Mahayogi Gorakhnath University Gorakhpur

Faculty of Health and Life Sciences

Department of Biochemistry

Ph.D. Course Work

In

Biochemistry 2025-26

CBCS

Name of the Program: PRE PhD COURSE in Biochemistry

Program Objectives:

- Enhancing and imparting skills and knowledge in advance research methodologies of biochemistry.
- Solving the existing scientific problems in area of basic and applied biochemistry.
- Creating highly skilled professionals with expertise in current trends of research in area of biochemistry.
- Imparting hand on experience to students of different techniques and instrumentations of advance biochemistry.
- Generating independent researchers who are capable of translating the research developed at laboratory scale to translational scale.
- Imparting skills needed to become a successful academician, scientists or inculcating the scientific ethics, temperament to contribute¬entrepreneur to field of science and help in nation building.

Program Specific outcomes (PSO)

The students who successfully complete the course will have following skills:

- Solid basic knowledge of research methodologies in area of modern biological sciences specifically applied biochemistry.
- Contributing new methodologies and results in area of the basic and advanced biochemistry for taking the research to next level.
- Innovative scientists, skilled workforce to work in specialized area of biochemistry.
- Independent researchers who can contribute through fulfilling responsibility of academicians, scientist and entrepreneur.
- Develop as a researcher at different research institute at national and international level where they can initiate their independent research.
- Develop skill so that they can be absorbed by R&D, academic or industrial sector of different biochemistry-based company/university/institute.

Ph. D. Biochemistry
Course Work

I Year: I Semester										
S No	**Course Code**	**Course**	**L**	**T**	**P**	**Evaluation Scheme**		**Total**	**Credits**	**Course Type**
						CIE	**ESE**			
Theory										
1	PBT701	Research Methodology	4	0	0	30	70	100	4	Core
2	PBT703	Research & Publication Ethics	2	0	0	30	70	100	2	Core
3	……	Discipline-Specific Courses-1	3	0	0	30	70	100	3	Departmental Elective
4	…… ……	Open Elective	3	0	0	30	70	100	3	Open Elective
5		Literature Review Project	2	0	0	0	100	100	2	Literature Review
Total			**14**	**0**	**0**	**120**	**380**	**500**	**14**	

Discipline Specific Elective Course (Any one of the followings)

Course Nature	Course Code	Courses
Discipline-Specific Courses	PBC711	Protein and Enzyme Engineering
	PBC712	Molecular and Cellular Biochemistry
	PBC713	Advanced Cancer Biology
	PBC714	Bioinformatics and Drug Design
	PBC715	Bioenergetics and Metabolism

Open Elective Course (Any one of the followings)

Course Nature	Course Code	Courses	
Open Elective Course	PMB722	Human Metabolic Disorders	Department of Medical Biochemistry
	PBT 722	Omics Technology	Department of Biotechnology
	PHS709	Modern Pharmaceutical Analytical Techniques	Faculty of Pharmaceutical Sciences
	PAY 701	Ayurveda Perspectives of Research Methodology	GGIMS Ayurveda College
	PMM 706	Microbial Metabolism	Department of Medical Microbiology
	PBC722	Advance Tools and Techniques of Biochemistry	Department of Biochemistry

Research Methodology
Code: PBT701

L	T	P	C
4	0	0	4

Course objectives (CO)

1. To introduce the research methodology and nature of problem to be studied and identifying the related area of knowledge.
2. To analyzing the data appropriate to the problem.
3. To reviewing literature to understand how others have approached or deal with the problem.
4. To know the idea of paper and Scientific/ thesis writing.
5. To introduce the funding agencies, databases and research metrics

Unit I Introduction of Research Methodology and Design

Meaning, objective, types and significance of research, problems encountered by researchers in India, Need and Features of Good Research Design, Types of Research Designs, Basic Principles of Experimental Designs, Design of experiments, and Synopsis design for research topic.

Unit II Quantitative Methods

Tools parametric and non-parametric statistics. Probability, chi square test, t-test, Confidence interval, Errors. Level of significance, Regression and Correlation coefficient, Analysis of variance for one way and two-way classifications, Multiple Comparisons- Least Significant Difference Test, Duncan's new Multiple Range Test, Factorial Analysis, Analysis of Covariance, Use of SPSS.

Unit III Research Problem, Editing, Data Collection and Validation

Definition, necessity and techniques of defining research problem, Formulation of research problem, Objectives of research problem. Primary and secondary data, Methods of collecting primary and secondary data, Importance and methods of editing and data validation.

Unit IV Scientific Writing and Report Generation

Basic concepts of paper and their writing, literature search, review of literature and peer review, Concepts of Bibliography and References, types of citation, graphical abstracts, significance of report writing, steps of report writing, Research proposal and Types of Research reports and Methods of presentation of report.

Unit V: Funding Agencies, Databases and Research Metrics

Funding agencies ICMR, CSIR, DBT-BIRAC, UGC, DST, SERB, ICAR etc. Indexing databases, Citation dataset, web of science, scopus etc. Impact factors of Journal as per citation report, Research Metrics- SNIP, SJR, IPP etc. Metrics: h-index, g-index, i10 index and altmetrics.

Suggested Readings

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
6. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
7. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
9. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
10. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
11. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
12. Satarkar, S.V., 2000. Intellectual property rights and Copy right. EssEss Publications.

