St. Xavier's College (Autonomous), Ahmedabad-9

MSc. Biochemistry
(Syllabus)
(Effective 2020-2023)

Programme Outcomes

PO1. Create a strong knowledge domain

PO2. Develop critical thinking, Problem solving and research aptitude

PO3. Skill development

PO4. Encouraging social interaction, service learning and develop equity centred national development (Social Extension work)

PO5. Self-directed and lifelong learning

PO6. Developing employability and entrepreneurial skills

PO7. Promoting Ecological sustainability development

PO8. Nurturing creativity and humane values

Programme Specific Outcomes for MSc Biochemistry

PSO1 An in depth understanding of molecular processes that enable proper functioning of various systems like division, defence, circulation, respiration etc of a living system, be it animal system, plant system, or microbial system.

PSO2 A skill set that enables independent working in a laboratory with ability to design experiments, analyze and interpret data, thereby, enhancing research aptitude

PSO3 Access research/review articles and understand critical aspects of concepts.

PSO4 Proficiency in communication (Spoken and written) and discussion of scientific literature.

PSO5 Comprehend the etiology, epidemiology, nutritional interventions and therapeutics of diseases/ disorders prevalent in humans, plants, animals and thereby play a pivotal role in social awareness of the same.

St. Xavier's College (Autonomous), Ahmedabad
MSc. Biochemistry
Semester I

Semester	Course		No. of hours per week			Course Credit
I			Lectures	Lab sessions	Total	
	PBC 1801	Proteins: Structure, synthesis and working	4		4	4
	PBC 1802	Nucleic acids	4		4	4
	PBC 1803	Carbohydrates And Lipids	4		4	4
	PBC 1804	Techniques in Biochemistry	4		4	4
	PBC 1805L	Practical Biochemistry -I		6	6	4
	PBC 1806L	Practical Biochemistry - II		6	6	4
		Total	**16**	**12**	**28**	**24**

Note: An average of 15 lectures per unit and a total of 60 hours per paper.

CORE Paper: Protein: Structure, Synthesis and Working
Course Code: PBC1801
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

By the end of the paper, a student should be able to:

CO1: To describe the structure of protein and correlate with its functions such as like molecular motors, interaction, carriers, signalling, repair and structure

CO2: To describe the synthesis of protein, its sorting and degradation

CO3: To understand and interpret the original experiments carried out to propose structure and functioning of various proteins

CO4: Ability to interpret Ramachandran plot and explaining proteins structure using bioinformatics tool

CO5: To explain techniques used in understanding the working of the proteins

CO6: To appreciate the importance of proper folding of proteins and relate to health, agriculture, and environmental issues arising from its expression.

Thus, the knowledge from this course can help in the following:

a. The students could pursue a career in Biochemistry as maintaining levels of these biomolecules in the body are of utmost importance.
b. The students can carry out basic and advanced research in Biochemistry, which in turn can be of great help in the agriculture, medical and diagnostic fields.
c. Basic knowledge of biochemistry is also required for Nutrition and Dietetics.
d. The understanding of proteins, its study, has opened up the field of Proteomics.

Unit-1: Proteins: structure and functions
Amino acids: classifications. Naturally occurring peptides –glutathione, peptide hormones, peptide antibiotics, receptors, cyclosporin. Primary, secondary, tertiary (*motifs and domains*), and quaternary structure of proteins, Ramchandran Plot, subunit interactions, coiled coil structures, symmetry and functional properties-haemoglobin; Evolution of proteins. Bioinformatics as a tool to understand protein structure and function

Unit-2: Protein synthesis
Eukaryotic translation machinery, structure and assembly of the ribosome, Synthesis of proteins, Molecular Chaperones, Protein folding- role of chaperones; Protein modifications: structure – function relation.

Unit-3: Protein sorting and degradation

Intracellular protein sorting, movement of proteins between cellular compartments: gated, transmembrane and vesicular transport. Protein transport and translocation to nucleus, mitochondria, chloroplast, peroxisomes, endoplasmic reticular system. Protein degradation, TAG protein destruction, SUMO.

Unit-4: Working of proteins

Working of proteins: as molecular motors, as structural molecules, in cell – cell interactions and recognition, as carriers, in transmitting signals, in catalysis; in repair systems; Proteins as multi enzyme complexes; single molecular dynamism (*molecular simulation)*

Suggested References

1. Modern Protein Chemistry: Practical Aspects Published: September 12, 2001 by CRC Press - 272 Pages Edited By: Gary C. Howard
2. Biochemistry. 7th edition. Berg JM, Tymoczko JL, Stryer L. New York: W H Freeman; 2014
3. Proteins: Structures and Molecular Properties: Thomas E. Creighton Publisher: W. H. Freeman 1992 Edition: Second Edition
4. Protein Engineering Protocols (Methods in Molecular Biology) Kristian Müller (Editor), Publisher: Humana Press; Softcover reprint of hardcover 1st ed. 2007 edition (November 10, 2010)
5. Protein Degradation Series, 4 Volume Set (v. 1) R. John Mayer (Editor), Publisher: Wiley-VCH; 1 edition (March 4, 2008)
6. Structural Aspects of Protein Synthesis Anders Liljas (Author) Publisher: World Scientific Pub Co Inc; 1 edition (November 2004)
7. Protein Targeting, Transport, and Translocation Ross Dalbey (Editor), Publisher: Academic Press; 1 edition (May 13, 2002).
8. How Proteins Work Mike Williamson, Publisher: Garland Science, 2012.

CORE Paper: Nucleic Acids: Structure and Working
Course Code: PBC1802
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

By the end of the paper, a student should be able to:

CO 1: To explain the synthesis, breakdown of nucleic acids and role of inhibitors which has applications in medical field.
CO 2: To demonstrate the existence of various forms of nucleic acids and its relevance and to comprehend that the modern concepts of DNA structure beyond what Watson – Crick proposed.
CO 3: To analyze how topological changes and condensation of DNA influences gene expressions
CO 3: To explain the concept of RNA interference and its applications in various fields
CO 4: To describe and interpret experimental result arising from various DNA based studies
CO 5: To apply the concepts of regulation of gene expression as a tool in research and industry
CO 6: To assess how genetic complexity is associated with repetitive sequences and gene duplications.

Unit-1: Bases of Nucleic acids

Synthesis of purine and pyrimidine – de novo and salvage pathways. Synthesis of deoxy and oxy-ribonucleotides, various functions of Nucleotides, Nucleotide degradation- catabolism of purines and pyrimidines. Disorders in purine and pyrimidine metabolism, Inhibitors of nucleotide synthesis and their role in chemotherapy.

