

MASTER IN BIOCHEMISTRY
Course Structure for M.Sc. (Biochemistry) Program w.e.f session 2020-21
School of Science, UPRTOU, Prayagraj

Semester	Course Code	Title of papers	Credit	Max. Marks	
1st SEM	PGBCH -101	Cell Biology and Biomolecules	4	100	
	PGBCH -102	Analytical Biochemistry	4	100	
	PGBCH -103	Bioenergetics and Metabolism	4	100	
	PGBCH -104P	Practical's based on PGBCH 101,102 and 103	6	100	
Credit I semester			18		
2nd SEM	PGBCH -105	Nutrition and Physiology	4	100	
	PGBCH -106	Bio Statistics	4	100	
	PGBCH -107	Clinical biochemistry	4	100	
	PGBCH -108P	Practical's based on PGBCH 105,106 and 107	6	100	
Credit II semester			18		
3rd SEM	PGBCH -109	Enzymology and enzyme technology	4	100	
	PGBCH -110	Immunology	4	100	
	PGBCH -111	Basic Biotechnology	4	100	
	PGBCH -112P	Practical's based on PGBCH 109,110 and 111	6	100	
Credit III semester			18		
4th SEM	Compulsory paper	PGBCH – 113	Industrial biotechnology	4	100
		PGBCH – 114P	Lab work on PGBCH-113	2	100
	Select any one group				
	Group-I	PGBCH -115	Bio-safety and IPR	2	100
		PGBCH -116	Bioinformatics	2	100
		PGBCH -117	Microbiology and Toxicology	2	100
		PGBCH -118(P)	Lab work on Clinical biochemistry	2	100
		PGBCH -119(P)	Lab work on Bioinformatics	2	100
		PGBCH -120(P)	Lab work on Bio-safety and IPR	2	100
	OR				
	Group-II	Dissertation		6	100
		Dissertation based viva voce		6	100
Credit IV semester			18		
Total credit/Max. Marks			72	2200	

PGBCH-101
Cell Biology and Bio-molecules

- Unit 1-**Cell biology and cell organelles: History of biochemistry, biochemical organization, architecture of cells, structure of prokaryotic and eukaryotic cell, structure of cell wall and cell membrane, structure and function of different cell organelles-mitochondria, nucleus, endoplasmic reticulum, chloroplast, Golgi apparatus, ribosomes, lysosomes, centrioles cytoskeleton.
- Unit 3-**Carbohydrates: Introduction to carbohydrates, monosaccharides-structure, properties and their derivatives, aldose and ketose, stereoisomerism of monosaccharides, acid and base reaction in monosaccharides, structure of disaccharides and oligosaccharides, types of polysaccharides, function of complex carbohydrate, glycosidic bonds, polysaccharides as energy storage.
- Unit 4-**Proteins: Introduction to protein, amino acids, primary, secondary, tertiary and quaternary structures of protein, structure of hemoglobin, protein-protein interaction, protein interaction with nucleic acid, function of protein and malfunction of protein.
- Unit 5-**Lipids: Introduction to lipids, types, structure and function of lipids, essential fatty and saturated fatty acid, wax, phospholipids, glycerophospholipids sphingophospholipids, glycolipids, glyceroglycolipids, sphingo-glycolipids, simple lipids, lipid bilayer structure, biological membrane: components and structure.
- Unit 6-**Nucleic acids: Introduction to nucleic acid, structure and components of nucleotides, nitrogen bases in nucleotide and nucleosides, nucleic acids, structures and types of RNA, double helix of DNA, Central Dogma, denaturation of DNA, nucleic acid sequencing, biological function of nucleotides.

PGBCH-102
Analytical Biochemistry

- Unit 1-**Aqueous solution and buffers, sample clarification, extraction and concentration,
- Unit 2-**Spectroscopy: origin of spectra and electronic transition, Visible and UV Spectroscopy-tools and techniques and applications, atomic adsorption, spectroscopy- tools and techniques and applications.
- Unit 2-** Chromatography- Principle, thin layer, ion exchange, affinity, hydrophobic exchange and gel filtration chromatography, principle and instrumentation of high performance liquid chromatography (HPLC).
- Unit 3-**Centrifugation- Principles of centrifugation, types of centrifuges, differential centrifugation, density gradient, and ultracentrifugation.
- Unit 4-** Electrophoretic techniques- general principles, electrophoresis of proteins, native-PAGE and SDS-PAGE, agarose gel electrophoresis for DNA, isoelectric- focusing, 2D gel electrophoresis
- Unit 5-** Microscopy-Basic principles and instrumentation of scanning electron microscopy (SEM) and transmission electron microscopy (TEM), scanning tunneling microscopy, specific staining of biological materials
- Unit 6-** X-ray diffraction and NMR principle, instrumentation and applications.

