COURSE OF STUDIES

for

Master of Philosophy

in

Pharmacology

UNIVERSITY OF HEALTH SCIENCES, LAHORE PAKISTAN

Program Rationale:

The rational of the program is to conduct high quality biomedical research and strengthen the subject based knowledge.

Mission Statement:

The mission of the Department of Pharmacology, within the broad mission of the University, is to conduct high quality programs of biomedical research and education. Our mission is to provide quality preclinical and clinical education in pharmacology and therapeutics for medical students, to educate and train postgraduate and biomedical scientists, to carry out basic research of recognized excellence, and to participate in governance and leadership in the University and in appropriate national scientific and professional societies. Our goal is to establish the areas of Pharmacogenomics. We have research programs investigating drug discovery, design and delivery.

Program Educational Objectives:

- The management team will serve the department by establishing an environment conducive to pursuing the vision.
- The management team will serve by establishing and maintaining an environment that fosters professional growth, a cooperative spirit at all levels, and respect for the individual and his/her uniqueness in all aspects of humane.
- Create an environment conducive to teaching, to practicing, and to conducting research.
- To provide an environment conducive to learning all aspects of Pharmacology: the ethical and legal, the technical, the cognitive, the interpersonal, and the compassionate.

- The department will serve the profession of Pharmacology by developing programs and processes that continuously advance practice and improve research.
- To provide solid understanding of basic pharmacology and to prepare our postgraduates with up to date knowledge of pharmacology to pursue careers as independent scientists, pharmacologists and as good research oriented teachers.
- To prepare the postgraduates for lifetime learning and problem solving.
- To discover new biomedical knowledge and to apply the insights gained form basic sciences studies for further advancement in therapeutics strategies.
- To increase the basic understandings of subject concepts of graduates through quality education so that they can successfully apply it effectively.
- To enhance the capabilities of graduates to utilize modern equipments efficiently and basic understanding of the underlying mechanism.
- To establish effective collaboration with other institutes and research centers for the benefit of the graduates to harness new technologies and to increase their vision.
- To enable the graduates to present his research findings effectively at National/International forums.

Program Learning Outcomes:

- Graduates will have access to modern equipment and can learn new techniques.
- Graduates will be equipped with the required up to date knowledge of their subject. Graduates with improved teaching skills with proper subject understanding will be produced.
- Regular practical and research work will help graduates to have access to modern equipments and techniques. Graduates will be able to produce high quality research with reliable research findings.
- Graduates will be able to have access new technologies not available locally and thus can enhance their vision. Research articles with high impact factor can be produced as a result of National/ International collaboration.

- By publishing research findings, department faculty will be able to win many research projects from National/International funding agencies. As a result of quality education and research work, university fame and ranking will be improved significantly.

SCHEME OF STUDIES (2-Year)

MS/MPhil Pharmacology

Semester #	Course code	Course title	Credit hours		
			Theory	Practical	Total
1	RM-701	Biostatistics and Research Methodology	2	0	2
	PHARM- 701	Advance Pharmacology- I	2	1	8
	PHARM- 702	Advance Pharmacology- II	2	1	
	EXRL-701	Instruments & Animal use in research	1	1	
	PHY-708	Elective Course Physiology	2	0	2
2	PHARM-703	Advance Pharmacology- III	2	1	8
	PHARM-704	Advance Pharmacology- IV	2	1	
	PHARM-705	Molecular pharmacology	1	1	
		Elective Course (Selected by Student on the basis of Research Area dully endorsed by H.O.D)	2	0	2
3	Research (thesis)		6		6
4	Professional & Teaching Skills Apprenticeship (PTSA)		2		2
					(Total: 30)

1. PHARM- 701 Advance Pharmacology- I

A. INTRODUCTION TO BASIC PRINCIPLES OF PHARMACOLOGY

Course Objectives:

By the end of this module the students should be able to

- Common routes of administration & excretion of drugs
- Compare efficacy & potency
- Types of antagonism
- Mechanism of hepatic enzyme induction
- Major phase I & phase II metabolic reactions