Unit-2: Nucleic acid Basic structure

Nucleic acids, correlating structure with functions, Hoogstein base pairing and its implications; Assembly of DNA into chromosomes, structure and function of centromeres and telomeres, packing and functions, importance of topological changes, chromatin and its remodeling, DNA super coiling, DNA-protein interactions, Cp and Mt DNA

Unit-3: RNA and interference

RNA, various forms, 3D structure, secondary and tertiary structure and significance, role of metals in folding of RNA; RNA as enzymes; evolutionary tree construction, RNA interference in plants, animals, and its applications

Unit-4: Working of DNA

Gene expression and regulations, molecular mechanism of regulation, operon model, lac, trp, arabinose operons, repression and attenuation, eukaryotes - C value paradox, repetitive DNA, gene dosage and gene amplifications.

References

1. Nelson and Cox (2012) : Principles of Biochemistry (Worth Publ. Inc. USA)

2. Rawn, J.D. (1989) : Biochemistry (Neil Patterson Publ. North Carolina)
3. Biochemistry. 7th edition. Berg JM, Tymoczko JL, Stryer L. New York: W H Freeman; 2014
4. Voet, D. and Voet, J.G. (2012) : Biochemistry (John Wiley & Sons Inc/, New York)
5. Genes IX: Benjamin Lewin (2015); Jones and Bartlett Publishers
6. Watson J et al, Molecular Biology of the gene, Edition 7, 2013; Benjamin Cummings
7. David Friefelder. Essentials of Molecular Biology. 4th Edition. Jones and Bartlett Publishers
8. Bruce Alberts *et.al*. Molecular Biology of the Cell. 4th Edition. Garland Science
9. Lodish et al. Molecular Cell Biology. 4th Edition. W. H. Freeman and Company.

CORE Paper: Carbohydrates and Lipids
Course Code: PBC1803
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

At the end of course students will be able to:

CO 1: To identify biological importance of carbohydrates and lipids

CO 2: To distinguish between anabolic and catabolic processes of carbohydrates and lipids

CO 3: Compare and contrast metabolic pathway of complex carbohydrates in different living system

CO 4: To elucidate the role of lipids in maintaining homeostasis at cellular and systemic level

CO 5: To recognize and explain the contribution of lipid biochemistry in understanding the development of certain human diseases such as Niemen-peck disease, Tay-Sachs syndrome, hypercholesterolemia etc.

Thus, the knowledge from this course can help in the following:

a. Understanding the metabolic disorders and developing sensitivity
b. Many of the carbohydrates, proteins and lipids discussed have commercial value and thus, find a place in Industrial Biotechnology.

II. Course Content

Unit-1: Carbohydrates: Structure – function relation

Structure and physiological functions of mono and oligosaccharides, Polysaccharides: starch, glycogen, cellulose, dextrin, inulin, chitosan, cellulose and hemicelluloses derivatives; Structure – function relationship and properties of heteroglycans, agar, alginic acid (seaweed polysaccharides), pectins, glycosaminoglycans (mucopolysaccharides) and glycocalyx oligosaccharides

Unit-2: Carbohydrate Metabolism

Metabolism and regulation of carbohydrates, glycolysis, alternate pathways, feeder pathways, glycogen metabolism Cell surface carbohydrates, L and P Selectins, advances in glycobiology; glycans in medicine. Glycomics

Unit-3: Lipid Metabolism

Utilization of fatty acids for energy production, alpha, beta and gamma oxidation of fatty acids. Integration and control of animal acylglycerol metabolism. Biosynthesis of fatty acids, Fatty acid desaturase and elongase. Biosynthesis of eicosanoids and its biological importance, prostaglandins, prostacyclins, thromboxanes. Formation of ketone bodies.

Unit 4: Compound and derived Lipid Metabolism

Biosynthesis of phospholipids and their biological functions, Biosynthesis of cholesterol, its regulation and excretion, surfactants, Lipoprotein metabolism; bile acids. Waxes: structure, different types, synthesis and functions (egs. microbial waxes, plant waxes, insect waxes and mammalian waxes).

Reference

1. Bohinski, R.C.(1987): Modern concepts in Biochemistry (Allyn & Bascon Inc. Boston)
2. Caret et al.(2013): Inorganic, Organic and Biological Chemistry (WMC Brown Publ.USA)
3. Nelson and Cox (2012) : Principles of Biochemistry (Worth Publ. Inc. USA)
4. Montgomery, R. et al (1990): Biochemistry: A case Oriented Approach (The C.V. Mosby Co., St. Louis)
5. Rawn, J.D. (1989) : Biochemistry (Neil Patterson Publ. North Carolina)
6. Biochemistry. 7th edition. Berg JM, Tymoczko JL, Stryer L. New York: W H Freeman; 2014
7. Voet, D. and Voet, J.G. (2012) : Biochemistry (John Wiley & Sons Inc/, New York)
8. Bhagwan N V, Medical biochemistry, 4th Edition, Bartlet and Jones
9. Gurr, M.I. et al (2016): Lipids: Biochemistry, Biotechnology and Health, 6th Edition, Wiley-Blackwell.
10. Ajit Varki, et al (2017): Essentials of Glycobiology, 3rd Edition, CSH Press

CORE Paper: Techniques in Biochemistry
Course Code: PBC 1804
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

At the end of course students will be able to.

CO 1: To describe the various centrifugal techniques used for fractionation of cells, cell organelles and bio-molecules.

CO 2: Apply the techniques of chromatography and electrophoresis to separate bio-molecules.

CO 3: Explain individual components of different instruments.

CO 4: Define the principles of various spectroscopic techniques used for characterization of bio-molecules.

CO 5: Implement the theoretical knowledge gained experimentally all the analytical techniques for characterization of bio-molecules.

Thus, the knowledge from this course can help in the following:

a. The students could pursue a career in industries that specialize in Instrumentation specifically for Life Science Research and Analysis
b. Avail jobs in Production, Quality Control and Research and Development divisions of Pharmaceutical and Biotech companies.
c. Explore possibility of using these techniques in future research
d. Start up companies supplying basic instruments like colorimeters, Electrophoresis, pH meters, etc.

II. Course Content

Unit-1: **Methods employed for separation: Centrifugation**
Preparative ultracentrifugation - differential centrifugation and density gradient centrifugation. Analytical centrifugation -Schlieren optical system - applications - determination of molecular mass and purity of macromolecules, characterization and molecular weight determination of macromolecules,

Unit-2: Electrophoresis
Migration of Ions in an electric field, factors affecting mobility, types of electrophoresis-Free and Zonal, General techniques of zonal electrophoresis, Specialized electrophoretic techniques-DISC, Gradient, High Voltage Electrophoresis, Isoelectric focusing, 2D electrophoresis, Immunoelectrophoresis, Pulse Field Gel Electrophoresis, Di-electrophoresis, Capillary electrophoresis.