PGBCH-103
Bioenergetics and Metabolism

- Unit 1-** Bioenergetics: Concept of free energy, standard free energy, determination of ΔG for a reaction, relationship between equilibrium constant and standard free energy change, biological standard state and standard free energy, change in coupled reactions,
- Unit 2-** Biological oxidation-reduction reactions: redox potentials, high energy phosphate compounds-ATP, phosphate group transfer, photosynthetic light reactions.
- Unit 3-** Coenzymes and cofactors: Prosthetic group, coenzymes involved in different metabolic pathways, classification of coenzymes, isozymes, abzymes, synzyme, pyridoxal phosphate and B₁₂ coenzymes.
- Unit 4-** Carbohydrate Metabolism: Glycolysis, fermentation, TCA cycle, electron transport chain, oxidative phosphorylation, gluconeogenesis, glycogenesis, energetic and regulation of metabolic cycles, metabolism of disaccharides, hormonal regulation of carbohydrate metabolism.
- Unit 5-** Amino acids: General reactions of amino acid metabolism-transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine and polyamines.
- Unit 6-** Metabolism of nitrogen compounds: Metabolism and regulation, decarboxylation, transamination, deamination, metabolism and regulation of urea, Urea cycle and its regulation.

PGBCH-105
Nutrition and Physiology

- Unit 1:** Basic Concepts of nutrition: Function of nutrients, measurement of caloric value of food, basal metabolic rate (BMR); factors affecting BMR, recommended dietary allowances, dietary recommendations human nutritional needs, malnutrition.
- Unit 2-** Elements of nutrition: Dietary requirement of carbohydrates, lipids and proteins; concepts of protein quality, micronutrients and macronutrients, essential amino acids, essential fatty acids and their physiological function, deficiency and toxicity of nutrients.
- Unit 3-** Vitamins and minerals: Dietary sources, biochemical functions, water soluble and fat soluble vitamins, requirements and deficiency diseases associated with vitamins, role of minerals in metabolism.
- Unit 4:** Introduction to physiology: Blood - composition and functions of plasma, erythrocytes, leucocytes and thrombocytes, blood coagulation, types of blood groups, antigen and antibodies, blood transfusion.
- Unit 5-** Digestive system: Compositions, parts of alimentary canal, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions, role of enzymes in digestive system,
- Unit 6-** Respiration: Inspiration and expiration, types of respiration, lungs structure, mechanism of breathing and its regulation,

PGBCH - 106

Bio-Statistics

- Unit-1:** Meaning and Types of Research, Significance of Research, About Research Problem and its Selection., Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry.
- Unit-2:** Measures of Relationship, Regression Analysis Association of Attributes, 3-Sigma Limits.About Sampling, Different Types of Sampling Designs, Simple Random Sampling, Stratified Sampling, Cluster Sampling.
- Unit-3:** Basic Concepts of Probability, Definitions of Probability, Additive and Multiplicative law of Probability, Conditional Probability, Bayes' Theorem. Random Variable and its types, Probability Mass Function, Probability Density Functions.
- Unit-4:** Source of Vital Statistics and Demographic Data, Rates, ratio, proportion, Measures of Fertility, measures of mortality, measures of morbidity, Migration. Probability Distributions, Binomial Distribution, Poisson distribution, Geometric Distribution, Normal Distribution, Exponential Distribution.
- Unit-5:** About Hypothesis and its Types, Level of Significance, Critical Region, P Value, Types of errors, Chi-Square Tests, t-tests, z-tests.
- Unit-6:** Analysis of Variance and Co-Variance, Basic Principles of ANOVA and ANCOVA. (One Way, Two Way and Three Way Analysis)