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Drug Discovery and Development
- Bio-assay/ Bio-equivalence
- Preclinical Research and Clinical Research
- Sources & Active Principles of Drugs
- Routes of Administration
- Transport across cell-membranes
- Absorptions & factors effecting drug absorptions
- Bio-availability
- Distribution of Drugs and Volume of distribution
- Metabolism (Zero order & 1st order kinetics)
- Elimination / excretion of drugs
- Plasma half life
- Pharmacodynamics and Mode of drug actions
- Signalling mechanism (Receptors, Channels & 2nd messenger)
- Dose response curves (Graded and quantal dose response curves)
- Agonist, Partial agonist, Inverse agonist & Antagonist
- Types of drugs antagonism
- Pharmacogenetics and pharmacogenomics
- Drug Interactions
- Adverse Drug Reactions (Allergy & Toxicity)
- Cummulation
- Factors modifying actions and doses of drugs
- Tolerance and Tachyphylaxis

B. DRUGS AFFECTING BLOOD

Course Objectives:

By the end of this module the students should be able to describe

- Oral and parenteral anticoagulants
- Haemostatics
- Antiplatelet and fibrinolytics drugs
- Fibrinolytics
- Management of Anaemia

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Drugs affecting blood coagulation
- Drugs therapy of Anaemias

C. TOXICOLOGY

Course Objectives:

By the end of this module the students should be able to describe

- Identify the clinically useful chelators and know their indications and adverse effects.

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Introduction of toxicology “occupational and environmental”
- Heavy metal intoxication and chelating agents
- Management of the poisoned patient

ADVANCE PHARMACOLOGY- I (PRACTICAL)

1. Preparation of various types of buffers and physiological salt solutions (PBS, HBSS, Tyrode's, Kreb’s Ringer and other laboratory solutions).
2. Preparation of stock solution and its dilutions.
3. Preparation of Molar, Molal and Normal solutions.
4. Introduction of dosage forms of drugs & calculation of doses on the basis of age, body weight & body surface area.
5. Calculation of Plasma half-life, AUC, Bioavailability, Volume of distribution (Vd), Clearance, Loading & maintenance dose.
6. Separation of serum and plasma from blood.
7. Dose response curves.

Recommended Books

- Katzung B.G. (2020). Basic and Clinical Pharmacology New York: McGraw-Hill Medical Publishers. 15th Edition
- Goodman Gillman (Nov, 2022). The Pharmacological basis of Therapeutics. New York: McGraw Hill Book Company. 14th Edition.
- Lipponcott (2022). Pharmacology. New York: Lippincot William & Willkin. 8th Edition.
- J D Tripathy (2018). Essential of Medical Pharmacology. New Delhi: Japees Brother. 8th Edition

2. PHARM- 702 Advance Pharmacology- II

A. AUTONOMIC PHARMACOLOGY

Course Objectives:

By the end of this module the students should be able to describe

- Steps in synthesis, storage, release and termination of action of major autonomic neuro-transmitters
- Major types of autonomic receptors
- Organ system effects of stimulation of para-sympathetic and sympathetic system.
- Effects of acetylcholine on major organs

- Clinical uses of cholinomimetic agonists
- Effects of atropine on major organs
- Sign, symptoms & treatment of atropine poisoning
- Major Clinical application of adrenoceptor agonists
- Clinical indications & toxicities of alpha & beta blockers

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Introduction to ANS
- Anatomy and general function of autonomic and somatic motor nervous systems
- Neurohumoral transmission
- Muscarinic receptor agonists, anticholinesterase agents, insecticides & Nerve gases
- Cholinesterase regenerators. Treatment of Myasthenia Gravis & Treatment of Glaucoma
- Parasympatholytic (Antimuscarinics)
- Agents acting at neuromuscular junctions and autonomic ganglia
- Sympathomimetic drugs (catecholamines and noncatecholamines) other adrenergic receptor agonists and indirectly acting sympathetic amines
- Adrenergic receptor blockers, adrenergic neuron blockers and Central sympatholytic

B. CARDIOVASCULAR PHARMACOLOGY

Course Objectives:

By the end of this module the students should be able to describe

- Major groups of anti-hypertensive drugs
- Strategies for relief of anginal pain
- Therapeutic and adverse effects of Nitrates, Beta-blockers & calcium channel blockers.
- Strategies in treatment of heart failure.
- Mechanism of digitalis toxic effects on heart.
- Major classes of anti-arrhythmic drugs

