DEPARTMENT OF BIOCHEMISTRY

UNIVERSITY OF KERALA

M. Phil. PROGRAMME IN BIOCHEMISTRY

SYLLABUS

(Under Credit and Semester systems w.e.f 2016 Admissions)

DEPARTMENT OF BIOCHEMISTRY

UNIVERSITY OF KERALA

M. Phil. Programme in Biochemistry

Syllabus

Programme Aim

The course aim to provide understanding of research methodologies, principles and applications of biological techniques and knowledge of various aspects of specialized areas in biochemistry.

Programme Objective

The objective of the course is to nurture students:

- Knowledge and awareness of analytical and statistical skills on various aspects of research in biochemistry.
- To make students aware on basic equipment and to expose them to various advanced laboratory techniques in the area of biochemistry and molecular biology.
- To make student able to build knowledge and understandings in aspects of enzymes, lifestyle diseases, phytochemical analysis , toxicological evaluation/ studies , as well as the basics of the research topics for laboratory work and research project.

Structure of the Programme

Semester No	Course code	Name of the Course	Number of credits
I	BCH 711	Research Methodology	4
	BCH 712	Advanced Biological Techniques	4
	BCH 713	Special Paper in Biochemistry	4
II	BCH 721	Dissertation	20
		TOTAL CREDITS	**32**

SYLLABUS FOR M. Phil. PROGRAMME IN BIOCHEMISTRY

Semester : I
Course Code : BCH-711
Course Title : RESEARCH METHODOLOGY
Credits : 4

Aim: The aim of this course is to make students aware of fundamentals of research and issues of ethics and plagiarism.

Objectives: To nurture analytical skills and awareness on various aspects of research in biochemistry.

Course Content

Module I - Foundations of Research

Definition, purpose - Relevance and scope, Motivation and objectives - Research methods *vs* Methodology. Types of research- pure versus applied, incremental versus innovative; multidisciplinary research.

Module II - Research Process and Design

Steps involved in research process; Identifying and defining research problems; Importance of literature review in defining a problem, Formulation of research objectives; Hypothesis, Research design- Meaning and need- induction - deduction. Features of good design- important concepts and different types; basic principles of experimental design.

Module III- Data Collection and Analysis

Observation and Collection of data - Methods of data collection – Sampling Methods- Data Processing and Analysis strategies – Measures of central tendency, standard deviation and standard error, ANOVA, Correlation, T test, Data Analysis with Statistical Packages, Bioinformatics tools (an outline)–Generalisation and interpretation of results.

Module IV - Scientific Reporting

Types of scientific reports – journal articles – Presentation at conferences- Thesis and dissertations – Books. Structure and components of scientific reports – Layout, Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication. Publication of scientific reports, Impact factor of

Journals, h-index, i10-Index, g-index.

Module V – Application of Results and Research Ethics

Commercialization – Copyright and Copyleft – royalty - Intellectual property rights and patent law – Ethical issues - Ethics in human and animal experimentation. Guidelines for using animals in biological research- The Prevention of Cruelty to Animals Act, India. Scientific misconduct such as Fabrication, Falsification, Plagiarism and Self-Plagiarism; software for checking plagiarism. Conflicts of interests; Citation and acknowledgement - Reproducibility and accountability.

References

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- Leedy, P.D. and Ormrod, J.E., 2004 *Practical Research: Planning and Design,* Prentice Hall.
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Semester : I
Course Code : BCH-712
Course Title : ADVANCED BIOLOGICAL TECHNIQUES
Credits : 4

Aim: The purpose of this course is to familiarize students with the principle and applications of all biochemical equipments.

Objectives: The objectives of this course are to make students aware on basic laboratory equipments and to expose them to various advanced laboratory techniques in areas of biochemistry and molecular biology.

Course Content

Module I: Techniques in Biochemistry

Centrifugation:- Principle; Types - Preparative, Analytical; Ultra centrifugation. Microscopy – Light microscopy, Bright field microscopy, phase contrast microscopy; Electron Microscopy – Transmission and Scanning electron microscopy; Confocal Microscopy; Fluorescent Microscopy; Preparation of samples for different microscopic techniques. Separation Techniques: Chromatography – Paper, TLC, HPTLC, Affinity, HPLC; Electrophoresis - Native PAGE, SDS PAGE, AGE, Blotting techniques, 2D-gel electrophoresis, Isoelectric focusing; Flow cytometry