Unit-3: Chromatography
Chromatographic techniques - General principles of partition and adsorption chromatography. Thin layer, column, ion - exchange, molecular exclusion, gas - liquid and HPLC,normal phase, reverse phase, chromatofocusing, immune affinity, capillary electrochromatography.

Unit-4: Characterization of macromolecules: Spectrophotometric techniques

UV – Visisble Spectroscopy, Infra-red (IR) Spectroscopy, Electron Spin Resonance (ESR), Nuclear Magnetic Resonance (NMR) and Fluorescence Spectrophotometry, Rayleigh and Raman Scattering, Mass spectroscopy (GC/LC – MS)

References:

1. Kensl. E. van Holde, W. Curtis Johnson, P. Shing Ho., Principles of Physical Biochemistry-Pearson Prentice Hall, 2nd Edition.
2. G. Rhodes., Crystallography made crystal clear, 1993. Academic Press.
3. Wilson Keith and Walker John., Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition, (2005), Cambridge University Press, New York.
4. R. R. Bergethon (2010) the Physical Basis of Biochemistry: The Foundations of Molecular Biophysics, 2nd Ed., Springer, and NY.
5. P. J. Walla (2009) Modern Biophysical Chemistry, Wiley-VCH.
6. D. Sheeham (2009) Physical Biochemistry 2nd Ed., Wiley-Blackwell.
7. J. A. Goodrich and J. F. Kugel (2006) Binding and Kinetics for Molecular Biologists. Cold Spring Harbor Press.
8. van Holde, K. E. (1998) Principles of Physical Biochemistry, Prentice Hall.
9. Freifelder, D., 1982, Physical biochemistry: applications to biochemistry and molecular biology
10. Galen Wood Ewing Instrumental Methods of Chemical Analysis McGraw-Hill College; Fifth edition (1985).
11. Robert D. Braun, Introduction to Instrumental Analysis Pharma Book Syndicate (2006)
12. Sambrook, Manniatis, 3rd Edition, Cold Spring Harbor.

Practical Paper: Practical Biochemistry - I
Course Code: PBC1805L
No. of Credits: 04
Learning Hours: 90 hrs

I. Course Outcome

By the end of the paper, a student should be able to:

CO 1: To explain techniques used in understanding biomolecules

CO 2: Ability to isolate and estimate various biomolecules

CO3: To learn to interpret the results

1. Estimation of glucose by glucose oxidase method/ anthrone method.
2. Estimation of liver glycogen.
3. Estimation of glucosamine
4. Estimation of total mucopolysaccharides.
5. Extraction of DNA from liver/ yeast/plants
6. Extraction of RNA from liver/ yeast/plants
7. Isolation of NAD from brewer's yeast
8. Extraction, separation and determination of absorption spectra of plant pigments
9. Isolation and estimation of serum cholesterol
10. Isolation of lecithin from egg yolk.

Practical Paper: Practical Biochemistry - II
Course Code: PBC1806L
No. of Credits: 04
Learning Hours: 90 hrs

I. Course Outcome

By the end of the paper, a student should be able to:

CO 1: To explain techniques used in understanding the nature of proteins and nucleic acids

CO 2: Ability to isolate and estimate various biomolecules

CO3: To learn to interpret the results

CO 4: Apply the techniques of chromatography and electrophoresis to separate bio-molecules.
CO 5: To explain individual components of different instruments.

1. Denaturation of DNA and UV absorption studies. (Demonstration).
2. Determination of N- and C-terminal amino acids (Demonstration).
3. Determination of protein by Lowry's method.
4. Separation of amino acids sugars and lipids by thin layer chromatography.
5. Separation of plant pigments by column chromatography.
6. Separation of serum proteins by PAGE.
7. Estimation of protein by a) BCA and b) Bradford methods.
8. Separation, identification and estimation of lipids by TLC.
9. Separation, identification and estimation of free amino acids.
10. Assessment of purity of DNA by 260/280 ratio
11. Off site visit to institutions/industries (Demonstration of Instruments)

References:

1. Introduction to Practical Biochemistry. Plummer D, Plummer M. Tata McGraw Hill Publications
2. Practical Textbook of Biochemistry for Medical Students. Vasudevan DM etal. 2nd Edition, 2013. Jaypee Brothers publishers.

Semester II

Semester	Course		No. of hours per week			Course Credit
II			Lectures	Lab sessions	Total	
	PBC 2801	Cell Biology	4		4	4
	PBC 2802	Enzymes: Structure to Function	4		4	4
	PBC 2803	Immunology	4		4	4
	PBC 2804	Neurobiology	4		4	4
	PBC 2805L	Enzymology Lab		6	6	4
	PBC 2806L	Cell biology and Immunology Lab		6	6	4
		Total	**16**	**12**	**28**	**24**

Note: An average of 15 lectures per unit and a total of 60 hours per paper.

CORE Paper: Cell Biology
Course Code: PBC 2801
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

At the end of course students will be able to...

CO 1: To describe the molecules of life and conserved structures; recount how the working of the cell was discovered through model organisms

CO 2: To be able to recognize and identify the importance and functions of cell membrane

CO 3: To develop capacity to distinguish signalling pathways for regulation of various cellular mechanisms

CO 4: To be able to explain mechanism of development across species

CO 5: To evaluate the use of various model organisms to relate the development of vertebrates

Thus, the knowledge from this course can help in the following:

a. To develop a critical mindset to understand the origin of life on earth, and appreciate the concept and value of evolution
b. Understand the basics of hormonal mechanism in the body

II. Course Content

Unit-1: Cells and evolution

The molecules of life: DNA, RNA, ATP, proteins, water, phospholipids with emphasis on why each was chosen as the building block.

How working of cell was discovered: Common experimental organisms and role of each to understand the functioning of a cell; Viruses to understand molecular cell biology; bacteria to understand fundamental functions of cell; yeast for cell cycle study, mice for study of human disease.

Evolutionary evidences of common ancestor - Helical motifs across various molecules like DNA, alpha-helix to microtubules; Conserved enzymes and primer sequences.

Unit-2: The cell boundary

Overview of membrane structure: Membrane lipids, membrane proteins and glycocalyx; Physical and chemical parameters that affect membrane fluidity; Membrane rafts; Lipid movement – ABC proteins; Gated and non-gated channels; Uniporters, Symporters and antiporters; Role of cytoskeleton in maintaining cell membrane.

Role of membrane in energy generation: Role of membrane in electron transport chain; Bacteriorhodopsin; ATP generation; the structure of F0-F1 complex, its assembly, movement of ATP synthase and production of ATP; The importance of proton motive force emphasizing the importance of membrane.