Course Learning Outcomes (CLO):

On completion of this course, the students will be able to:

1. Understand the limitations of particular research methods.
2. Develop skills in qualitative and quantitative data analysis and presentation.
3. Develop advanced critical scientific thinking skills.
4. Describe the idea of paper and scientific/ thesis writing.

Research & Publication Ethics
Code: PBT703

L	T	P	C
2	0	**0**	**2**

Course Objectives (CO)

1. To describe philosophy, ethics and scientific conduct.
2. To explain the publication ethics and publication misconduct.
3. To understand open access publication, databases and research metrics

Unit-I Philosophy, Ethics and Scientific Conduct
Introduction to philosophy: definition, nature and scope, concept, branches; Ethics: definition, moral philosophy, nature of moral judgements and reactions, Ethics with respect to science and research, intellectual honesty and research integrity, Scientific misconducts: falsification, fabrication and plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data, and falsification of images.

Unit-II Publication Ethics
Definition, introduction and importance of publication ethics, Best practices/standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals.

Unit-III Open Access Publishing
Open access publications and initiatives, SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Unit-IV Publication Misconduct
Group discussions on -Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, Using Software tools - Anti-plagiarism tools like Turnitin, Urkund and other open source software tools.

Unit-V Databases and Research Metrics
Databases - Indexing databases, Citation databases: Web of Science, Scopus etc., Research Metrics - Impact factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score, h-index, g index, i10 index, altmetrics, Citation of bibliography using Mendeley.

Suggested Reading:

1. RESEARCH & PUBLICATION ETHICS by Wakil kumar Yadav, Jitendranath Gorai, Ms Seema Shukla, Yogendra Kumar, Dr Dinesh Sriwash, Dr Dev Brat Mishra, Dev Kamlesh Paswan, NOTION PRESS, India, Singapore-Malesia, ISBN-13:9781685546717.
2. RESEARCH & PUBLICATION ETHICS, A COMPLETE GUIDE TO CONDUCTING & PUBLISHING RESEARCH ETHICALLY, by enago academy.
3. Research and Publication Ethics: A Textbook,March 2022,Edition: First edition, Publisher: Concept Publishing Company Pvt. Ltd., New Delhi, ISBN: 978-93-5439-084-5
4. Elsevier | Ethics in Research & Publication, ethics.elsevier.com.

Course learning outcome (CLO):

Upon completion of the course students will be able to:

1. Describe philosophy, ethics and scientific conduct.
2. Explain the publication ethics and publication misconduct.
3. Understand open access publication, databases and research metrics

Protein and Enzyme Engineering
(Discipline Specific Elective)
Code: PBC711

L	T	P	C
3	0	0	3

Course Objectives

The course will help the scholars to

1. Understand the structure and organization of protein structure
2. Learn and understand the catalytic mechanisms of enzymes.
3. Develop expertise in the purification of enzymes and their analysis in various solvent systems.
4. Learn the kinetics of enzyme catalyzed reactions.
5. Learn the importance of enzyme immobilization and its wide applications in medicine and industries.
6. Study the techniques for clinical analysis and also biochips and biocomputers.

UNIT I: Protein, enzymes and protein engineering

Protein structure, functions, compositions and conformation of proteins. Enzyme catalysis-Acid base catalysis, covalent catalysis, an example, serine proteases. Enzyme kinetics - Michaelis menton equation, Line weaver Burk plot, Hills equation, Hans plot. Protein engineering, folding themes, folding proteins, protein structure prediction and modeling, codon shuffling and codon optimization.

UNIT II: Isolation and purification of protein and enzymes

Isolation, purification and characterization of protein through different method. Determination of amino acid composition, sequence and molecular weight. Bioinformatics tools for protein characterization, western blotting. Sources of enzymes for industry, extraction of enzymes for scientific and industrial purposes. Downstream processing of enzymes, uses of soluble enzymes. Study of enzymes in aqueous biphasic systems. Factors affecting the enzyme activity -Substrate concentration, Enzyme concentration, pH, temperature etc.

UNIT III: Enzyme immobilization and their applications

Techniques employed for immobilizing enzymes, kinetics of immobilized enzymes. Advantages and disadvantages in the utilization of soluble enzymes, immobilized enzymes and immobilized cells. Different types of reactors of immobilized enzymes and their applications.

UNIT IV: Clinical analysis of enzymes

Application of ELISA and EMIT in clinical analysis. Different types of Biosensor spotentiometric, amperometric, piezo - electric and immuno biosensors. Electro analytical applications of enzymes, Methods of coenzyme regeneration. Biochips and Biocomputers.

UNIT V: Enzymes in Biotechnology

Enzyme catalysis in organic solvents, Restriction endonucleases, DNA ligases, DNA polymerase and their uses in Biotechnology. Site directed mutagenesis, artificial enzymes, ribozymes and Abzymes and their uses.

Suggested Readings

1. Dr. Aditya Arya (2018). Understanding Enzymes: An Introductory, S.G. Press.
2. Anil Kumar, Sarika Garg (2017). Enzymes and Enzyme Technology, M.V. Publishers.
3. Khan, M. Y., Khan, Farha (2022). Principles of Enzyme Technology, PHI Learning Private Limited, Delhi.
4. Enzyme Technology Challenges (2022) - https://www.youtube.com/watch?v=5g61pEe0C1U.
5. Enzyme Technology - https://www.youtube.com/watch?v=BJBAC1Ddqeg

Course Outcomes

On completion of the course, students will be able to

1. Understand the structure of proteins and mechanism of action of enzymes.
2. Understand the catalytic mechanisms of enzymes.
3. Apply the knowledge of enzyme immobilization to produce more products out of it.
4. Understanding of enzyme purification by downstream processes and the efficiency testing of enzymes in various solvent systems.
5. Apply the knowledge of enzymes gained in medicine and industry
6. Handle the sophisticated instruments and clinical analysis of enzymes.