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Drug therapy of hypertension
- Drug therapy of Cardiac failure and Cardiomyopathies
- Drug therapy of Cardiac arrythmias
- Drug therapy of Coronary artery diseases (IHD, Angina & Myocardial Infarction)
- Drug therapy of Hyperlipedemias

C. RENAL PHARMACOLOGY (DIURETICS)

Course Objectives:

By the end of this module the students should be able to describe

- Describe formations of various body fluids and their imbalance
- Describe renal physiology
- List different diuretics and their clinical uses

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Carbonic-anhydrase inhibitors
- Loop diuretics
- Thiazide diuretics
- Potassium sparing diuretics
- Osmotic diuretics
- ADH antagonists

ADVANCE PHARMACOLOGY- II (PRACTICAL)

1. To demonstrate the effects of Acetylcholine & Atropine on isolated piece of rabbit's ileum.
2. To demonstrate the effects unknown drugs on rabbits' ileum.
3. To demonstrate the effect of Homatropine, Acetylcholine and adrenaline on rabbit eye.
4. To demonstrate the effect of unknown drugs on rabbit eye.
5. To demonstrate the effect of various drugs on frog/rabbit heart.
6. To demonstrate the effect of unknown drugs on frog/rabbit heart.

Recommended Books

- Katzung B.G. (2020). Basic and Clinical Pharmacology New York: McGraw-Hill Medical Publishers. 15th Edition
- Goodman Gillman (Nov, 2022). The Pharmacological basis of Therapeutics. New York: McGraw Hill Book Company. 14th Edition.
- Lipponcott (2022). Pharmacology. New York: Lippincot William & Willkin. 8th Edition.
- J D Tripathy (2018). Essential of Medical Pharmacology. New Delhi: Japees Brother. 8th Edition

3. PHARM- 703 Advance Pharmacology- III

A. CENTRAL NERVOUS SYSTEM PHARMACOLOGY

Course Objectives:

By the end of this module the students should be able to describe

- Major excitatory and inhibitory CNS neurotransmitters in CNS
- Difference between voltage–gated and ligand-gated ion channels
- Pharmacodynamics actions of major sedative–hypnotics in terms of their clinical uses and adverse effects.
- Drug of choice for partial seizures, generalized tonic- clonic seizures & myoclonic seizures.
- Distinctive toxicity of new anti-seizures drugs
- Blood–Gas partition co-efficient
- Minimum alveolar anaesthetic concentration
- Mechanism of action of local anaesthetics
- Toxic effects of local anaesthetics
- Difference between depolarizing and non-depolarizing blockers
- Therapeutic and toxic effects of major anti-parkinsonism agents

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.

2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Neurotransmitters in CNS and their receptors
- Pharmacotherapy of parkinsonism and other movement disorders
- Drug therapy of spasticity and acute muscle spasms
- Drugs effective in the therapy of epilepsies
- Drug therapy of anxiety (anxiolytics)
- Drug therapy of insomnia
- Drug therapy of behavior disorders and antipsychotics
- Drug therapy of affective disorders-Antidepressants, antimanics and drugs used in Bipolar
- Affective Disorders.
- Moods stabilizing Drugs
- Pre-Anaesthetic medication
- General anesthetics
- Local anesthetics
- Pharmacology of analgesic drugs (Opoids)
- Pharmacology of Alcohol
- Pharmacological rationale for the management of migrainous headaches and ergot alkaloids. Ø CNS Stimulants and psychotomimetics
- Pharmacotherapy of Appetite Disorders (Anorexia Nervosa and Bolemia Nervosa)
- Drug Dependence and Drug abuse

B. GASTRO-INTESTINAL PHARMACOLOGY

Course Objectives:

By the end of this module the students should be able to describe

- Identify different groups of drugs used in peptic ulcer disease.
- List different drugs used in emesis and their mechanism of action
- Identify commonly used anti-diarrheal drugs
- Identify commonly used in purgatives
- Describe the drugs used in management of inflammatory bowel disease

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.

