Ph.D. Biochemistry/Biotechnology Coursework  
Paper I – Research Methodology

**Unit–I Scientific Research and Scientific Writing**

**Unit–II Biostatistics**
Collection and classification of data- diagrammatic and graphic representation of data. Measurement of central tendency-standard deviation-normal distribution-test of significance based on large samples-small samples. Student \( t \) test. Correlation and regression. Chi square test for independence of attributes. ANOVA.

**Unit–III Basic Concepts of Computers**
History of Computers, Concept of Computer hardware, Concept of Computer languages, Concept of Computer Software. Computer applications in Biology.

Spreadsheet tools: Introduction to spreadsheet applications, features, Using formulae and functions, Data storing, Features for Statistical data analysis, Generating charts/graph, and other features, Tools–Microsoft Excel or similar presentation tools: Introduction, features and functions, Power Point Presentation, Customizing and showing presentation. Use of Internet and WWW, Use of search engines.

**Unit–IV Bioethics and Patenting**
Declaration of Bologna. Ethics in animal experimentation. CPCSEA guidelines: Animal care and technical personnel environment, animal husbandry, feed, bedding, water, sanitation and cleanliness, water disposal, anesthesia and euthanasia.

**Unit–V Bioinformatics**

**Books recommended**
6. Ethics and the use of alternatives to animals in research and education. Shiranee Pereira, CPCSEA.
Ph.D. Biochemistry / Biotechnology Coursework

Paper II- Analytical Techniques

Unit–I Chromatography Techniques
Performance parameters (retention time, elution volume, capacity factor, plate height, and resolution).

Unit–II Microscopy and Cell culture techniques
Cell culture techniques: Equipment- hoods, CO₂ incubator. Safety considerations, aseptic techniques, eradication of infections. Animal cell cultures: primary cultures, cell lines, media and growth requirement, subcultures, cell quantification, cryopreservation, cell viability. Elementary details of bacterial and plant cell cultures.

Unit–III Immunochemical techniques

Unit–IV Electrophoretic and Spectroscopy techniques

Unit–V Molecular Biology Techniques

Books recommended
Ph.D. Biochemistry / Biotechnology Coursework

Paper III– Cell and Molecular Biology

Unit–I Intercellular communication, Cell cycle, and Cell death

Unit–II Cell Signaling

Unit–III Genome Complexity
Eukaryotic chromatin: nucleosomes, higher order chromatin structure.DNA sequence elements: unique sequence DNA, repetitive DNA- SINEs, LINEs, satellite, minisatellite and microsatellite DNA. C-value paradox. Gene families, pseudogenes (brief account).

Unit–IV Regulation of Gene Expression

Unit–V Nucleic acid-Protein Interactions and Protein folding

Text Books
Unit 1: Insulin-Blood glucose homeostasis and diabetes

Unit 2: Molecular mechanism of insulin action and regulation of metabolism
Insulin signaling pathways; Insulin receptor and its substrates, PI3K, Akt and downstream targets (GLUT, FOXO, GSK3β), Cbl pathway, Ras – Mitogen – activated protein kinase cascade; Turning off the insulin signal by PTP1B and serine kinases. Insulin resistance (IR) — definition; tissue sites of IR; defects in insulin signaling; genetic and acquired forms of IR; role of FFA and intracellular TG in IR, Role of cytokines secreted by adipose tissue — TNF–α, adiponectin, resistin, leptin, interleukin 6.

Unit 3: Pathogenesis of Diabetes
Type 1 Diabetes Mellitus: Genetic factors — HLA genes and molecules; Environmental agents — autoantigens, chemicals, viruses, bacteria, vaccination , perinatal factors, food components, stress; gut dysfunction and diabetes; Islet histology in type 1 diabetes, immune mechanisms of beta - cell destruction; Animal models for type 1 diabetes — alloxan, streptozotocin, other β-cell toxins, spontaneous type 1 diabetes – BB rats.
Type 2 Diabetes Mellitus: Obesity and Nutritional factors — epidemiology, body mass index, sympathetic nervous system activation- role of hypothalamus, insulin resistance, beta cell defects; Animal syndromes resembling type 2 diabetes — diabetic mice (db/db), desert rodents, sand rats and spiny mice, obese (ob/ob) mice – Diet induced type 2 diabetes.