Molecular and Cellular Biochemistry
(Discipline Specific Elective)
Code:PBC712

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To study about basics of molecular biology.
2. To study the prokaryotics and eukaryotics transcription and translations
3. To get aware of the types of mutations.
4. To study about the cellular communications.
5. To know the different types of cell signaling pathways.

Unit-I Replication. Repair and recombination.

Replication: Initiation elongation and termination in prokaryotes and Eukaryotes. Enzymes and accessory proteins, Fidelity. Replication of single stranded circular DNA. Gene stability and DNA repair, enzymes, photoreactivation, Nucleotide excision repair, mismatch correction, SOS repair. Recombination. Homologous and non- homologous site specific recombination. Chi sequences in prokaryotes. Gene targeting. Gene disruption. FLP/FRT and Cre/Lox recombination.

Unit-II Prokaryotic and Eukaryotic transcription and gene regulation

prokaryotic transcription , Transcription unit, promoters, constitutive and inducible. Operators, regulatory elements, Initiation. Attenuation. Termination, Rho dependent and independent. Anti termination. Transcriptional regulation, positive and negative. Operon concept, Lac, Trp, Ara, His, and Gal operons. Transcriptional control in Lamda phage.Transcript processing. Processing of tRNA and rRNA . Eukaryotic transcription and regulation. RNA polymerase structure and assembly. RNA polymerase I, II,III. Eukaryotic promoters and enhancers. General transcription factors. TATA binding proteins and (TBP) and TBP associated factors(TAF). Activators and repressors. Transcriptional and post transcriptional gene silencing. Post transcriptional modifications. Processing of hnRNA, tRNA, rRNA, 5'- cap formation: 3'-end processing and poly adenylation, splicing , RNA editing. Nuclear export of mRNA, mRNA stability, catalytic RNA

Unit-III Translation and transport:

Translation machinery: Ribosomes: composition and assembly, Universal genetic code: degeneracy of codons: termination codons: Isoaccepting tRNA,Wobble hypothesis: Mechanism of initiation , elongation and termination: Co and translational modifications. Genetic code in Mitochondria: Transport of proteins and molecular chaperons: protein stability: Protein turn over and degradation

Unit-IV Mutations and Transposons:

Oncogenes and tumor suppressor genes, Nonsense: Missense and point mutations, Intragenic and intergenic suppression: frameshift mutation: physical: chemical and biological mutagens; Transposition- transposable genetic elements in prokaryotes and Eukaryotes: Mechanisms of transposition : role of transposomes in mutation: Viral and cellular oncogenes: Tumor suppressor genes from humans: Structure , function and mechanism of action of pRB and p53 tumor suppressor proteins: Activation of oncogenes and dominant negative effect: Suppression of tumor suppressor genes: Oncogenes as transcriptional activators.

Unit-V Cellular junction and signaling

Cell junctions, Cell Adhesion and the extracellular matrix-cell junctions, cell-cell adhesion, the extra cellular matrix of animals, integrins, Plant cell wall, molecular motors, dynamic structure of cytoskeleton and cell behavior. Cell communication: G protein linked receptors and G protein mediated signaling. Second messengers. Role of Calcium, Lipid signaling, phospholipase and phosphoinocitides signalling. Signaling through enzyme linked cell surface receptors- cytokine receptors and JAK-STAT pathway. Receptor Tyrosine kinases. Map Kinase pathways. Down modulation of a signal integration of signals and Gene controls. Experimental approaches for building a comprehensive view of signal induced responses, responses of cells to environmental influences.

Suggested Readings

1. Karp. Cell &MolBiol 7thed 2013. Wiley.
2. Nelson & Cox. Lehninger Principles of Biochemistry.Freeman,6th ed. 2012.
3. Krebs JE et al. Lewin's. Genes XI. Jones & Bartlett Publ, 2012.
4. Alberts et al Molecular biology of the cell. 5th ed. Garland Sci. 2007.
5. Watson. Molecular Biology of the Gene. 7th ed. Pearson Edu, 2013.
6. Twyman. Advanced Molecular Biology.BIOSSci Publ. 2000.

Course Learning Outcomes (CLO)

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

1. Develop foundational knowledge in the area of basic molecular biology and cell signaling
2. Equip the scholar to visualize the biochemical process in terms molecular events
3. Learn about DNA replication, transcription, translation and gene regulation.

Advanced Cancer Biology
(Elective)
Code: PBC713

L	T	P	C
3	0	0	3

Course objectives:

1. To introduce molecular and cellular biology involved in carcinogenesis
2. To introduce types of tumor growth and metastasis.
3. The implications of the biological findings on cancer prevention, diagnosis, and treatment will be covered

UNIT I: Introduction to Cancer

Types of growth– hyperplasia, metaplasia, dysplasia, anaplasia and neoplasia. Nomenclature of neoplasms. Differences between benign and malignant tumours. Multistep tumorigenesis, Migration, Invasion and metastasis Epithelial to Mesenchymal Transition, Angiogenesis, Apoptosis and Autophagy. Epidemiology of cancer- types of epidemiological research. Methods of epidemiological investigation- cohort studies, case-control studies (elementary details only). Tumour assessment– grading and staging (elementary details only).