Unit-3: Regulatory molecules of the cell

Introduction to signal transduction. How signal reaches from extracellular to intracellular response. The role of signaling molecules, receptors, G-protein coupled receptors-Structure and mechanism; secondary messengers- amplifiers, GTP-binding protein-ON/OFF switch. Why protein kinases and phosphatases are mostly involved in regulation.
Tyrosine kinases- role in cell division, epidermal growth factor, cytokines mediate through it. JAK/STAT pathway.

Ras/MAP kinase pathway: Down regulate the JAK/STAT pathway, regulates GTPase switch proteins, SOS binding and Scaffold proteins in eukaryotic cells.

Regulation by altering the protein structure - Acylation, nucleotidation, Ubiquitination, Notch/Delta pathway.

Unit-4: Cells to multicellular organisms

Germ cells and fertilization; Cellular Mechanisms of development; Morphogenetic movements and the shaping of the body plan; Differentiated cells and the maintenance of tissues; Cell diversification in the early embryo; Cell memory, cell determination and concept of positional values; Developmental control genes and the rules of cell behavior (nematodes/ C. elegans); Genesis of the body plan and homeotic selector genes and the patterning of body parts in Drosophila Early development of Drosophila: cleavage and mid blastula transition, Gastrulation, genetic mechanism of patterning, Maternal effect genes, Segmentation, Para segmentation and genes involved in it. Role of homeotic sector gene*s;* neural development.

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References

1. Molecular cell Biology: Lodish, Berk, Kaiser, Krieger et al. 8th ed, WH Freeman, 2016
2. Molecular Biology of the Cell The problems Book (6ed): John Wilson and Tim Hunt
3. The Cell: Bruce Alberts, Alexander Johnson, Julian Lewis (2015) 5th ed, 2008, Garland Science
4. The Cell: A molecular approach (7ed) Geoffrey Cooper and Robert Hausman
5. World of the Cell (8ed): Jeff Hardin and Gregory Paul Bertini
6. Cell and Molecular Biology: Concepts and Experiments (7ed): Gerald Karp.

CORE Paper: Enzymes: Structure to function
Course Code: PBC 2802
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

By the end of the paper, a student should be able to:

CO1: To describe the different models of enzyme catalysis and the mechanisms for its assessment
CO2: To explain various methods for identifying active site residues
CO3: To illustrate the several methods for the enzyme regulation
CO4: To appreciate the applicability of enzymology in various industries for growth and sustainability
CO5: To develop skill for analyzing kinetic data of enzyme substrate reaction

Thus, the knowledge from this course can help in the following:

a. To develop a critical mindset to understand the mechanism of enzyme action and develop broader mindset on change!
b. Understand the usefulness of enzymes in industry and motivate to initiate start ups

Unit-1: How enzymes work

Acid-base catalysis, covalent catalysis, proximity, orientation effect, role of metal ion in enzyme catalysis. Strain & distortion theory. Measurement of enzyme activity - two point assay, kinetic assay, using radiolabelled substrates. Determination of active site amino acids - chemical probe, affinity label, and site-directed mutagenesis, intrinsic and extrinsic regulations. Investigation of 3-D structure of active site. Mechanism of action of lysozyme, carboxypeptidase, serine proteases, nitrogenases and examples from other classes of enzymes.

Unit-2: Enzyme regulation

General mechanisms of enzyme regulation, Different plots for the determination of K_m & V_{max} and their physiological significances, product inhibition. Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) inhibition; Competitive, non-competitive, uncompetitive, linear-mixed type inhibitions and their kinetics, determination of Ki and numerical based on these. Importance of Kcat/Km; Suicide inhibitors; Covalent modifications of enzymes. Mono cyclic and multicyclic cascade systems with specific examples; feed forward stimulation. Allosteric enzymes, its physiological significance, qualitative description of "concerted" & "sequential" models for allosteric enzymes, Co-operatively phenomenon, MWC and KNF models. Half site reactivity, Flip-flop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamoylase & phosphofructokinase.

Unit-3: Kinetics and drug designs for enzymes

Use of initial velocity, Review of unisubstrate enzyme kinetics, multisubstrate enzyme kinetics, Protein-ligand binding and its measurement, Hill and Scatchard plots, analysis of binding

isotherms, inhibition and exchange studies to differentiate between multi substrate reaction mechanism, Drug discovery, delivery and mechanism of action, specific emphasis on designing of drugs which can block the action of an enzyme or can activate it, catalytic antibodies, Ribozymes and DNAzymes, methods to improve biocatalysts, Pathway engineering

Unit-4: Industrial and clinical uses of enzymes

Industrial uses of enzymes - sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production. Immobilized enzymes: methods, kinetics and their industrial applications.

Clinical enzymology - Enzymes as thrombolytic agents (tissue plasminogen activator), anti-inflammatory agents, digestive aids. Enzymes and isoenzymes in diagnosis – Lactate Dehydrogenases, Creatine Kinases, transaminases, phosphatases.

References:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry-Trevor Palmer
2. Principles of Biochemistry- Lehninger, David L. Nelson and Michael M. Cox
3. Biochemistry-Donald Voet, Judith G. Voet
4. Fundamentals of Enzyme Kinetics: Athel Cornish and Bowden, Portland Press, 2004
5. Understanding the control of metabolism: David Fell, Portland Press, 1996
6. Fundamentals of Enzymology: Price and Stevens, OUP, 1999
7. Enzyme structure and mechanism: Alan Fersht, WH Freeman, 1984
8. The Enzymes: Dixon and Webb, Academic Press
9. Industrial Enzymology: Tony Godfrey, Jon Reichelt

CORE Paper: Immunology
Course Code: PBC 2803
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

At the end of course students will be able to

CO 1: To have an in depth understanding on the history of important landmarks in the mammalian immune system

CO 2: To be able to correlate the molecules and organs of immune system

CO 3: To be able to understand and infer the use of immunological for methods diagnosis and therapeutics

CO 4: To be able to analyse the negative connotations of the immune system

CO 5: Compare and contrast the response of the host immune system to different pathogens

Thus, the knowledge from this course can help in the following:

a. To appreciate the intricacies of life and the process of immunological defense mechanisms
b. To develop deeper understanding of certain diseases

II. Course Content

Unit-1: Cells and Molecules of immune system

Granulocytes: Eosinophils, Basophils, Neutrophils; Natural killer cells, Antigen presenting cells: structure and function, B cells, T cells, Peripheral γδ T cells, Antigens: Antigenicity vs immunogenicity, Factors that influence immunogenicity, B and T – cell epitopes, haptens - adjuvants. Antibodies: Structure, Antibody classes and biological activities, the immunoglobulin superfamily, organization and expression of immunoglobulin genes. Camelids; Cytokines: Properties, cytokine receptors, MHC: General organization and inheritance of MHC, cellular distribution of MHC molecules, TOLL receptors, The complement system: The components and functions of complements