PGBCH-107

Clinical Biochemistry

- Unit 1-** Role of clinical biochemistry in laboratory, clinical utility, blood samples, respiratory and metabolic control of pH, disorder of acid base balance, blood gases and its measurement, anion gap.
- Unit 2-** Nutrition, drugs and digestion: Composition of body fluids, macro and micronutrient, assessment of nutritional status, therapeutic drugs monitoring, drugs overdose, digestive process, gut hormones and clinical disorder.
- Unit 3-** Genetic and chemical control: DNA and genetic information, genetic damage by ionization radiation, mutation and carcinogens, cancer and tumors marker, transport, action and measurement of hormones, endocrine disorder, investigation of endocrine diseases.
- Unit 4-** Control of water and electrolyte metabolism: Water balance, osmolarity of sodium disorder, balance of water, electrolyte and potassium, measurement of sodium and potassium, control of calcium, disorders related to calcium metabolism.
- Unit-5-** Transport and Storage: plasma proteins, protein groups, measurement of plasma protein, lipids transport and lipids disorders, atherosclerosis, and specific proteins, lipoproteins.
- Unit-6:** Inborn errors of metabolism: Inheritance, Investigation of IBEM, Investigation of suspected IBEM, Prenatal diagnosis, Phenylketonuria, Cystic fibrosis,

PCBCH-109
Enzymology and Enzyme Technology

- Unit 1-** Introduction to enzymes: Nomenclature and classification of enzymes, general properties of enzymes, active sites, cofactors and specificity. Isolation, purification and large scale production of enzymes with principles and applications of the involved techniques, viz gel filtration, ion exchange and affinity chromatography, centrifugation and electrophoretic techniques.
- Unit 2-** Enzyme kinetics: Enzymatic reaction mechanisms, Michaelis- Menten equation, Effect of substrate, pH, temperature and inhibitors on enzyme activity. Mechanism of enzyme action and regulation: Active and regulatory sites, chemical modification, feedback inhibition, positive and negative cooperativity, allosteric enzymes, marker enzymes, enzyme region and stererio specificity, .
- Unit 3-** Isozymes, multi-enzymes complexes, artificial enzymes, catalytic antibodies, Enzyme engineering-strategies, directed evolution, degradation of unnatural substrates. protein mediated transport, enzyme inhibition, determination of KI, suicide inhibitors.
- Unit 4:** Isolation and purification of enzymes. criteria for enzyme homogeneity, bioenergetics of enzymes reactions, catalytic antibodies.
- Unit 5:** Industrial enzymes: In detergent, food, leather, dairy, medicines and chemical industries. Enzyme immobilization: Introduction, methods, applications and limitations.
- Unit 6-** Enzymes: introduction to enzymes and their properties, classification, active site and enzyme specificity, activation energy and transition state, types of mechanism enzymes, enzyme catalyzed reactions, factors effecting the enzyme catalysed reactions, enzyme unit, enzyme velocity, general properties of enzymes.

PGBCH-110
Immunology

- Unit1-** Introduction to immunology, architecture of immune system, primary and secondary lymphoid organism, maturation and selection of T cells, types of immunoglobulin's, immunization, stem cell, immune technology, clonal selection theory,
- Unit 2-** Immunity: Types of immunity- innate, acquired, adaptive and cellular immunity, immune response, inflammatory barrier, hormonal influence, peptide binding by class I and class II major histocompatibility complex
- Unit 3-** Cells and Organs of immune System, B-cells maturation, activation and differentiation, t-cell maturation, activation and differentiation, t-cells and b-cells reports, macrophages, dendritic cells, natural killer cells (NK cells), organization and expression of immunoglobulin genes.
- Unit 4-** Antigen processing and presentation, effector responses of cell- mediated and humoral immunity, cytokines, complement system, classification of common vaccines for humans, vaccines (hepatitis, influenza, measles), blood groups and Rh factor,

Unit 5-Immune response to infection diseases: lymphocytes, primary and secondary response, signal transduction properties, antibody receptor structure, hypersensitivity,

Unit-6: Transplantation immunology, immunologic tolerance, immunology of tumors, cancer and AIDS

PCBCH-111 Basic Biotechnology

Unit 1: Biotechnology: An overview-definition, scope and importance of Biotechnology, useful products of biotechnology, A brief account of microbes in industry and agriculture, Fermented and Probiotic foods, Food spoilage and preservation, Metabolic engineering for over production of metabolites, Biotransformation.