UNIT II: Carcinogenesis

Growth characteristics of cancer cells. Morphological and ultrastructural properties of cancer cells. Metabolic alterations in neoplastic transformation. Tumour markers. Osteoblastic and osteolytic metastasis Role of PTHrP, CSF-1 and RANKL in cancer progression and metastasis. Radiation and viral carcinogenesis. Chemical carcinogenesis– Activation of procarcinogens (benzo(a)pyrene only). Stages in chemical carcinogenesis– Initiation, Promotion and Progression. Tumour promoters. Screening for chemical carcinogens– Ames test and whole animal bioassay.

UNIT III: Genetic and Epigenetic Basis of Cancer

Oncogenes and Proto-oncogenes. Mechanisms of oncogene activation. Oncogenic proteins involved in signaling pathways- growth factors and their receptors, Ras oncogenes, nonreceptor cytoplasmic kinases, nuclear transcription factors, anti-apoptotic proteins. Tumour suppressor genes– loss of heterozygosity. *p53*, *Rb*, P*TEN*, *BRCA1* and *BRCA2*. The genetic model for colorectal cancer. Epigenetic alterations in cancer- DNA methylation, histone acetylation and deacetylation. HDAC inhibitors. MicroRNA and cancer.

UNIT IV: Hallmarks of Cancer

Overview of hallmarks of cancer. Cell proliferation- overview of cell cycle, role of Myc and Ras in cell cycle control, deregulation of cell cycle in cancer. Apoptosis- overview, dysregulation of apoptosis in cancer. Cellular and molecular mechanisms of invasion and metastasis. Tumour angiogenesis. VEGF signaling. Brief account of role of inflammation in cancer.

UNIT V: Tumour analysis and therapeutics

Identification of tumours by imaging and histological techniques (brief account only). Molecular methods of analysis: genomic methods- *FISH*, comparative genomic hybridization, Microarrays and laser capture microdissection. Cancer chemotherapy– antimetabolites, antibiotics, platinum compounds, hormones. Multidrug resistance. Basic concepts of radiotherapy, ADEPT, genetic prodrug activation therapy, biological therapy- brief account of gene therapy and immunotherapy for cancer. Multidrug resistance.

Suggested Readings:

1. The Biology of Cancer, 2nd Edition, Robert AWeingberg, ISBN-10: 0815342209, ISBN-13: 978-0815342205
2. Cancer Biology, 4th Edition, Raymond W Ruddon, ISBN-10: 0195175441 | ISBN13: 978-0195175448
3. The Cancer Handbook- M. R. Alison., Nature Publ. Group (2007)
4. Cancer Principles and Practice of Oncology – De Vita V.T. Jr., Hellman, S. and Rosenberg, S.A., J.B. Lippincott, Co., Philadelphia (2008) 8th edition.
5. Basic Science of Oncology. Tannock, I. and Hill, R.P., Mc Graw Hill Publication (2004).
6. Fundamentals of Oncology. H.C.Pitot (2002) 4th edition.
7. Journal articles

Course learning outcome (CLO):

On completion of this course, the students will be able to:

1. To understand molecular and cellular biology involved in cancer
2. To understand difference among carcinogenesis, tumor growth, and metastasis.
3. To understand advanced biological findings on cancer prevention, diagnosis, and treatment.

Bioinformatics and drug design
(Elective)
Code: PBC714

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To study the existing software to extract information from large databases and to use this information in computer modeling.
2. To study about basics of drug delivery.
3. To study the problem-solving skills, including the ability to develop biological sample sequencing methods.
4. To develop an understanding of the modeling and docking from biomolecules Database

Unit-I: Bioinformatics

Introduction of bioinformatics, Applications of Bioinformatics. Use of Internet and search engines (www, HTML, URLs, Netscape, Explorer, Google, PubMed), Searching for sequence databases like FASTA, BLAST algorithm, multiple sequence alignment, BLAT, and RasMol), databases (GENBANK, EMBL, DDBJ, Swissport, PIR, TIGR). Data generation; Generation of large-scale molecular biology data (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Artificial intelligence

Unit-II: Biological Database

Introduction to data types and sources, population and sample, classification and presentation of data. Quality of data, private and public data sources. General Introduction of biological databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDB sum)

Unit-III: Data Storage and Retrieval

Flat files, relational, object-oriented databases and controlled vocabularies. File Format (GenBank, DDBJ, FASTA, PDB, SwissProt). Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighbouring search. The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts. General Introduction to XML, UMLS, CORBA, PYTHON and OMG/LIFESCIENCE. BLAST and FASTA Algorithm. Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization.