Unit-2: Pathways of immune system

Antigen presenting cells Processing and presentation pathways - the cytosolic and endocytic pathway, presentation of non-peptide antigens. Activation of complement, regulation of the complement pathways B cells: Maturation, activation and proliferation, antigen induced B- cell differentiation, regulation of B-cell development. T cells: T cell maturation, Thymic selection of T cells, T_H cell activation, T cell differentiation, Role of T – cells in cell death,

Unit-3: The immune response

The humoral response - primary and secondary response. Role of T_H cells in humoral response..,. Cell mediated response: Effector responses, General properties of effector T cells. Response to infectious agents: Virus, bacteria, protozoa; emerging infectious disease. Leukocyte migration and inflammation; Damage associated molecular mechanisms/platforms (DAMS); Pathogen associated molecular mechanisms/platforms (PAMS), MHC and immune responsiveness

Unit-4: Diseases related to immune system and treatment

Hypersensitive reactions- Gel and Coombs classification. Types of hypersensitive reactions. Cytokine-related diseases, therapeutic uses of cytokines MHC and disease susceptibility; Primary immunodeficiencies- Severe combined immunodeficiency, AIDS. Autoimmunity: Organ specific, systemic autoimmune disease, proposed mechanisms for autoimmunity; Treatment, Antibody Drug Conjugate (ADC), Immunotherapy, complement deficiencies

Reference

1. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN: 13: 978-0-7167-8590-3 / ISBN: 10:0-7617-8590-0.
2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
3. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4.
4. Immunology: Jan Klain, Blackwell scientific
5. Immunology: Ivan Roitt, (10^{th} ed), Blackwell Scientific Press, 2010.
6. Roland Atlas, Microbiology
7. Microbiology: Willey, Sherwood, Woolverton, Microbiology 7^{th} ed. McGraw Hill, 2008

CORE Paper: Neurobiology
Course Code: PBC 2804
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

By the end of the paper, a student should be able to:

CO 1: To give an overall understanding of the organisation of nervous system
CO 2: To explain the process of neuronal cell signalling and the role of ion channels
CO 3: To calculate the membrane potentials that can lead to signal transmission and to equate a neuron to a circuit to calculate the potentials
CO 4: To differentiate and to characterise neurotransmitters and neuromodulators
CO 5: To target molecules involved in the nervous system for designing drugs to treat neurological disorders
CO 6: To describe the sensory systems' structure and functions
CO 7: To describe the psychophysical laws of perception and its nuances
CO 8: To design simple experiments to study aspects related to the nervous system.

Unit-1: Introduction of nervous system and organization of brain

Introduction of nervous system, vertebrate nervous system, cells of the nervous system (Neurons and glia), organization of synapses, and organization of neurons in the brains. Functional regions of brain: spinal cord, medulla oblongata, pons, cerebellum, midbrain, diencephalon, cerebral hemisphere.

Unit-2: Ion channels and membrane potentials

Brief introduction on cytology of neurons and protein trafficking of nerve cells. Ion channels: importance of ion channels for signaling, the flux of ions through the channels, opening and closing of ion channels, three families of ion channels and their examples.

Resting potential and action potentials: membrane potential, contribution of different ion channels and its calculations to maintain resting potential. Generation of action potentials by different voltage gated ion channels and its propagations. Calculations and reconstruction of action potential.

Unit-3: Neurotransmitters and neuromodulators

Criteria for neurotransmitters and neuromodulators; synthesis, localization and effects of acetylcholine, serotonin, catecholamines, purines (any two examples), amino acids (any two examples), peptides (any two examples), NO and cannabinoids.

Unit-4: Molecular basis of sensory transduction

Elementary attributes of sensory transduction in visual and auditory systems: modality intention, timing and location. Conversion of attributes into energy, receptor transduction of energy into electrical signal. Sensory neurons and their mode of action.

Psychophysical laws of perception. Modification of sensory threshold by psychological and pharmacological factors.

References:

1. Neurobiology and Functional approach: Georg Striedter, OUP, 2015
2. Neurobiology: Gordon Shepherd, 3rd edition, OUP,
3. Principles of Neurobiology: Liqun Luo, Galrland Science 2015
4. Principles of Neural Science. (5th ed), Eric Kandel and James Shwartz, A James Hudspeth. Fifth Edition. Tata McGraw Hill Publications, 2012

Practical Paper: Enzymology
Course Code: PBC 2805L
No. of Credits: 04
Learning Hours: 90 hrs

I Course Outcome
At the end of course students will be able to

CO1: To describe the different models of enzyme catalysis and the mechanisms for its assessment
CO2: To appreciate the applicability of enzymology in various industries for growth and sustainability
CO3: To develop skill for analyzing kinetic data of enzyme substrate reaction

1. Estimation of Riboflavin by Arnold's fluorimetric method
2. Estimation of Thiamine by thiochrome method
3. Fractionation of cells by differential centrifugation and Assay of marker enzymes
4. Effect of environmental factors such as pH, temperature, time and inhibitors on alkaline phosphatase.
5. Isolation and purification of peroxidase.
6. Molecular weight determination of enzyme by SDS PAGE.
7. Isozyme detection
8. Immobilization studies: Preparation of peroxidase entrapped in alginate beads and determination of percent entrapment
9. Assay of clinically important enzymes : Assay of serum creatinine phosphokinase activity

Practical Paper: Cell Biology and Immunology
Course Code: PBC 2806L
No. of Credits: 04
Learning Hours: 90 hrs

I Course Outcome
At the end of course students will be able to
CO1: To study the techniques used in understanding the characteristics of immune system
CO2: To understand the nature of yeast growth
CO3: To be able to evaluate the suitability of various immunological techniques to study a system
CO4: to be able to understand the development of these techniques.

1. Isolation of yeast and study of its cell shape
2. Viability studies of yeast using Trypan Blue and MTT
3. Establishing synchronous cultures of yeast
4. Study of growth curve of yeast and determination of doubling time
5. Study of stages of cell division (onion roots)
6. Single radial immunodifusion
7. Double radial immunodiffusion
8. Immunoelectrophoresis
9. Rocket immunoelectrophoresis
10. IgG purification
11. Off site visit to institutions/industries (Demonstration of Instruments)
12. Optical illusions: Black and white, pattern matching, colour blind test etc.