2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Drugs used in acid-peptic disease & Gastro-esophageal Reflux Disease (GERD)
- Drugs affecting gastrointestinal motility
- Emetics & Anti-emetic agents
- Laxatives and purgatives
- Antispasmodics, antimotility agents and antidiarrhoeals
- Drugs used in the treatment of inflammatory bowel disease
- Drug therapy of irritable Bowel Syndrome (IBS)

C. RESPIRATORY PHARMACOLOGY

Course Objectives:

By the end of this module the students should be able to describe

- Major classes of drugs used in Asthma
- Strategies of drug treatment of Asthma
- Mechanism of action of drugs used in Asthma
- Role of Mucolytics

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Bronchodilators and drugs used for COPD
- Anti-tussives
- Expectorants

- Mucolytic agents
- Drug therapy of allergic Rhinitis & other allergic disorders

D. AUTACOIDS

Course Objectives:

- List the major organ system effects of histamine and serotonin
- Describe the Pharmacology of H1 anti-histamine drugs
- Describe the Pharmacology of H2 anti-histmine drugs
- Describe the Pharmacology of Serotonin agonists and antagonists and their major applications.
- List the major effects of prostaglandin and leukotrienes
- List the important site of synthesis and effects of thromboxone and prostacyclin in the vascular system.
- List the currently available therapeutic antagonists of leukotrienes and prostaglandins and their targets.
- Explain the different effects of aspirin on prostaglandin synthesis and on leukotriene synthesis

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Histamine & Anti-Histamines
- Serotonin, agonists & antagonists
- Prostaglandins, other Eicosanoids & Analogues
- Vasoactive Peptides

ADVANCE PHARMACOLOGY- III (PRACTICAL)

1. To study the effects of CNS depressant drugs in rat/mice/frog.
2. To study the effects of CNS stimulant drugs in rat/mice/frog.
3. To study the effects of unknown drugs on CNS of rat/mice/frog.
4. To determine the time required for the induction and recovery from anesthesia for various general anesthetics in rat/mice.
5. The study the effects of local anesthetics on rabbit's eye.

Recommended Books

- Katzung B.G. (2020). Basic and Clinical Pharmacology New York: McGraw-Hill Medical Publishers. 15th Edition
- Goodman Gillman (Nov, 2022). The Pharmacological basis of Therapeutics. New York: McGraw Hill Book Company. 14th Edition.
- Lipponcott (2022). Pharmacology. New York: Lippincot William & Willkin. 8th Edition.
- J D Tripathy (2018). Essential of Medical Pharmacology. New Delhi: Japees Brother. 8th Edition

4. PHARM- 704 Advance Pharmacology- IV

A. DRUGS USED IN INFECTIOUS, NEOPLASTIC DISEASES

Course Objectives:

By the end of this module the students should be able to describe

- Describe Mechanism of anti-bacterial action of beta lactam Antibiotics.
- Identify drugs in each subclass of penicillins
- List the major adverse effects of penicillins and cephalosporin.
- Describe Mechanism of action and clinical uses of aminoglysides, tetracyclines and chloramphenicol.
- List toxic effect of aminoglycosides, tetracyclines and chloramphenicol.
- Describe mechanism of action of folate antagonists and their adverse effects.
- Describe development of resistance against different antibiotics
- Describe mechanism of action, clinical uses and toxicity of Quinolones.
- Describe mechanism of action and uses of azoles and polyene antifungal drugs.
- Identify the main topical anti-fungal agents.
- Describe mechanism of action of anti-herpes drugs.
- Describe mechanism of action of anti-HIV drugs.
- Identify the drugs used against HBV and HCV.
- Identify major urinary antiseptics and their adverse effects.
- List various anti-mycobacterial drugs and their adverse effects
- Describe different regiments for tuberculosis.
- List different anti-amoebic drugs and their adverse effects.
- List various anti-malarial drugs.
- Explain life cycle of common parasites and drugs effective against nematodes.
- List drugs effective against trematodes, cestodes.
- Describe the cell cycle kinetics to the modes of actions and
- Clinical uses of anti-cancer drugs.

- Identify the major classes of Anti-cancer drugs, their mechanism of action and toxic effects.
- Understand the rationale underlying the strategies of combination drug chemotherapy
- List immunosuppressants their mechanism of action and use.