Unit-IV: Molecular Modelling in Drug Discovery

Drug discovery process, Role of Bioinformaics in drug design, Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation, lead optimization and validation, Structure and ligand based drug design, modelling of target-small molecule interactions, Molecular simulations. Protein Modelling

Unit- V: Modelling and Docking from Biomolecules Database

Databases (protein, nucleic acid, Domain), multiple sequence alignment, phylogenetic clustering and analysis, protein modeling, Molecular Docking; Types of Molecular Docking, docking algorithms and programs, Structure-based methods to identify lead compounds; de novo ligand design; Applications of 3D Databases Searching and virtual Screening; Combinatorial chemistry and library design, virtual screening, drug likeness and compound filtering, Absorption, distribution, metabolism, excretion and toxicity (ADMET) property prediction, computer based tools for drug design. QSAR

Suggested Readings

1. Thomas E. Creighton, Proteins: Structure and Molecular Properties, W H Freeman & Co, 2011.
2. Alexei V. Finkelstein, Oleg Borisovich Ptitsyn, Protein physics: A course of lectures, Academic Press, 2002.
3. Carl-Ivar Brändén, John Tooze, Introduction to Protein Structure, Garland Pub., 1999.
4. Jack Kyte , Structure in Protein Chemistry , Garland Science, 2007.
5. David Whitford, Proteins-Structure and function, Wiley, 2005.
6. Kessel and Nir Ben-Tal, Introduction to Proteins-Structure, function and motion, CRC press, Taylor and Francis, 2011.
7. Georg E. Schulz, R. Heiner Schirmer, Principles of protein structure, Springer, 199
8. Carbon Nanotubes in Drug and Gene Delivery, Authors Mahdi Karimi, Amir Ghasemi, Soroush Mirkiani, Seyed Masoud Moosavi Basri and Michael R Hamblin.
9. Nanotechnology-Based Approaches for Targeting and Delivery of Drugs and Genes, 1st Edition 2017, Editors: Vijay Mishra, Prashant Kesharwani, Mohd Cairul Mohd Amin, Arun Iyer

Course Learning Outcomes (CLO)

At the end of the course, the student should be able to:

1. Describe the existing software to extract information from large databases and to use this information in computer modeling.
2. Discuss the data storage methods, retrieval.
3. Describe the problem-solving skills, including the ability to develop biological sample sequencing methods.
4. Develop an understanding of the modeling and docking from biomolecules Database.
5. Discuss about basics of drug delivery.

Bioenergetics and Metabolism
(Elective)
Code: PBC715

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To understand the metabolism of biomolecules and their regulation in living cells
2. To have knowledge in basic concepts of bioenergetics
3. To study respiration mechanism and electron transport
4. To understands the diseases related to biomolecules metabolism

Unit-I Bioenergetics: First and second law of thermodynamics, standard free energy, reasons for high standard free energy of hydrolysis of ATP, determination of ΔG for a reaction; Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions; Biological oxidation-reduction reactions; Redox potentials; High energy phosphate compounds – introduction, phosphate group transfer

Unit-II Carbohydrates Metabolism: Metabolism of Carbohydrates: Glycolysis, citric acid cycle, its function in energy generation and biosynthesis of energy rich bond; various forms of fermentations in micro-organisms, Pentose phosphate pathway and its regulation; Gluconeogenesis, glycogenesis and Glycogenolysis; Glyoxylate and Gamma amino butyrate shunt pathways, Cori cycle, anaplerotic reactions, Entner-Doudoroff pathway, glucuronate pathway; Metabolism of disaccharides. Hormonal regulation of carbohydrate metabolism. Energetics of metabolic cycle. Disorders related to carbohydrates metabolism.

Unit-III Metabolism of lipids and vitamins: Metabolism of Lipids: Introduction, hydrolysis of tri-acylglycerols, α-, β- ω oxidation of fatty acids; Fatty acid biosynthesis; Lipid biosynthesis; Metabolism of cholesterol and its regulation. Energetics of fatty acid cycle. Biosynthesis of Vitamins – Ascorbic acid, thiamine, pantothenic acid and Folic acid and fat soluble vitamins. Disorders related to lipids, and vitamins metabolism.

Unit-IV Metabolism of Amino acid and nucleic acid: Amino acid metabolism - Transamination, decarboxylation, Oxidative and non-oxidative deamination of amino acids; metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine and polyamines; Urea cycle and its regulation. Overview of biosynthetic pathways of amino acids and their regulation; Assimilation of ammonia, biosynthesis of essential and non-essential amino acids, regulation of glutamine synthetase and aspartate family of amino acids. Nucleotides metabolism: Biosynthesis and degradation of purine and pyrimidine nucleotides and

its regulation. Purine salvage pathway. Disorders related to Protein metabolism and nucleic acids.

Unit-V Respiration and Electron transport: Electron Transport Chain in Mitochondria and chloroplast: Organization and role in electron capture Oxidative Phosphorylation: Electron transfer reactions in mitochondria; F1F0 ATPase - Structure and mechanism of action; Chemiosmotic theory; Inhibitors of respiratory chain and oxidative phosphorylation, Uncouplers and ionophores; Regulation of oxidative phosphorylation.

Suggested Readings:

1. Lehninger: Principles of Biochemistry, 4th edition, by David L. Nelson and M.M. Cox (2005) Maxmillan/ Worth publishers/ W. H. Freeman & Company.
2. Fundamentals of Biochemistry, 3rd edition, by Donald Voet and Judith G Voet (2004) , John Wiley & Sons, NY
3. Biochemistry, 2nd edition, by R.H. Garrett and C. M. Grisham (1999). Saunders College Publishing, NY.
4. Biochemistry, 6th edition, by Jeremy M. Berg (2007). W.H. Freeman & Co., NY.
5. Harper's Biochemistry, 26th edition, by R.K. Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V. W. Rodwell (2003). Prentice Hall International.
6. Biochemistry, 3rd edition, by C.K. Mathews, K.E. vans Holde and K.G. Ahern (2000). Addison-Wesley Publishing Company.
7. Biochemistry (2004) by J. David Rawn, Panima Publishing Corporation, New Delhi.