Unit 4: Biochemistry and molecular cell biology of diabetic complications

Unit 5: Therapeutics
Medical nutrition therapy: Glycemic index of common foods; Recommended nutrient composition of diet in diabetes; Macronutrients and Micronutrients. Nutritive and non nutritive sweeteners. Pharmacotherapy: Antidiabetic agents, hypoglycemic agents, antihyperglycemic agents, Mode of action – Inhibitors of intestinal carbohydrate digestion and absorption (dietary fibre supplements, α glucosidase inhibitors), Rapid acting and long acting insulin analogues, Insulin secretagogues, Potentiators of insulin secretion (sulphonyl ureas, meglitinides, GLP-1, exendin 4 and DPP4 inhibitors), insulin mimetics (vanadium), insulin sensitizers (thiazolidinediones, metformin), lipid lowering agents, fatty acid oxidation inhibitors, soluble amylin analogues. Pancreas and islet transplantation. Stem cell therapy and gene therapy for diabetes (Elementary details).

References:
UNIT 1: Introduction to Cancer

UNIT 2: Carcinogenesis

UNIT 3: Genetic and Epigenetic Basis of Cancer

UNIT 4: Hallmarks of Cancer

UNIT 5: Tumour analysis and therapeutics

REFERENCES
5. Journal articles.
Unit 1 Blood flow and Vasculature
Circulatory System. Macro versus microvasculature, structure of blood vessels, pressure and peripheral vascular resistance, conducting versus resistant vessels, blood flow and endothelial function, endothelial heterogeneity, neuronal, endocrine and autocrine regulation of vessel tone, autocrine production by haemodynamic forces, cardiovascular response to exercise, vascular permeability and diapedesis.

Unit 2 Vasculogenesis and Angiogenesis
Vascular progenitors, concepts of sprouting and intussusceptive angiogenesis, vascular endothelial growth factors, pericytes and vessel maturation, integrins and extracellular matrices in angiogenesis, concepts in lymphangiogenesis, angiogenic and angiostatic factors, matrix metalloproteases in angiogenesis, hypoxia and angiogenesis.

Unit 3 Cardiac Physiology, Myocardial Infarction and Ischemia-reperfusion Injury
Anatomy of the heart, valves, physiology and functions. Cardiac cycle. Electrocardiogram, ion channels in cardiac function, gap junctions and conductivity.
Myocardial infarction-risk factors, etiology, metabolic abnormalities, animal models of MI.

Unit 4 Atherosclerosis and Hypertension
Atherosclerosis, causes, risk factors, atherosclerotic plaque, consequences, biochemical findings and treatment. Inflammation and atherosclerosis.

Unit 5 Drugs in the management of cardiovascular diseases
Antihypertensive drugs- Diuretics, ACE inhibitors, angiotensin receptor blockers, calcium channel blockers, β-adrenergic blockers, α-adrenergic blockers, central sympatholytics, vasodilators. Cardiac glycosides, Antiarrhythmic drugs, nitrates, anticoagulants, antiplatelets, fibrinolytics.

References
PH.D. BIOCHEMISTRY / BIOTECHNOLOGY SYLLABUS

Paper IV Chronobiology

Unit-I: Introduction
History of chronobiology, ubiquity of biological rhythms, types of biological rhythms, glossary of terms used in biological rhythm studies, fundamental properties of biological rhythms, selective advantages of biological rhythms in organisms, ultradian, infradian and circannual rhythms, measurement and analysis of rhythm data, cosinor analysis

Unit-II: Anatomy and physiology of circadian clocks
Anatomy and physiology of biological clocks, circadian pacemakers in various organisms, suprachiasmatic nuclei (SCN) – neuroanatomy and neurochemistry, pineal gland, afferent and efferent pathways of central biological clock, peripheral clocks, functional organization of circadian systems in eukaryotes

Unit-III: Chronoendocrinology
Endocrine rhythms in mammals, ultradian rhythms of hormones, normal rhythms of ACTH and alterations in disease states, 24h GH profile in men and women – alterations in disease states, 24h profile of prolactin in normal subjects – alterations in disease states. Diurnal and ultradian variations of leptin in normal subjects – alterations in obesity and weight loss, temporal pattern of release of prolactin and oxytocin, pineal gland and melatonin rhythm, diurnal and ultadian variations of glucose tolerance and insulin secretion, Abnormal circadian rhythms of adrenal hormones in Addison’s disease and Cushing’s syndrome