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Principles of Chemotherapy
- Empiric and rational therapy
- Sensitivity testing
- Bactericidal and Bacteriostatic action
- Spectrum of activity
- Choice of Anti-microbial Agent
- Problems with the use of Anti-biotics
- Prophylactic use of Anti-biotics
- Combination therapy
- Resistance to antibacterial, Biochemical mechanisms & how it spreads
- Drug Interactions& Incompatibilities of Antibacterials
- Factors affecting antibiotic dosage & route of administration
- Cell wall inhibitors: Pencillins, Cephalosporins & others
- Folate antagonists: Sulphonamides, Trimethoprim, Co-trimoxazole
- Protein synthesis inhibitors: Tetracyclines, Aminoglycosides, Chloramphenicol,
- Macrolides & miscellaneous
- Quinolones & Fluoroquinolones
- Urinary Antiseptics
- Antimycobacterial: Anti T.B. Drugs & Antileprosy Drugs
- Anti-Fungal Drugs: For systemic Infections & for Superficial Infections
- Different groups of drugs used in cancer chemotherapy, their mechanism of action, pharmacokinetics, indications, contraindications, adverse effects, toxicities and drug interactions
- Immunotherapy of cancer
- Immunoglobulins

- Immuno-modulators: Immuno-suppressants & Immuno-stimulants, T cell markers & receptor-potential use in immune modulation

B. PHARMACOLOGY OF RHEUMATIC DISEASE

Course Objectives:

By the end of this module the students should be able to describe

- Mechanism, adverse effete for the treatment of rheumatoid arthritis & gout
- Describe the Disease Modifying Anti-Rheumatic Drugs (DMARD) used in management of rheumatoid arthritis.

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- Non.steroidal anti-inflammatory drugs (NSAIDS) and Treatment of Rheumatiod Arthritis & Gout.
- Disease modifying anti rheumatic agents

C. ENDOCRINE PHARMACOLOGY

Course Objectives:

By the end of this module the students should be able to describe

- Identify major posterior pituary hormones and their effects
- Identify the drugs used for treatment of acromegaly & hyper
- Prolactinemia
- List and describe the principal drugs used in treatment of Hypothyroidism and hyperthyroidism.
- List several natural and synthetic glucocorticoids and their actions
- List the indications and contraindications of glucocorticoids
- Name estrogen and progestins, describe their actions uses and Toxicity.
- List the benefit and hazards of hormonal contraceptives and HRT
- List the types of insulin preparation, their actions and adverse Effects
- Describe major classes oral anti diabetic drugs
- List the agents used in treatment of hypercalcemia and osteoporosis

Learning Outcomes:

1- Graduates will be equipped with required up to date knowledge of their subject.
2- Graduates with improved teaching skills, proper subject understanding and high standards of professional ethics will be produced.
3- Regular practical and research work will help graduates to have access to modern equipment and techniques which will make them competent and skilled professionals to win good jobs.
4- Graduates will be able to produce high quality research with reliable research findings and will be able to supervise their students in future.

Course Outline:

- The role of endocrine system and its function
- Regulation and control of human endocrine system
- Mechanisms of hormonal control
- Drugs that modify the functions of adrenal gland
- Drugs that modify growth hormone functions
- Drugs that modify anterior pituitary hormone functions Ø Thyroid & Ant-thyroid Drugs
- Male sex hormones, anabolic steroids and inhibitors.
- Female sex hormones, contraceptives, ovulation inducing agents & Treatment of Infertility
- Corticosteroids & Antagonists
- Pharmacology of dopamine agonists and antagonists & treatment of hyperprolactinemia
- Labour inducing agents & drug therapy of postpartum hemorrhage
- Drugs that affect glucose metabolism and drug therapy of diabetes mellitus

ADVANCE PHARMACOLOGY- IV (PRACTICAL)

1. Cell culture and sensitivity testing.
2. Study of Different Laboratory Animals and Their Application.
3. Routes of Drug Administration to Laboratory Animals.
4. Effect of different Bronchodilators on rat Trachea.
5. Induction of allergic asthma in rats/mice.
6. Preparation of plants extracts by using different solvents (water, ethanol, methanol, acetone, n-butanol, chloroform. n-Hexane etc.)
7. Fractionation, purification and separation of compounds in plant extracts

Recommended Books

- Katzung B.G. (2020). Basic and Clinical Pharmacology New York: McGraw-Hill Medical Publishers. 15th Edition
- Goodman Gillman (Nov, 2022). The Pharmacological basis of Therapeutics. New York: McGraw Hill Book Company. 14th Edition.