Unit 2: Molecular Biology & Recombinant DNA Technology: Concept of Recombinant DNA technology and Gene Cloning, advance methods of molecular biology, Vectors, vector engineering, Enzymes involved in RDT, Recombinant gene construction, Gene transfer methods, Gene expression studies, Polymerase Chain Reaction (PCR).

Unit 3: Agriculture, Food and Environmental Biotechnology: Role of biotechnology to improve yield and nutritional values of crop, GM Foods, Labeling of GM Foods, Risks (Health, Environment etc) associated with GM Foods, Biobusiness, Biosafety, Role of biotechnology in pollutants remediation (air, water and soil) and energy productions, Bioremediation, Restoration of degraded lands and Conservation of biodiversity.

Unit 4: Plant and Animal Biotechnology: Introduction to plant tissue culture and its applications, Gene transfer methods in plants, transgenic plants, In-vitro fertilization and embryo transfer in humans and livestock, Transfection techniques and transgenic animals, Animal Cloning.

Unit 5: Medical Biotechnology: Biotechnology in medicine, Vaccines, Diagnostic, Forensic, Gene therapy, Nano Medicine & Drug Delivery Cell & Tissue Engineering, Genetic disorders, Molecular methods of disease diagnosis,

Unit 6: Hybridoma technology, Gene therapy, Stem cells for treatment of diseases, Therapeutic molecules, Immunological techniques. Different types of culture media.

PCBCH-113 Industrial Biotechnology

Unit 1: Introduction to bioprocess technology, bioreactors, Isolation, preservation and maintenance of industrial microorganisms, kinetics of microbial growth and death, media for industrial fermentation, air and media sterilization.

Unit 2: Types of fermentation processes: Analysis of batch, fed-batch, and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, photo bioreactors etc.) measurement and control of bioprocess parameters.

Unit 3: Downstream processing: Introduction, removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, Membrane process, Drying and crystallization, Whole cell immobilization and its industrial application.

- Unit 4:** Industrial production of chemicals: Alcohol (ethanol), acids (citric, acetic and gluconic), Solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline),
- Unit 5:** Introduction to food technology: Elementary idea of canning and packing, Sterilization and pasteurization of food products, Technology of typical food/ food products (bread, cheese, idli).
- Unit 6:** Isolation and screening of industrially important microorganism, different processes of biofuels production, petroleum microbiology.

PGBCH-115

Biosafety and IPR

- Unit-1** Bio-safety and risk assessment issues, regulatory framework, National biosafety policies and law, The Cartagena protocol on biosafety.
- Unit-2:** WTO and other international agreements related to biosafety; Cross border movement of germplasm; Risk management issues containment. The WTO and other international agreements; Intellectual properties, copyrights, trademarks, trade secret, patents, geographical indications, etc.;
- Unit-3:**General principles for the laboratory and environmental biosafety; healthy aspects; toxicology, allergenicity, antibiotic resistance etc. Impact on environment;
- Unit-4:**Gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of super-weeds/super viruses etc.
- Unit-5:** Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-isotopic procedures; Benefits of transgenics to human health, society and the environment.
- Unit-6:**Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products. Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing;

PGBCH-116

Bio-Informatics

- Unit-1:** Introduction to bioinformatics: Introduction of bioinformatics, Aim, scope, and research areas of bioinformatics, use of internet and search engines (WWW, HTML, URLs, Netscape, Explorer, Google, PUBMED) database management system, database browsing.
- Unit-2:** Biological databases-Sequence and molecular file formats, introduction, sequence file formats, sequence conversion tools, molecular file formats, molecular file format conversion sequence alignments, scoring matrices, PAM,, BLOSUM, alignment of pairs of sequences, multiple sequence alignment (MSA)
- Unit-3:** Molecular phylogeny: Introduction of phenotypic, phylogeny and molecular phylogeny, representation of phylogeny, molecular clocks, methods of phylogeny, statistical evaluation of the obtained phylogenetic,
- Unit-4:** Biological sequence databases: Biological databases, classification scheme of biological databases, biological database retrieval systems, national center for

biotechnology information (NCBI), tools and databases of NCBI, database retrieval tool, sequence submission to NCBI,

Unit-5: Blast, PSO- blast, nucleotide database, protein database, gene expression database, structural database, chemical database, other database, Molecular Simulation and drug designing.