References:

1. Introduction to Practical Biochemistry. Plummer D, Plummer M. Tata McGraw Hill Publications
2. Practical Textbook of Biochemistry for Medical Students. Vasudevan DM et al. 2nd Edition, 2013. Jaypee Brothers publishers.

Semester III

Semester	Course		No. of hours per week			Course Credit
III			Lectures	Lab sessions	Total	
	PBC 3801	Molecular Biology	4		4	4
	PBC 3802	Recombinant DNA Technology	4		4	4
	PBC 3803	Plant Biochemistry	4		4	4
	PBC 3804	Diseases: Nutritional and Molecular Perspectives	4		4	4
	PBC 3805L	Molecular Biology Techniques		6	6	4
	PBC 3806L	Techniques in Plant Biochemistry		6	6	4
		Total	**16**	**12**	**28**	**24**

Note: An average of 15 lectures per unit and a total of 60 hours per paper.

CORE Paper: Molecular Biology
Course Code: PBC 3801
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

By the end of the paper, a student should be able to:

CO 1: To compare the replication and repair mechanism in eukaryotic system with the prokaryotic system
CO 2: To explain the process of transcription in eukaryotes and its multi-level regulation
CO 3: To correlate the external signalling with the changes in gene expression
CO 4: To describe gene regulation and its significance in biological sciences
CO 5: To learn to apply various molecular biology techniques in research
CO 6: To explain methodologies that have been used to understand the concepts of molecular Biology
CO 7: To design simple experiments based on the concepts of gene expression in eukaryotes.

Unit-1: DNA replication in eukaryotes
Cell cycle and replication; Molecular identification of origin of replication; Formation of pre – replication complex; Initiation and elongation of replication; Regulation of pre – replication complex formation and activation; Finishing replication in eukaryotes: role of telomerase in solving end replication problem; Comparative study of replication in prokaryotes and eukaryotes; DNA repair systems in prokaryotes and eukaryotes; Repair by recombination; Translesion DNA synthesis.

Unit-2: Transcription in eukaryotes

RNA polymerases in eukaryotes; Core RNA pol II promoters; Transcription factors; Regulatory sequences: promoter proximal sequences, upstream activator sequences, enhancers, silencers, boundary elements and insulators; Transcription initiation and role of mediators, nucleosome modifiers and remodelers, transcriptional activators; Elongation and proof reading; Transcription by RNA polymerases I and III; Transcription termination; RNA processing : Splicing pathways, alternative splicing, exon shuffling, RNA editing.

Unit-3: Gene regulation in eukaryotes

Conserved mechanisms of transcriptional regulation from yeast to mammals; eukaryotic activators; Signal integration and combinatorial control; Transcriptional repressor; control of transcriptional regulators and signal transduction; Gene silencing by histone modification; Post transcription initiation regulation.

Unit-3: Special Techniques

Gene knocking and gene knock out; Eastern Blotting; Northeastern blotting; Reverse North Blotting; Southwestern blotting; Recombinase Polymerase amplification; Ribosome profiling; Promoter bashing; Branched DNA assay; Ligase chain reaction; Chromatin Immunoprecipitation (CHiP); Oligomer restriction; Genome editing; CRISPR/Cas systems for editing, regulating and targeting; Mutagenesis methods.

References

1. Molecular Cell Biology. Lodish et al. 5th Edition. W.H. Freeman and Company
2. Molecular Cloning – A laboratory manual. Sambrook – Russel, Vol 1, 2, 3. Third edition. CSHL Press
3. Molecular Biology of the Gene. Watson et al. 7th Edition. CSHL Press, Pearson and Cummings
4. Molecular Biology of the Cell The problems Book (6ed): John Wilson and Tim Hunt
5. The Cell: Bruce Alberts
6. The Cell: A molecular approach (7ed)Geoffrey Cooper and Robert Hausman
7. World of the Cell (8ed):Jeff Hardin and Gregory Paul Bertini
8. Cell and Molecular Biology: Concepts and Experiments (7ed): Gerald Karp
9. Molecular Biology: Principles and Practice. Michael Cox and Jennifer Doudana
10. Molecular Biology: genes to Proteins: Burton Tropp
11. Molecular biology: Structure and dynamics of genomes and proteins: Jordanka Zlatanova and Kensal van Holde
12. Benjamin Lewin. Genes XI. Jones and Bartlett. 2014

CORE Paper: Recombinant DNA Technology
Course Code: PBC 3802
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

By the end of the paper, a student should be able to:

CO1: To explain the basic tools required in recombinant DNA technology
CO2: To explore the methods used to study gene location and structure
CO3: To know the various techniques used to study the gene expression and regulation
CO4: To assess the techniques used in analyzing transcripts and proteins
CO5: To be discuss problems associated with production of recombinant molecules
CO6: To explore the use of recombinant DNA technology in betterment of the society

Unit-1: Basics of gene manipulation
Introduction to Recombinant DNA (rDNA) technology, Isolation of DNA, RNA and Plasmids, Techniques used in rDNA technology (Types of PCR, DNA Sequencing & Automated DNA sequencing, FISH, Comet assay), Gene construction, Transformation

Unit-2: DNA manipulation in prokaryotes
Plasmids as cloning vehicles, Types of Plasmid vectors, Bacteriophage, other vectors, expression vectors, Construction of genomic and c-DNA libraries, recombinant selection and screening, Expression of clone genes in *E.* coli, Cloning in bacteria other than *E. coli.*

Unit-3: DNA manipulation in eukaryotes
Cloning in *S. cerevisiae* and other microbial eukaryotes, Gene transfer to plants, Double Termination, Technique of Gene transfer to animal cells, Transferring genes into animal oocytes, eggs, embryos and other specific tissues, Targeted gene replacement

Unit-4: Applications
DNA Microarray, SSR, DNA Markers, Use of rDNA technology in diagnostics, Detection of Genetic disorders, DNA finger printing, Protein engineering, Developing novel Vaccines, metabolite engineering, SNP detection, Generation of novel plants and animals, Disadvantages of rDNA technology, ethical concerns of rDNA technology

References:

1. Recombinant DNA: James Watson and Richrad Meyers
2. From genes to Genomes: Concepts and applications: Jeremy Dale and Malcolm von Schantz
3. Principles of Gene manipulation and Genomics: SB Primrose and RM Twyman, 7th ed, 2006, Blackwell Scientific
4. Advanced Genetic analysis: Philip Meneely, Oxford University Press, 2009
5. Genome science: A practical and conceptual introduction to molecular genetics analysis in eukaryotes: David Micklos, Bruce Nash and Uwe Hilgert

CORE Paper: Plant Biochemistry
Course Code: PBC 3803
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

At the end of course students will be able to:

CO1: To understand the process of photosynthesis and to compare with different types of carbon fixation.