- Lipponcott (2022). Pharmacology. New York: Lippincot William & Willkin. 8th Edition.
- J D Tripathy (2018). Essential of Medical Pharmacology. New Delhi: Japees Brother. 8th Edition

5. PHARM- 705 Molecular Pharmacology

Course Objectives:

On completion of this course students should:

- be able to describe the genomic regulation of drug action
- be able to discuss the molecular pharmacology of receptors, channels and enzymes
- have gained a knowledge of molecular biology techniques used in pharmacology
- be able to accurately record experimental data and draw conclusions from experimental data
- be able to demonstrate their ability to work in teams and communicate scientific information effectively

Learning Outcomes:

- To enhance the capabilities of graduates to utilize modern techniques efficiently and basic understanding of the underlying technology.
- Graduates will be able to produce high quality research with reliable research findings.

Course Outline:

- *Introduction to Molecular Pharmacology*: The impact molecular biology techniques have had on the study of pharmacology will be discussed. The role of molecular pharmacology in 21st century pharmacology will be explored
- *Genomic Regulation of Drug* Actions: Pharmacogenetics and Pharmacogenomics, The Regulation of Gene Transcription.
- '*Receptor-Ligand' Interactions and Protein Structure*: the non-covalent interactions underlying the molecular recognition between a protein ('receptor') and a small molecule ('ligand'), the relationships between affinity and specificity, enthalpy and entropy and these noncovalent interactions. Basics of protein structure, including the structure and properties of amino acid side chains and the four levels of protein architecture, primary through to quaternary structure. We will focus on the importance of non-covalent interactions in protein structure.
- *Molecular Pharmacology of Enzymes, Channels and Receptors*: How enzymes work, Drug modulation of enzyme function, Receptor enzymes, Voltage-gated ion channels, Ligand-gated ion channels, G-Protein coupled receptors (GPCRs), GPCRs: role of structural motifs.

- *Signal Transduction and Modulation*: Second messengers, Guanine nucleotide-binding proteins (G-proteins), Regulation of GPCR signalling, Receptor internalisation & alternative signalling pathways,
- *Receptor Theory*: Constitutively active receptors and inverse agonists, Allosteric modulators, Signalling-bias.
- *New concepts in Pharmacology*: the emerging concepts in receptor pharmacology that are currently being published and debated at scientific meetings, including heteromers, itopic ligands and signalling texture

Molecular pharmacology (Practical)

1. Drug induced changes of gene expression of transcription factors will be examined.
2. Tissue/cell culture, RNA isolation, RNA quantification, RT-PCR and gel electrophoresis.
3. Hands on training on qPCR.
4. Primer designing
5. *In vitro* activation and inhibition of receptors (for example PAR2 receptors)
6. The principal and procedure of western blot.

Recommended Books

Micheal R, Green and Joseph Sambrook, 2012, Molecular Cloning: A Laboratory Manual 4rth edition, Cold Spring Harbour, NY; Cold Spring Harbour Laboratory Press

6. EXRL- 701 Instruments & Animal use in research

Course Objectives:

After completing the course, the student should be able to:

- Identify and describe the national and international legislation which regulate the scientific use of animals
- Describe the authorisation that is needed before acting as a user, breeder or supplier of laboratory animals and especially the authorisation required for projects
- Indicate who bears primary responsibility for the animals undergoing procedures
- Describe the differing views within society concerning the scientific use of animals
- Identify ethical and animal welfare issues in their own work
- Demonstrate a comprehensive understanding of the principle of the 3Rs, list examples of how the 3Rs can be implemented in research projects and list sources of information related to the 3Rs
- Describe the basic biology of the relevant animal species, including basic anatomy, physiology, reproduction, and behaviour; and recognise the importance of attending to biological and behavioral needs