Unit-IV: Chronopharmacology and chronotherapy
Basics of chronopharmacology – clinical chronopharmacology – circadian dependence of drug pharmacokinetics – chronoefficacy of doxorubicin, oxaliplatin and cisplatin – chronopharmacokinetics of antineoplastic drugs, chronotolerance, circadian rhythms and cancer chemotherapy, cancer chronotherapy, chronobiological concepts underlying the chronotherapy of cancer, chronotherapy of metastatic colorectal cancer, the relevance of circadian rhythms in human health, jet lag, shift work, chronobiology of asthma, human blood pressure and sleep disorders

Unit-V: Molecular chronobiology
Circadian clock genes in Drosophila (per, tim, dbt, dclock and cycle), regulation of expression of clock genes, autoregulatory transcriptional feedback loops, basic actions and interactions among clock gene products, circadian clock controlled genes, circadian clock genes in mammals, autoregulatory transcriptional feedback loops of clock genes in mammals, autonomous functions of clock genes in peripheral tissues, circadian clock genes in humans.

Reference Books
2) R. Refinetti 2005 Circadian Physiology 2nd ed. CRC Press, Boca Raton, FL, USA
3) A. Sehgal 2004 Molecular biology of circadian rhythms Wiley-Liss, USA
4) J. C. Hall 2003 Genetics and molecular biology of rhythms in Drosophila and other insects Elsevier Science, USA
6) Touitou Y et al., 2006 Handbook of Medical Chronobiology Taylor and Francis
Unit-1


Unit-2:


Unit-3


Unit-4


Unit-5


References

Ph.D. Biochemistry/Biotechnology Coursework  
Paper IV- Neurobiology

Unit–I
Anatomy of the brain, major anatomical subdivisions of the human brain; the surface anatomy and interior structures of cortical and subcortical regions; anatomical connectivity among the various regions; development of brain, blood supply to brain and the CSF system, Cytoarchitecture and modular organization in the brain.

Unit–II
Basic features of the nervous system, meninges, ventricular system, CSF, blood brain barrier, peripheral nervous system: cranial nerves, spinal nerves, autonomous nervous system; major structures and functions, spinal cord.

Unit–III
Cells of the nervous system, structure of neurons-types and functions, neural conduction, communication between neurons, Synaptic conduction, Neurotransmitters: acetylcholine, glutamate, GABA, serotonin, dopamine and histamine, neuromodulators, and hormones. Sleep: biological functions of sleep, rhythms of sleeping (ultradian, circadian, infradian), neural basis of biological clocks

Unit–IV
Bipolar Disorder, Schizophrenia, Substance abuse disorders, Major affective disorders, Anxiety disorders, antipsychotic drugs and mood stabilizers.

Unit–V

References
2. Parkinson's Disease For Dummies. MicheleTagliati et al. 2011
3. Alzheimer Disease: From Clinical Description to a Theory of Disease and Treatment, Armenian Medical Network, 2011.
Ph.D. Biochemistry / Biotechnology Syllabus
Paper IV- TOXICOLOGY

Unit-I, Classes of Toxicants:
Metals, Agricultural chemicals (Pesticides), Food additives and Contaminants, Toxins,
Solvents, Therapeutic drugs of Abuse, Combustion products, Cosmetics
Toxicants: Air, Water, Soil, Domestic and Occupational settings

Unit-II, Absorption and Distribution of Toxicants
Routes of absorption, Mechanisms of Transport, Physicochemical properties relevant to
diffusion, Toxicant distribution, and Toxicokinetics.
Metabolism of Toxicants: Phase I Reactions and Phase II Reactions
Reactive Metabolites: Nature, Stability, Fate, Factors Affecting toxicity of reactive
metabolites, Reactive Oxygen Species.
Elimination of Toxicants: Renal, Hepatic, and Respiratory system

Unit-III, Acute and Chronic Toxicity
Acute and chronic exposure and its effect
No-observed-adverse-effect level (NOAEL), Lowest-observed-adverse-effect level (LOAEL),
Maximum tolerable concentration (MTC), Maximum tolerable dose (MTD), Median lethal
concentration (LC50), Median lethal dose (LD50), Median lethal time (LT50), Absolute lethal
concentration (LC100) and Absolute lethal dose (LD100).
Toxicity Testing Experimental Administration of Toxicants, Chemical and Physical
Properties Exposure and Environmental Fate, In Vivo Tests, In Vitro and Other Short-Term
Tests and Ecological Effects.