Course Learning Outcomes (CLO)

At the end of the course, the student should be able to:

1. Understand the pathways associated with the degradation and biosynthesis of biomolecules
2. Analyze the mechanistic basis for the action of selected enzymes, the thermodynamic basis for the folding and assembly of proteins and other macromolecules
3. Learn the fundamentals of respiration and electron transport.

Human Metabolic Disorders
(Open Elective)
Code: PMB722

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To demonstrate advanced understanding of key aspects of biochemistry and molecular biology at the individual organ and system level and the integration between body systems.
2. To demonstrate understanding of how alterations to normal body biochemistry can contribute to disease.
3. To demonstrate understanding of key biochemical, molecular biology, genetic and analytical techniques, including state of the art technologies used in understanding the biochemistry of human disease.

Unit I Introduction
Basic Enzymology, Overview of Carbohydrate Metabolism / Glycogen Storage Disorders, Disorders of Fructose Metabolism, Galactose Metabolism, Diabetes and Hypoglycemia.

Unit II Amino Acid Metabolism
Overview of Amino Acid Metabolism, Disorders of Amino Acid Metabolism, disorders of Urea cycle and inborn errors.

Unit III Nucleic Acid Metabolism
Overview of Nucleic Acid Metabolism, Disorders of Purine Metabolism, Disorders of Pyrimidine Metabolism and Porphyrias.

Unit IV Energy Metabolism
Overview of Energy Metabolism / Pyruvate Metabolism and the TCA Cycle, Disorders of Beta Oxidation and Electron Transport Chain.

Unit V Lipid Metabolism
Overview of Lipid and Lipoprotein Metabolism, Dyslipidemias, Disorders of Cholesterol and Bile Acid Synthesis and Storage, Glycolipids and Complex Carbohydrates, Lysosomal Storage Disorders, Organelle Function Disorder.

Suggested Readings:

1. Lehninger Principles of Biochemistry, Eighth Edition| ©2021.
2. Biochemistry, 4th Edition, Donald Voet, Judith G. Voet

Course Learning Outcome (CLO)

At the end of the course, the student should be able to:

1. Explain advanced understanding of key aspects of biochemistry and molecular biology at the individual organ and system level and the integration between body systems.
2. Explain how alterations to normal body biochemistry can contribute to disease.
3. Discuss key biochemical, molecular biology, genetic and analytical techniques, including state of the art technologies used in understanding the biochemistry of human disease.

Omics Technology
(Open Elective)
Code: PBT722

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To introduce basics of Omics terminologies and scope.
2. To introduce genomics, transcriptomics and metabolomics
3. To introduce mechanisms underlying the complex architecture of many phenotypic traits of agricultural relevance.
4. To introduce biochemical and molecular markers

Unit I Omics terminologies and scope

Omics and its relevance in agriculture; Definitions, terminologies and scope in crop improvement.

Unit II Biochemical and Molecular markers

Morphological, biochemical and DNA-based markers (RFLP,RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH). Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Markerassisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.

Unit III Marker assisted selection

molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

Unit IV rDNA Technology

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer.

Unit V Transgenic Production

Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases, molecular farming.

Suggested Readings:

1. Genomes by T.A. Brown, John Wiley & Sons Ltd, New York
2. Genome analysis (Volume I, II, III and IV) a Laboratory Manual by Bruce Birren,Eric D. Green, Sue Klapholz, Richard M. Myers and Jane Roskams, Cold SpringHarbor Laboratory Faculty Pharmaceutical Sciences
Press.
3. Discovery Genomics, Proteomics and Bioinformatics, Campbell AM &Heyer L, 2004

Course Learning Outcomes (CLO):

On completion of this course, the students will be able to:

1. To describe the combination of genomics, transcriptomics and metabolomics
2. Understanding of the mechanisms underlying the complex architecture of many phenotypic traits of agricultural relevance.
3. To understand the basic knowledge of Omics terminologies and scope.
4. To understand the uses of biochemical and molecular markers

(Open Elective)

Modern Pharmaceutical Analytical Techniques

Code: PHS 709

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To promote research in advanced areas of science and technology.
2. To provide advanced instrument knowledge to research scholars.
3. To enhance the skill of scholar for use/operation/applications of sophisticated instruments.

Course Contents

Unit I Nuclear Magnetic Resonance spectroscopy
Principles of H-NMR and C-NMR, chemical shift, factors affecting chemical shift, coupling constant, Spin–spin coupling, instrumentation and applications.

Unit II Mass Spectrometry
Principles, Fragmentation, Ionization techniques electron impact, chemical ionization, and Quadrupole, instrumentation, applications.

Unit III UV Spectroscopy.
Electronic transitions, principles, chromophores, auxochromes, spectral shifts, solvent effect on absorption spectra, Beer and Lambert's law, deviations, instrumentation and pharmaceutical applications.

Unit IV IR spectroscopy including Theory, Modes of Molecular vibrations, Sample handling, Instrumentation of IR Spectrometer, Factors affecting vibrational frequencies, Applications of IR spectroscopy and Data Interpretation.