- Describe the environmental factors of importance for maintaining an appropriate health status for the animals, and how a laboratory animal facility is organized to maintain an appropriate health status and welfare of animals
- Describe the biological consequences of acclimatization, habituation and training
- Describe how genetically altered animals can be used for scientific research and the importance of monitoring such animals very carefully
- List potential human health hazards associated with contact with laboratory animals and describe how these can be prevented or reduced
- Describe abnormal behaviour and signs of discomfort, pain, suffering or distress
- Discuss methods available for assessing animal welfare
- Describe the principle of implementing early humane endpoints and how this implementation can influence animal health and welfare during the course of an experiment
- Define the term "humane killing" and list appropriate euthanasia methods for the relevant animal species
- Recognize that the choice of a euthanasia method may influence the scientific outcome
- Describe appropriate methods and principles for handling animals, and describe common techniques / procedures, including administration and sampling techniques
- Describe how to monitor the microbiological health of laboratory animals
- Describe the terms sedation, local anesthesia and general anesthesia
- Describe the components of pain physiology and list the types of analgesic drugs that are effective at the different components
- Describe how to do pre-operative, intraoperative and post-operative evaluation of research animals
- Describe different methods to optimize post anesthetic recovery
- Indicate some of the problems associated with pain recognition and pain management in animals

Learning Outcomes:

- To enhance the capabilities of graduates to utilize modern experimental research techniques efficiently and basic understanding of the underlying mechanism.
- Graduates will be able to produce high quality research with reliable research findings.

Course Outline:

- Legislation
- Ethics, animal welfare and 3R (levels 1 and 2)
- Health hazards
- Humane endpoints
- Severity classification
- Humane killing of animals
- Public administration and the course of events in animal experiments
- Species specific biology of laboratory animals

- Management of laboratory animals
- Handling
- Experimental conditions
- Pain and suffering
- Stress, biorythms and acclimatization
- Anesthesia Anesthesia and analgesia for minor and long-lasting procedures
- Basic surgery
- Health monitoring
- Euthanasia
- Microbiological qualities
- Genetically modified animal models
- Environmental factors that may influence animal experiments
- Assessment of pain
- Principles of minimally invasive procedures on animals
- Sample size calculation in animal models

Instruments & Animal use in research (Practical)

1. Enlist major advance instrumentation used in pharmacology research
2. Handle and restrain the rodent in order to safely administer the solution via gavage needle and through intraperitoneal route
3. Blood collection techniques from the saphenous and tail veins in mice/rats.
4. Compare various restraint equipment and techniques
5. Specialized technique to humanely euthanize a mouse
6. Identify different behavioural characteristics of mice, rats and rabbits

Recommended Books

- Sobti, R.C. ed., 2021. Advances in Animal Experimentation and Modeling: Understanding Life Phenomena. Elsevier.
- Nagarajan, P., Gudde, R. and Srinivasan, R. eds., 2021. Essentials of Laboratory Animal Science: Principles and Practices. Springer Singapore.
- Weichbrod, R.H., Thompson, G.A.H. and Norton, J.N. eds., 2017. Management of animal care and use programs in research, education, and testing.
- Monamy, V., 2017. Animal experimentation: A guide to the issues. Cambridge University Press.

7. RM- 701Research Methodology & Biostatistics

Research Methodology Course Objectives:

The major objective of Research Methodology in Pharmacological is to

- Understand a number of research methods useful for academic and professional investigations in experimental design focused on pharmacokinetics and pharmacodynamics which deals with the absorption, distribution, biotransformation and excretion of the drugs and its metabolites

from the body, along with the biochemical and physiological effect of the drug as well as its mechanism of action respectively.

- Enable the students to design new experiments after clear understanding of previous data to find lead molecules in pharmacology.
- Overview different approaches, considerations and challenges involved in experimental research in Pharmacology.
- Review core human research methods such an interview, ethnographies, surveys, and experiments. This course particularly provides necessary knowledge for students who are key personals of drug development.

Learning Outcomes:

- To enhance the capabilities of graduates to utilize modern research methodologies efficiently and basic understanding of the underlying mechanism.
- Graduates will be able to produce high quality research with reliable research findings.