Unit-6: Protein 3D structure and classification database, protein database bank, harnessing data from PDB, data deposition tools, PDB Data, RCSB PDB structural genomics information portal, retrieval of structural database from MMDB, converted domain database (CDD).

PCBCH- 117

Microbiology and Toxicology

Unit-1: Microbial diversity and systematic: Modern approaches to bacterial taxonomy, polyphasic classification, General characteristics of primary domains and of taxonomic groups belonging to Bacteria, Archaea and Eukarya, Nomenclature and outline of bacterial classification as per Bergey's Manual, Accessing microbial diversity using molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE),

Unit-2: Methods in Microbiology: Theory and practice of sterilization, Pure culture techniques, Principles of microbial nutrition, Construction of culture media, Enrichment culture techniques, Isolation and culture of aerobic and anaerobic bacteria, Culture collection, preservation and maintenance of microbial cultures.

Unit-3: Metabolic Diversity among Microorganism: Microbial Nutrition: nutritional types and modes of nutrition in bacteria, Extremophiles. Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth and Continuous culture.

Unit-4: Chemotherapy/Antibiotics Antimicrobial agents; Antibiotics: Penicillins and Cephalosporins and Broad- spectrum antibiotics, sulfa drugs, Antifungal antibiotics, Mode of action, Molecular mechanism of drug resistance. Bacterial Genetic System: Transformation, Conjugation, Transduction, Recombination, bacterial genetic map with reference to E coli.

Unit 5: Microbial diseases: Bacterial and virus diseases with reference to tuberculosis, cholera, AIDS, Rabies, food born diseases.

Unit 6: Introduction to Environmental Toxicology, Bioconcentration, Bioaccumulation, and Biomagnification, Toxicokinetics, Xenobiotics Compounds, Biotransformation of Xenobiotics, Environmental Xenobiotic,

Books Recommended:

1. Principles of Biochemistry: Lehninger, Nelson and Cox. Student Edition, CBS 1439 Publishers and Distributors, Delhi.
2. Biochemistry: Lubert Stryer, published by W. H. Freeman
3. Biochemistry: U Satyanarayana, published by Elsevier, India
4. Fundamentals of Biochemistry: Dr J L Jain, S. Chand and Company
5. Textbook of Biochemistry and Human Biology: Talwar and Srivastava. Eastern Economy Edition, Prentice Hall, India.
6. An Introduction to Practical Biochemistry: DT Plummer, Tata McGraw-Hill Publishing Co. Ltd. New Delhi.
7. Immunology, C Vaman Rao, Narosa Pub.
8. Textbook of Basic and Clinical Immunology, Sudha Gangal and S. Sontakke
9. Research Methodology, Ranjit Kumar, Pearson Pub.
10. Research Method, G Rugg and M. Petre
11. Elements of Biostatistics, S Prasad, Rastogi Pub
12. Biostatistics Principles and Practice, B. Antonisamy, Tata McGraw-Hill Publishing Co. Ltd.
13. Bioinformatics Principles and Application, Z Ghosh and Mallik, OUP
14. A Text book of Microbiology: R C Dubey and D K Maheswari, S Chand & Company
15. Biotech Expanding Horizons: B D Singh, Kalyani Pub.
16. A Text book immunology and immunotechnology by B. Annadurai.
17. Fundamentals of Cognitive psychology by R. Reed Hunt and Herny C. Ellis
18. Clinical Biochemistry, R. Luxton.
19. An Introduction to Applied Cognitive Psychology: A Esgate and David Groom, TMH
20. Clinical Biochemistry: R. Luxton, 1999, Butterworth-Heinemann, Oxford
21. An Introduction to industrial microbiology, Dr. P.K. Shivakumar, published by S. Chand
22. Singh BD, 2007. Biotechnology: Expanding Horizons. Kalyani
23. Discovery genomics, proteomics and bioinformatics, Campbell AM & Heyer L, 2004, Pearson education.
24. Handbook of nanostructured biomaterials and their applications in Nanobiotechnology, Nalwa HS, 2005, American Scientific Publication.
25. Nanobiotechnology, Niemeyer CM & Mirkin CA, 2005, Wiley Interscience.