Unit-IV, Organ Toxicity
Hepatotoxicity- causes, mechanism of damage, diagnosis and treatment
Nephrotoxicity- types of toxicity, chronic interstitial nephritis and monitoring.
Neurotoxicity- neurotoxic agents, prognosis and treatment

Unit-V, Reproductive and endocrine toxicology
Developmental toxicity, endocrine disruptors, sites and mechanism of toxicity, adverse
structural and functional changes of glands
Respiratory toxicology- Biochemical and molecular mechanisms of inhaled environmental
and occupational chemicals-Pulmonary toxicity of metals and metal compound
Immune system- Immunosuppression or allergy, autoimmunity and inflammatory-based
disease or pathologies
Forensic and Clinical Toxicology-Samples used detection and classification.

Reference Books:
2. V.V. Pillay –Modern Medical Toxicology-2013-Jaypee Kindle edition
Ph.D. Biochemistry/ Biotechnology Course Work

Paper IV- Plant molecular biology and Abiotic stress

Unit- I

Molecular Biology: Basic concepts of Genome organization in Prokaryotic and Eukaryotic systems, Mitochondrial and chloroplast genome organization and regulation, Eukaryotic genome structure organization and replication, control of gene expression- transcription and post transcription mechanism, Epigenetics- DNA methylation, Histone acetylation and deacetylation, RNA Interference siRNA and miRNA.

Unit - II

Genetic Engineering: Plasmid cloning, Gene expression, Recombination mediated cloning, Infusion cloning, Golden gate assembly, Genome editing using CRISPR, Development of multi gene construct. Plant tissue culture, Genetic transformation, various types of gene transfer methods- Agrobacterium mediated gene transformation, Biolistics-mediated transformation, In planta transformation, floral dip method; double haploid technology.

Unit - III

Abiotic stress: Drought, Salinity, Temperature are major abiotic stresses- effects on plant cellular and physiological processes, Plant growth and development.

Unit - IV

Molecular mechanism for stress tolerance: Stress signal perception and transduction and regulation of gene expression, ABA as a stress signaling molecule, cytokinin as a negative signal, Oxidative stress-Reactive Oxygen Species (ROS), Regulation of protein synthesis and turn over under stress.

Unit - V

Plant adaptive mechanisms for improving stress tolerance: Drought avoidance and tolerance mechanism, Water Use Efficiency (WUE), Phenotyping methods for drought, Identify of stress responsive genes to improve tolerance mechanism, molecular markers, QTLs, Transgenic and molecular breeding, Stress adaptive mechanism for temperature and salinity stresses

TEXT BOOKS
UNIT- I

**Molecular Biology:** Basic concepts of Genome organization in Prokaryotic and Eukaryotic systems, Mitochondrial and chloroplast genome organization and regulation, Eukaryotic genome structure organization and replication, control of gene expression- transcription and post transcription mechanism, Epigenetics- DNA methylation, Histone acetylation and deacetylation, RNA Interference siRNA and miRNA.

UNIT –II

**Genetic Engineering:** Plasmid cloning, Gene expression, Recombination mediated cloning, Infusion cloning, Golden gate assembly, Genome editing using CRISPR, Development of multi gene construct. Plant tissue culture, Genetic transformation, various types of gene transfer methods- Agrobacterium mediated gene transformation, Biolistics mediated transformation, In-planta transformation, floral dip method; double haploid technology.

UNIT – III

**Abiotic stress:** Drought, Salinity, Temperature are major abiotic stresses- effects on plant cellular and physiological processes, Plant growth and development.

UNIT- IV

**Molecular mechanism for stress tolerance:** Stress signal perception and transduction and regulation of gene expression, ABA as a stress signaling molecule, cytokinin as a negative signal, Oxidative stress-Reactive Oxygen Species (ROS), Regulation of protein synthesis and turn over under stress.

UNIT- V

**Plant adaptive mechanisms for improving stress tolerance:** Drought avoidance and tolerance mechanism, Water Use Efficiency (WUE), Phenotyping methods for drought, Identify of stress responsive genes to improve tolerance mechanism, molecular markers, QTLS, Transgenic and molecular breeding, Stress adaptive mechanism for temperature and salinity stresses