CO2: To illustrate the importance of promoting plant diversity and green cover

CO 3: To be able to compare and contrast the pattern of development in plants with respect to animals

CO 4: To develop capacity for assessing and analyzing the effect of environmental, chemical factors on plant growth development

CO 5: To enable to developing the apotheosis to understand intricate behaviour of metabolic pathways in different plant types

CO 6: Imparting the capability to use various modus operandi to augment plant health and growth

CO 7: To enable the use of in-age techniques for the finest production of varied plant-derived phyto-chemicals

II. Course Content

Unit-1: Photosynthesis and its regulation

The Architecture of Photosynthesis; Factors affecting rate of photosynthesis: Effect of abiotic stress like water, temperature, carbondioxide on photosynthesis; C3, C4 and CAM pathways; Regulation of C3 pathway and RUBISCO, Pi translocator, Regulation of Hatch – Slack pathway; Regulation of CAM pathway; Regulation of photosynthesis by light quality: UV, visible, infra re and far infra red; Importance of lipids in photosynthesis; Allometry and photosynthesis; Effect of sound waves on growth and photosynthesis; Functional genomics and evolution of photosystems.

Unit-2: Plant – microbe interactions

Fundamentals of Plant Microbe Interactions and introduction to plant beneficial microbes, Mechanics of Plant growth Promotion by microbes (Direct mechanics and Indirect mechanics), Strains of Bacteria and fungi studied for phyto-augmentation, Microbes as bio-control agents (Antifungal Compounds of Plant Growth Promoting Rhizobacteria and Its modeAction), Microbes in inducing systemic resistance in plants, Beneficial effect of plant microbe interaction under abiotic stresses via ACC deaminase production, Basics of microbial Quorum sensing, Constraints in Bioformulation, Commercialization, and Future Strategies.

Unit-3: Plant metabolic engineering

Introduction; Secondary metabolites and their commercial importance; Secondary metabolites as defence against pathogen and insect herbivores; Synthesis and regulation of secondary metabolites: Taxols, Isoprenoids, Phenolics: anthocyanins, lignin, flavonoids and saponins; Elicitors: Classification, growth hormones and carbohydrates as elicitors; metabolic engineering of plant system, Inserting a heterologous genes, Blocking a metabolite or a pathway, Overexpression of endogenous pathway genes, Expressions of biosynthetic genes in alternative systems. Biofuel production by engineering plant metabolism to produce ethanol from sunlight.

Unit-4: Plant development

Use of *Arabidopsis thaliana* as a model to study plant development; Early development in flowering plants: formation of shoot – root axis, structuring of three layers of cells to formation of cotyledons and seeds; sequential generation of different parts of a plant from meristem; Development of seedling based on environmental signals; Patterns of division, elongation and differentiation of cells; Genes and signals involved in meristem maintenance; Transformation of plant architecture by mutations; Coordination of development in different plants by signals due to hormones (PGRs); Light signalling processes in plants to ensure optimal metabolic responses to external stimuli; Role of homeotic selector genes in determining different parts of a flower; Key steps of carbohydrate metabolism that tune whole plant growth; Plant responses to stress and impact on growth; Senescence in plants; Gene silencing as a tool to study gene function.

Reference

1. Biochemistry and Molecular Biology of plants: Bob Buchanan and Wilhelm Gruissem, ed 2, 2015, John Wiley.
2. Plant Biochemistry: Hans Walter Heldt and Birgit Piechulla, ed 4, Academic Press, 2010
3. Plant genomes and Genetics: Erich Grotewold and Joseph Chappell, 2015, Weily Blackwell
4. Plant Biochemistry: Florence Gleason and Raymond Chollet, Johns and Bartlett, 2011.
5. Plant Physiology: Taiz L and Zeiger E, ed 5, Sinauer Associates, Inc

CORE Paper: Diseases: Nutritional and Molecular Perspectives
Course Code: PBC 3804
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

At the end of course students will be able to

CO 1: To name and describe metabolic syndromes and life style disorders; justify suitable nutritional measures for their prevention.
CO 2: To be able to present an informed discussion on patho-physiology, etiology of cardiovascular diseases and illustrate the role of nutritional interventions in reducing prevalence.
CO3: To describe the molecular, dietary origins and causes of types of cancers and recognize the adverse effects of the disease on nutritional intake of patients.
CO4: To develop capacity to distinguish malnutrition related disorders by identifying underlying causes and infer the outcome.
CO5: To enable to categorize bone disorders with respect to related nutritional deficiencies and evaluate the status of bone deformities and weakening in patients.

II. Course Content

Unit-1: **Metabolic syndromes**
Definition of metabolic syndrome, its association with insulin resistance.

Obesity: Prevalence, etiology: biochemical, molecular and genetic basis (single gene defects, polygenic interactions, genes for energy balance, empty calories and its relation with childhood obesity) of obesity; Health risks associated with obesity; Short term and long term regulation of body weight; drugs and their mechanism of action for obesity. (Article to be discussed: Molecular biology of fat expansion)

Diabetes mellitus: Prevalence, pathophysiology, assessment, treatment and self-management of diabetes, acute and long term complications, preventing diabetes. (Article to be discussed: biochemistry and molecular biology behind diabetes complications)

Unit-2: Cardiovascular diseases
Genetic contribution to disorders of lipoprotein metabolism: Genetic causes of high LDL cholesterol, Defective apolipoprotein B, Autosomal recessive hypercholesterolemia, cholesterol ester transfer protein deficiency, Lipase polymorphism.
CHD: Prevalence, pathophysiology, etiology, Prevention, Lipoprotein assessment, emerging risk factors
Hyperlipidemia: cholesterolemia, dyslipidemia, dietary factors, treatments and prevention.
Hypertension: Prevalence, pathophysiology, role of nutrition and diet: **Sodium chloride**: Genetic influence, physiological mechanism; Role of obesity and insulin resistance in

hypertension; Role of potassium, calcium magnesium and alcohol; Hypertension and stroke; prevention and treatment.
(Article to be discussed: Pathophysiology of arterial wall)

Unit-3: Cancer Biology
Cancer: origin, terminology, malignant transformation of cell, oncogenes and cancer induction, etiology of cancer, cancer critical genes, molecular basis of cancer cell behavior, cancer treatment: present and future; Cancer and its connection with inflammation.
Relationship of diet and cancer: role of fat, dietary fiber, alcohol, tobacco and smoking.
Nutritional support to the patients with cancer: Significance and causes of malnutrition, Impaired caloric intake, maldigestion and absorption, Enteral and parenteral nutrition.