Module II: Cell Culture

Principles of cell culture; Aseptic techniques, Sterilization, Equipment and materials, Media Preparation; Types of culture, primary culture - isolation and maintaining cells in culture, subculture; cell lines; Microbial contamination-monitoring and eradication. Cell quantitation-counting, DNA estimation, protein estimation. Estimation of cell viability by Trypan blue exclusion method and cytotoxicity by MTT assay, Cryopreservation of cells; Applications primary and cell line culture techniques

Module III : Techniques in Molecular Biology

Isolation, characterization and analysis of nucleic acids. DNA fingerprinting and PCR - Types of PCR. Primer designing. Cloning and Expression Vectors. Gene expression studies- Transformation and Transfection. Gene Library. Reporter genes in expression studies. Protein–nucleic acid interaction studies-Gel shift Assay, DNA footprinting, ChIP assay. Transgenic animals as research models- Knock out and Knock in of specific genes.

Module IV : Immunological and Histochemical Techniques

Production of antibodies; Immunoprecipitation techniques, Immunoassay – RIA, ELISA, Immunofluorescence. Histochemical Techniques – Enzyme histochemistry, Immunohistochemistry, *in situ* hybridization; staining – Basic, Acidic, Metachromasia (toluidine blue staining), Preparation of tissues – Fixation techniques, Tissue Sectioning, Smear and spread preparation; Freeze etching.

Module V: Spectrometry

Mass spectrometry – Working principle; types of ionizations, Mass analysers, Detectors; Tandem Mass spectrometry, Quadrupole and Time of Flight Mass spectrometry; MALDI-ToFIR and NMR spectrometry. {NMR, FTIR, HPLC, HPTLC, GCMS, LCMS, MSMS, Flow cytometry,

References

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- Rajan Katoch (2011) Analytical Techniques In Biochemistry And Molecular Biology. Springer -Verlag New York
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- R. Ian Freshney (2010) Culture of animal cells : A Manual of Basic Technique. Sixth edition. John Wiley & Sons
- Avinash Upadhyay, Kakoli Upadhyay, Nirmalendu Nath (2014) Biophysical Chemistry Principles & Techniques. Himalaya Publishing House

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- Mather, Jennie P., Roberts, Penelope E. (1998) Introduction to Cell and Tissue Culture: Theory and Techniques. Springer publications US
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- Marvin McMaster. (2005) LC/MS: A Practical User's Guide. Wiley Interscience.
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Semester : I
Course Code : BCH-713
Course Title : SPECIAL PAPER IN BIOCHEMISTRY
Credits : 4

Aim : The aim of this course is to make students aware of various aspects of biochemistry.

Objectives : This course enables students to acquire a specialized knowledge and understanding of the aspects of enzymes, life style diseases, phytochemical analysis, toxicological studies and the basics of their research topic which are essential for laboratory work and research project.

Course Content

Module I – Enzymology

Enzymes, Enzyme Kinetics, Mechanism of enzyme action, Enzyme inhibition, Isoenzymes and Coenzymes, Enzyme regulation.

Module II – Lifestyle Diseases

Oxidative stress, Free radicals and antioxidants. Pathogenesis, causes, risk factors, preventive measures and disease management of Atherosclerosis, Diabetes, Hypertension, Obesity, Cancer, Cataract and Arthritis. Interrelationship between lifestyle diseases and inflammation; inflammatory markers

Module III – Phytochemical Analysis

Plant secondary metabolites – types and structure of alkaloids, phenolic acids, tannins, lignins, flavonoid, terpenes; Extraction – traditional solvent extractions, supercritical fluid extraction, Isolation of secondary metabolites – Choice of solvents, Method of Fractionation; Bioactivity guided Isolation and Fractionation; Characterization of secondary metabolites – Qualitative and quantitative analysis

Module IV – Toxicological Studies

Toxicity - Factors that influence toxicity, Dose response relationships, synergism and antagonism, determination of ED50 & LD50, Toxicity testing - Acute, Chronic, and Sub-chronic toxicity test; Mutation studies – Ames test; Toxicity evaluation in cultured hepatocytes.