Unit V Chromatography
Principle of Chromatography, apparatus, instrumentation and pharmaceutical applications of absorption, partition chromatography, Thin Layer chromatography, GLC and HPLC.

Suggested Readings:

1. Instrumental Methods of Analysis: Willard, N., CBS Publishers, New Delhi.

2. Douglas A. Skoog, Principles of Instrumental Analysis, 6th Edition, 2007.

3. Indian Pharmacopoeia 1996, Volume I and Volume II, Controller of Publications, Delhi.

Course Learning Outcome (CLO)

At the end of the course, the student should be able to:

1. Discuss the advanced areas of science and technology.
2. Describe advanced instrument utility for the research scholars.
3. Faculty Pharmaceutical Sciences
4. Aware of Use/operate/apply sophisticated instruments in the research.

(Open Elective)

Ayurveda Perspectives of Research Methodology

Code: PAY 701

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To promote research ideas in various fields of Ayurveda Science.

2. To develop integrated research approaches for advanced studies in the field of Ayurvedic science.

3. To create awareness of integrated research in fundamental, drug and clinical studies.

Unit I: Ayurvedic Research Methodology

- Empirical Researches according to Acharya Charak
- Evidence based research as found in later Samhita
- Shastra Lakshan (ideal texts), Tantra Yukti
- Research based literature terminology as found in Samhita
- AYUSH Research Portal, UGC Care list

Unit II: Literary and Fundamental Research in Ayurveda

- Ancient manuscripts/ rare books, collection and compilation related to drugs and diseases
- Popular commentaries and translation on Brihatryi and need of further addition
- Traditional Knowledge and Digital Library (TKDL)
- Contemporary literature and publications related to Ayurveda
- Lexicographic work

Unit III: Drug Research in Ayurveda

- Aushadhi lakshan (ideal drug)
- Collection of raw drugs
- Good Manufacturing Practices (related to ASU drugs)
- Pharmacognostic and pharmacological aspects as found in Ayurveda
- Reverse pharmacology
- Recent publications and finding in ayurvedic drug research
- Medico-Ethno Botanical Survey, parts of major Forest divisions
- The Ayurvedic Formulary of India, The Ayurvedic Pharmacopeia of India, NMPB
- Advance techniques and instruments used in drug research

Unit IV Clinical Research in Ayurveda

- Principles and applied aspects of diagnostic & therapeutic techniques in ayurveda
- Method of patient examination (Rogi Pariksha)
- Concept of Prakriti- Vikriti
- Clinical research designing and Standard questionnaires as per ayurvedic perspectives
- Good Clinical Practices
- Recent publications related to clinical research in ayurveda

Suggested Readings;

1. P. V. Sharma, "Charak Samhita," Chaukhambha Orientalia, Varanasi, 1983.
2. Anonymous, Research Publications in Ayurvedic Sciences, Catalogue of Research information on Ayurveda and Related Sciences, Central Council of Research in Ayurveda
3. Ranjit Kumar (2011). Research Methodology, a Step-by-Step Guide for Beginners (3rd ed.). New Delhi: SAGE Publishers Ltd.
4. Kothari, C.R. (2019) Research Methodology: Methods and Techniques. 4th Edition, New Age International Publishers, New Delhi.

Course Learning Outcome (CLO)

At the end of the course, the scholar should be able to:

1. Discuss the advanced areas of research in Ayurveda by knowing the basic principles of ayurveda.
2. Describe the integrated research areas by utilizing the advanced instrument for the drugs research.
3. Aware of applied aspects of diagnostic instruments in the Ayurvedic clinical research.
   Microbial Metabolism

(Open Elective)
Microbial Metabolism
Code: PMM 706

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To study the microorganisms types based on nutrition and transport.
2. To study the growth of microorganisms and effect of environmental factor on growth.
3. To study about phototrophic metabolism in microorganisms.
4. To promote research in advanced areas of Microbial gap.

UNIT-I **Microbial growth and growth kinetics:**

Bacterial growth curve, generation time, measurement of microbial growth, growth kinetics, synchronous culture, continuous and batch culture, chemo static and turbidostatic, environmental factors affecting growth, nutritional diversity in bacteria.Solutetransport:Activeandpassivetransport,Primaryandsecondarytransport,Transportkinetics, ABC transporter, PEP-PTS system, catabolite repression, inducer expulsion.

UNIT-II **Diversity and regulation of glucose metabolism in microbes:**

Embden-Meyerhof-Parnas pathway - Variations of EMP pathway in different groups of bacteria; Overall balance sheet; Regulation; Modes of NAD regeneration; alcoholic and lactic acid fermentation, Pentose phosphate pathway – HMP pathway and its link with glycolysis, Fermentative mode of glucose oxidation - Entner-Doudoroff pathway; variations of ED pathway in different groups of microbes and its implications, Fate of pyruvate, Citric acid pathway – Stoichiometry and energy gain; Regulation; Alternate forms of TCA; ReductiveTCA;BranchedTCA;Glyoxylatecycle.

UNIT-III **Nitrogen metabolism:**

Nitrogen assimilation, GS-GOGAT pathway and its regulation, Utilization of other modes of nitrogen, nitrate and nitrite utilization, amino acid biosynthetic pathways and their regulation, amino acid utilization – reduction amination and deamination; decarboxylation; Stickland reaction; amino acid oxidases, polyamine biosynthesis and utilization.