Unit-4: Malnutrition related disorders
Anemia: Iron deficiency anemia, pernicious anemia, folic acid deficiency anemia, copper/sideroblastic anemia, Vitamin E responsive anemia.
PEM: Marasmus and Kwashiorkar, marasmic kwashiorkar, Dwarfing and underweight; Secondary PEM. **Osteoporosis and osteomalacia**, Starvation, anorexia nervosa.
(Article to be discussed: Molecular mechanisms of immunosuppression in severe PEM)

References:

1. Cell biology of fat expansion. JCB Vol: 208, No:5, 501-512,2015.
2. Past and present of anti-obesity agents. Am J. Health syst pharma Vol 72, May 1, 2015
3. Biochemistry and molecular biology of diabetic complications. Nature, vol 414, Dec 2001.
4. Molecular biology of heart diseases. Internal medicine 35,243-248, 1996.
5. Metabolic regulation: A human perspective, Keith Fryan, 3rd Edition, Blackwell Scientific
6. Biochemistry with Clinical Correlations: T.Devlin, 2002, John Weiley
7. Human Nutrition and Dietetics: Davidson and Passmore
8. Human Nutrition and Dietetics (ed 10), JS Garrrow, Philip james and A Ralph. Churchil Livingston 1999.
9. Clinical Biochemistry: NV Bhagawan (ed 4), Jones Bartlet Publishers
10. Nutrition: Helen Andrews Guthrie, 1999
11. Biochemical, Physiological and Molecular aspects of human Nutrition (ed3): Kathleen Mahan
12. Molecular basis of human nutrition: Tom sanders and Peter Emery

Practical Paper: Molecular Biology Techniques
Course Code: PBC 3805L
No. of Credits: 04
Learning Hours: 90 hrs

I. Course Outcome

By the end of the paper, a student should be able to:

CO1: To explain the basic tools required in recombinant DNA technology
CO2: To be discuss problems associated with production of recombinant molecules
CO3: To explore the use of recombinant DNA technology in betterment of the society

1. Isolation of DNA and gel electrophoresis
2. Using Gel Documentation System to analyze DNA
3. Random mutagenesis and screening
4. DNA amplification by PCR and its phylogenic analysis
5. Southern Transfer
6. Cot curve
7. Plasmid Isolation
8. Transformation of pBR322 in *E. Coli* (DH5 alpha) and its screening
9. Transformation of pUC8 and its screening
10. Restriction digestion of Genomic DNA (Software)
11. Restriction digestion of Plasmid DNA
12. RNA Isolation
13. Recovery of DNA from Low-Melting-Temperature Agarose Gels: Organic Extraction
14. Comet assay/ DNA Ligation
15. Isolation of Lambda phage

Practical Paper: Techniques in Plant Biochemistry
Course Code: PBC 3806L
No. of Credits: 04
Learning Hours: 90 hrs

I. Course Outcome

By the end of the paper, a student should be able to:

CO1: To understand the process of photosynthesis and to compare with different types of carbon fixation.

CO 2: To quantify the secondary metabolites that are needed for plant growth

CO 3: Assessing and analyzing the effect of environmental, chemical factors on plant growth development

1. Isolation of chloroplasts
2. Estimation of chlorophyll
3. Measurement of Hill's reaction
4. Isolation of phosphate solubilizers
5. Isolation of IAA producing bacteria
6. Isolation and quantification of alkaloid
7. Isolation and quantification of flavonoid

References

1. Molecular Cloning by Sambrook and Manniatis

Semester IV

Semester	Course		No. of hours per week			Course Credit
IV			Lectures	Lab sessions	Total	
	PBC 4801	Research Methodology and Scientific Writing	4		4	4
	PBC 4802	Research Project			12	12
		Total	**16**	**12**	**28**	**24**

Note: An average of 15 lectures per unit and a total of 60 hours per paper.

CORE Paper: Research Methodology and Scientific Writing
Course Code: PBC 4801
No. of Credits: 04
Learning Hours: 60 hrs

I. Course Outcome

At the end of course students will be able to

CO1: To enable to promulgate the understanding of formulating, pursuing and analyzing research benefitting human development
CO2: To sensitize students regarding the ethics of conducting research by enabling in-depth understanding of plagiarism
CO3: To impart necessary traits to analyze, compare, logically criticize and evaluate biological data
CO4: To developing competitive acumen to use modern-age computer programs to analyze and represent research data
CO 5: To be able to develop and elevate skills of scientific writing to present research interpretations in a form of research paper, presentation, book chapters and short communication

II. Course Content

Unit-1: Basic concept to approach research

Searching interest of research, Defining the research question, Approaches and Methodology, objectives, significance and techniques of research, retrieving research materials (Literature review), compiling records. Introduction to kinds of scientific documents: research paper, review paper, book reviews, theses, conference and project reports (for the scientific community and for funding agencies). Ethics in research: Honesty and integrity, Misconducts: Falsification, fabrication, plagiarism. Best/ standard practices and guidelines.

Unit-2: Biostatistics

Probability distribution: Binomial, Poisson and Normal. Parametric and Nonparametric statistics, Confidence Interval, Errors. Quantitative Techniques: calculation of mean, the range, statistics of dispersion, coefficient of variation and analysis of variance the standard deviation, standard error, student t-test, student t-distribution, chi-square test, correlation, Levels of significance, Regression.

Unit-3: Computer applications and computational data management

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, Presentation of Power Point Presentation, Customizing presentation, Showing presentation, Tools – Microsoft Power Point or Similar. Web Search: Use of Publication search engines and libraries (PubMed, PubMed central, CrossRef, Google scholar). Use of Biological data bases to retrieve data.

Unit -4: Scientific writing

Components of a research paper– the IMRAD system, title, authors and addresses, abstract, acknowledgements, references, tables and illustrations. Use of automated referencing softwares (Mendley, EndNote, etc.), Introducing various Publishers (Nature, PlosOne, Elsevier, Springer, etc.), Understanding essential terms (Citations, Impact factor, h-index and i10-index), Selecting appropriate journal to publish an article. Preparing Manuscript, Dealing with publishers – submission of manuscript, ordering reprints. Basic formats of thesis and writing thesis, Oral and poster presentation of research papers in conferences/symposia. Preparation and submission of research project proposals to funding agencies. Redundant publication: duplication and overlapping of publications, selective reporting and misinterpretation of data. Conflict of interest, Violation of publication ethics: authorship and contributorship.

References

1. Ljubomir Todorovic. Original (Scientific) Paper – the IMRAD Layout. Archive of Oncology 2013. 11(3); 203 -05
2. Fundamental of Research Methodology and Statistics. Yogesh Kumar Singh. New Age International Publishers. 2006
3. Research Methodology: Methods and Techniques. C. R. Kothari. New Age International Publishers. 2004.