Course Outline:

- Source of literature
- Literature survey
- Writing techniques
- Data analysis using statistical techniques
- Understand research articles
- Peer review journals
- Computer-Aided Drug Desig
- Molecular Docking and Structure-Based Virtual Screening
- Protein–Protein Docking in Drug Design and Discovery

Recommended Books

- Kothari, S. R ed., 2016. Research Methodology: Methods and Techniques. Oxford Book Co.
- Greenfield, T. and Greener, S. eds., 2016. Research methods for postgraduates. John Wiley & Sons.
- Gore, M. and Jagtap, U.B. eds., 2018. Computational drug discovery and design. Humana Press.

Biostatistics Course Objectives:

The objective of biostatistics is that after completing the course, the student should be able to:

- Provide a clear specification of the hypothesis to be tested.
- Include the parameters to be tested.
- Select and define the endpoints in clinical research.
- Understand and evaluate the results of health care studies

- Participate in medical research projects and communicate the results of bio statistical research to patients and other health care workers in ways that are easy for them to understand.
- After completion of this course, they will be able to design and evaluate their result.

Learning Outcomes:

- To enhance the capabilities of graduates to utilize modern biostatistical tools efficiently and basic understanding of the underlying mechanism.
- Graduates will be able to produce high quality research with reliable research findings.

Course Outline:

- Introduction
- Definition of biostatistics
- Application of statistics
- Basic principles of experimental design
- Types of design
- Test of Hypothesis and significance
- Student t test and "F" Distribution
- ANOVA test
- Chi square test

- Introduction: What is Biostatistics? Application of statistics in biological and pharmacological sciences.
- Sample and Population: Simple random sampling, Sampling distribution and standard error, Stratified random sampling, Systemic and cluster sampling. Test of Hypothesis and
- significance: Statistical hypothesis, Level of significance, Test of significance, Confidence intervals, Test involving binomial and normal distribution.
- Goodness of fit test: Chi-square distribution, it properties and application, Contingency tables, Test of homogeneity.
- Student "t" and "F" Distribution: Properties of "t" distribution and "F" distribution, Test of significance based on "t"-distribution and "F"-distribution.
- Analysis of variance: One-way classification, Partitioning of sum of squares and degree of freedom, Two-way classification, Multiple compression tests such as LSD, P-values, The analysis of variance models.
- Experimental Designs: (Advantages & Disadvantages) Basic principles of experimental designs, The completely randomized designs (CR-designs), Randomized complete block designs (RCB designs), Latin square designs (LS-designs), Factorial experimental designs, Computer methods of statistical evaluation, Corelation/regression analysis

Recommended Books

- Bryan Kestenbaum (2018). Epidemiology and Biostatistics Practice Problem Workbook. NY: Springer.
- Wayne W. Daniel, Chad L (2018). Cross. Biostatistics: A Foundation for Analysis in the Health Sciences

Course Title: Professional & Teaching Skills Apprenticeship (PTSA)

Credit Hours:02

Professional Skills Apprenticeship credit hours: 01

Teaching Skills Apprenticeship credit hours (CMT): 01

Professional Skills Apprenticeship:

- Following workshops

Serial No.	Workshop Name
1	DNA/RNA isolation/purification/Quantification
2	Preparation of cDNA
	Primer designing
3	PCR and its variants and Performance of Reverse Transcription Polymerase Chain Reaction (RT-PCR)
4	Real Time PCR (qPCR)
	Gel Electrophoresis
5	Statistical Analysis (Graph Pad Prism) How to perform One Way ANOVA through Graph Pad Prism, Post Hoc Tuckeys Test etc.) Gel Documentation (Image J) Semi Quantitative analysis/Densitometry analysis
6	Article writing skills, How to Publish Research Articles/Review paper

- Project/research Article writing and Submission

- Laboratory Safety and Protocols
- Introduction to relevant softwares
- Practical training in various laboratory techniques
- Proficiency in using laboratory equipment.
- Data collection and reporting
- Running small/Pilots scale projects
- Writing research project for funding
- Presenting research findings

Teaching Skills Apprenticeship

CMT® Certificate in Medical Teaching

All students of M Phil programme will get registered for the CMT Certification in the final semester. Completing the course work and successfully getting certified for CMT, which is a patent of UHS, will be a compulsory integral component of PTSA (Professional and Teaching Skills Apprenticeship) for the 4th semester of all M Phil programs at UHS.