UNIT-IV **Lipid metabolism:**

Biochemistry of lipids, lipid distribution in different groups of microbes, fatty acid biosynthesis, synthesis of different types of lipids – neutral lipids; phospholipids and glycolipids, biosynthesis of archaeal lipids, synthesis of storage lipids, lipid utilization, beta-oxidation pathway –

regulation and energy calculation, Lipid accumulation pathway, biochemical and molecular distinction between oleaginous and non-oleaginous microbes.

UNIT-V **Programming metabolism in relation to overproduction of selected metabolites:** Introduction to primary and secondary metabolism, classification of secondary metabolites, introduction to metabolic engineering – strain development and pathway engineering, Case studies on primary metabolites viz. citric acid, succinic acid, lactic acid, ethanol fermentation, amino acid pathways (glutamate, lysine, shikimic acid), Case studies on secondary metabolites viz. polyhydroxyalkanoates, polyketides and antibiotics

Suggested Readings:

1. "Physiology and Biochemistry of Prokaryotes" by David White, published
    a. By Oxford University Press, 4th edition, 2011.
2. "Microbial Biochemistry" by G. N. Cohen published by Springer Netherlands, 3rd edition, 2014.
3. "Microbial Physiology" by Albert G. Moat, John W. Foster, Michael P. Spector, published by John Wiley & Sons, 4th edition, 2002.
4. "Biochemistry" by Geoffrey Zubay, published by William C Brown, 4th edition, 2002
5. "The Metabolic Pathway Engineering Hand book" by Christina Smolke, published

by CRC Press, 2009.

Course learning outcome

After completing the course, the students will able to:

1. Classify the micro-organisms types based on nutrition and transport.
2. Study the growth of microorganisms and effect of environmental factor on growth.
3. Study about phototrophic metabolism in microorganisms.
4. Study the mechanism and types of microbes.

Advance Tools and Techniques of Biochemistry
(Open Elective)
Code: PBC722

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To learn different types of analytical and molecular techniques.
2. To understanding chromatography, spectroscopy, microscopy, electrophoresis techniques.
3. To study molecular techniques like PCR, sequencing, microarrays etc.
4. To make understand use of these techniques in research area.

Unit–I Chromatography Techniques

Performance parameters (retention time, elution volume, capacity factor, plate height, and resolution). Low pressure liquid chromatography (LPLC):principle, columns, matrix materials, procedure. HPLC-columns, matrix, mobile and stationary phases, sample application, pumps, detectors. HPTLC- principle, procedure, applications. Fast protein liquid chromatography. Reversed phase chromatography.

Unit–II Microscopy and Cell culture techniques

Light microscopy- components, specimen preparation. Optical contrast, specimen stains. Fluorescence microscopy, fluorophores. Optical sectioning: confocal microscopes, multiple photon microscopes. Imaging living cells and tissues. Stereomicroscope. Electron microscopy:principle, specimen preparation for TEM &SEM.

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

Antibody labeling: radiolabeling, labeling with fluorochromes and enzymes, biotinylation. Immunoassays: competitive binding, immunometric, solid-phase immunobinding, enhanced, peptide-based, fluorescence and photoluminescence-based. Immunohisto/cytochemistry. Immunofluorescence techniques. Immunoelectron microscopy. Flow cytometry.

Unit–IV Electrophoretic and Spectroscopy techniques

Electrophoresis of proteins. SDS-PAGE, isoelectric focusing, 2D-PAGE.Detection, estimation and recovery of proteins in gels. Electrophoresis of nucleic acids: agarose gel electrophoresis, DNA sequencing gels, pulsed field gel electrophoresis. Electrophoretic mobility shift assay. Southern, Northern, Western, and Southwestern blotting. Elementary details of mass spectrometry :principle, instrumentation, ionization, mass analyzers, MALDI-TOF, tandem mass spectrometry, PMF. Basic principle and biological applications of IR, NMR and ESR. CD, ORD. X ray diffraction

Unit–V Molecular Biology Techniques

Probe preparation: end labeling, random primer labeling, nick translation, molecular beacon-based probes. RFLP, DNA fingerprinting, FISH. PCR-principle and applications. RT-PCR. Real-time quantitative PCR, differential display PCR. DNA sequencing: automated fluorescence method, pyrosequencing, cycle sequencing. Whole-genome sequencing (shotgun and clone-by-clone approach). Microarrays: DNA and protein arrays.

Suggested Readings:

1. Wilson and Walker.Principles and techniques of Biochemistry and Molecular biology.7th ed. Cambridge
University Press 2012.
2. Boyer, R. Modern Experimental Biochemistry.3rd ed. Addison Weslery Longman, 2000.
3. Sambrook.Molecular Cloning.Cold Spring Harbor Laboratory, 2001.
4. Friefelder and Friefelder.Physical Biochemistry - Applications to Biochemistry and Molecular Biology.WH
Freeman & Co. 1994.
5. Upadhyay, Upadhyay and Nath. Biophysical Chemistry Principles and Techniques. Himalaya Publ. 1997.

Course Learning Outcome (CLO)

At the end of the course, the student should be able to:

1. Learn different types of analytical and molecular techniques.
2. Understand chromatography, spectroscopy, microscopy, electrophoresis techniques.
3. Study molecular techniques like PCR, sequencing, microarrays etc.
4. Use of these techniques in research area.