Module V : Optional Unit (Any one from the following)

a) Bacteremia and Acute Inflammation

Bacterial endotoxins: lipopolysaccharide (LPS) and lipoteichoic acid (LTA). LPS-biochemistry and signalling mechanism. LPS mediated acute inflammatory response. Signaling pathways of LPS mediated activity. Acute inflammatory mediators – macrophage

response. G-protein coupled receptors- structure and functional features. G-protein- types. Adenylate cyclase and cAMP mediated signalling. Adenosine Receptors: Role in extracellular signaling and cytokine cascasde. Common agonists and antagonists.

b) Nutrition in Health and Disease

Major nutrients- Macro and Micro nutrients. Biological value and dietary sources. Nutritional disorders – Pathogenesis, Biochemical changes and Managements. Dietary modifications for Obesity, Diabetes and Hypertension. RDA of micronutrients. Anti-nutritional factors of plant origin.

c) Phytohemagglutinins

Agglutinins, agglutination assay, Lectins: Animal and plant, Isolation, Purification and characterization of lectins, Biological properties of Lectins: Antitumor, Antibacterial, Antiviral, Antioxidant, Antilipidemic activities, Phytohemagglutinins- Sources, biological functions and applications in medical and research field.

d) Tissue Engineering and Biocomposites

Principle, definition and biomaterials used in tissue engineering, Definition for scaffolds and implants, biodegradable polymeric scaffolds, hydrogels, Bioceramics and biocomposites. Design, synthesis and applications of Biomaterials, Cell- Biomaterial Interaction; Biocompatibility. Applications of tissue engineering.

e) Nanoscience and Nanobiotechnology

Nanomaterials- Definition, Types- Carbon based, Metal based; Nanocomposites, Nano rods, Gold Nano rods; Polymeric nanocapsules, Nano-films, quantum dots; Classification based on dimension of nanomaterial; Synthesis of nanomaterial- Chemical, Physical and Green methods; Characterization methods of nanomaterials; Nanotoxicology

f) Inflammatory Diseases

Cells and organs of immune system, innate immunity, Phagocytosis, Complement system, Acute and chronic inflammatory reaction, Adaptive immunity – B cell, T cell activation, proliferation, differentiation, and effctor function. Lipid mediators, Cytokines, Cell adhesion molecules, MMPS, oxidative stress, Clinically important inflammatory biomarkers, Toll like receptors, Scavenger Receptors, nuclear Factor Kappa B, JAK/STAT, IRF, MAPK, Akt, RANKL, Molecular biology of Chronic Inflammatory Diseases

g) Cancer Biology

Neoplasia, causes of cancer, properties of cancer cells, classification of cancer, oncogenes and tumor suppressor genes, tumor markers, chemical carcinogenesis, physical carcinogenesis, viral carcinogenesis, cancer stem cells, diagnosis of cancer, current cancer treatment modalities, modern approaches in the treatment of cancer.

h) Cataract Biology

Structure of eye, Lens- structure and function, Lens fibers, Composition of lens, Lens proteins, Crystallins, Types of cataract- Nuclear cataract, cortical cataract, Symptoms and causes of cataract, Oxidative stress and cataract, Calcium and cataract, Lenticular antioxidants, Diabetic cataract, Treatment of cataract- phacoemulsification, extracapsular cataract extraction, intracapsular cataract extraction, complications of cataract surgery, Experimental models of cataract studies.

i) Diabetes

Diabetes Mellitus – classification, pathophysiology, glucose homeostasis, hormonal regulation of diabetes mellitus, insulin synthesis and secretion, insulin receptors, insulin signaling pathways, glucose transporters, insulin resistance. Metabolic changes in diabetes.

j) Extracellular Matrix Remodeling and Epigenetics

Cell-cell and cell matrix interaction, ECM remodeling enzymes –Matrix metalloproteinases (MMPS), A disintegrin and metalloproteinase with thrombospondin motifs(ADAMTS)-structure, function, regulation and role of these enzymes in atherosclerosis. Tissue inhibitors of metalloproteinases. Cell signaling, Role of NFκB, PPAR-γ

Epigenetics- Chromatin structure, DNA methylation, Histone modifications, acetylation/ deacetylation, methylation/ demethylation, phosphorylation/dephosphorylation, enzymes involved and mechanism. Epigenetics in atherosclerosis and inflammation.

References

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- A. Pusztai (2012) Chemistry and Pharmacology of Natural Products, Cambridge University Press
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- Suzanne Craft Diabetes, Insulin and Alzheimer's disease (Research and Perspectives in Alzheimer's Disease) 2010th Edition, Springer Publications.

Semester : II
Course Code : BCH-721
Course Title : DISSERTATION
Credits : 20

Aim : The aim of this course is to expose students to different aspects of research methodology, molecular and biochemical research and data analysis.

Objectives : The primary objective of a dissertation work is to act as an introduction to biological research and its various aspects. Students shall carry out a research project specific to individual laboratory of the supervision teacher they are assigned with.