, EDCF, and EDHF. Pharmacology of endothelins and nitric oxide. Clinical implications of endothelial dysfunction.

**Chronobiology and Chiral Pharmacology:**
Basic concepts and clinical potentials of chronobiology and chiral configuration.

Reading Material Recommended

1. Annual Review of Pharmacology and Toxicology
2. Annual Review of Medicine
3. Trends in Pharmacological Sciences
4. Advances in Pharmacology
5. Trends in Biotechnology
6. Advances in Drug Therapy
7. Drug Discovery Today.
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1. Four-point bioassays of various agonists using rectus abdominus muscle of frog, guinea pig ileum, rat uterus, rat fundus. Calculate log fiducial limits of error.
2. To study the effect of various agonists on isolated guinea pig tracheal chain, isolated phrenic nerve-diaphragm, isolated rat aorta, isolated rabbit atria and gastrocnemius muscle of rabbit.
3. Identification of unknown drug using anesthetized dog by recording mean arterial blood pressure, respiration, gastrointestinal motility, nictitating membrane, and spleen volume.
4. Effect of various agents on rat blood pressure.
5. Effect of various pharmacological agents on heart rate, coronary flow rate, and force of contraction on isolated mammalian heart.
6. Exercises to calculate pharmacokinetic parameters, bioavailability and bioequivalence using serum/plasma and urine excretion data.
7. Study of hepatoprotective agents using various experimental models.
8. Calculation of LD50 and experiments related to toxicity.

**Reading Material Recommended**

2. Edinburg University Pharmacology Staff (ed.) Pharmacological Experiments on Isolated Preparations, Livingstone, U.K.