

PMA101 BASIC MATHEMATICS

L	T	P	Cr
2	1	0	2.5

Prerequisite(s): None

Real Number Systems: Linear and quadratic equations - Permutations and combinations, Binomial theorem, Complex numbers.

Differentiation: Limit, continuity and differentiability, Differentiation of standard functions, Product rule quotient rule, Applications of derivatives, Cartesian graphing using first and second order derivatives.

Integration: Integration by parts, Substitution and Partial fraction, Properties - Definite integrals and applications to area of regions.

Differential equations: Solution of differential equations of first order and second order differential equations with constant coefficients.

Determinants and Matrices: Properties of determinants, Elementary operations, Rank of a Matrix, Row reduced echelon form, Solution of system of linear equations, Matrix inversion using row reduction method.

Coordinate geometry: Systems of Co-ordinates in two Dimension, distance formula area of triangle, locus, slope of line, various forms of equations of a line, equation of circle (Standard and general form).

Recommended Books

1. Hall, H.S. and Knight, S.R., *Higher Algebra*, Laxmi Publications (2000).
2. Thomas, G.B. and Finney, R.L., *Calculus and Analytical Geometry*, Pearson Education (2007) 9th ed.
3. Simmons, G.F., *Differential equations*, McGraw Hill (2006).
4. Narayan, S., *Differential and Integral Calculus*, S. Chand (2005).
5. Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., *An Introduction to Linear Algebra*. Affiliated East-West Press. (1976).

PBT101 GENERAL BIOLOGY

L	T	P	Cr
2	1	0	2.5

Pre-requisite(s): None

Introduction: Definition of biology and its various branches, Origin of life, Molecular basis and characteristics of life, Levels of Biological Organization.

Diversity of Living World: Microbes, Plant Kingdom and its classification, Animal Kingdom and brief description of non-chordates and Chordate phyla, Typical features of animal life.

Cellular and Structural organization: Prokaryotes and Eukaryotes, Basic structure of plant and animal cells, Organization of plant and animal tissues, Plant morphology and anatomy.

Growth and Development: Basics of cellular division, Processes of mitosis and meiosis, Mendel's Laws of Inheritance, Patterns of inheritance – Incomplete dominance, Multiple alleles, Co-dominance, Lethal genes, Polygenic inheritance, Sex linked inheritance.

Plant Physiology: Plant Growth, Transportation of fluids, Mineral nutrition, Photosynthesis in higher plants, Plant growth, Respiration, Plant growth hormones, Reproduction in Plants.

Animal and Human Physiology: Digestion and absorption, Breathing and exchange of gases, Body fluids and circulation, Excretion, Neural control and coordination, Chemical coordination and integration, Animal reproduction.

Recommended Books

1. Bhatia K.N. and Tyagi M.P., *Elementary Biology*, Trueman Book Company (2007).
2. Dhami P.S., Srivastava H.N. and Chopra G., *A Textbook of Biology*, Pradeep Publications (2007).
3. Campbell, N.A. and Reece, J.B., *Biology*, Pearson-Education (2005).

PBT102 MICROBIOLOGY

L	T	P	Cr
3	1	3	5.0

Prerequisite(s): None

Introduction to Microbiology: Scope of microbiology and emerging avenues, Development of microbiology.

Microbial Diversity: Microbial taxonomy and detailed classification of the microbial world as per Bergey's manual of classification (Bacteria, Archaea, Eukarya), Bacterial cell structure and morphological features (cell wall, outer membrane, flagella, endospores and gas vacuoles), microbes beyond cellular organization (Viruses, viroids, virusoids and prions).

Microbial Nutrition and Growth: Cultural characteristics of microorganisms, Techniques for enumeration of microorganisms in soil and water, Pure culture and enrichment culture techniques for the isolation of heterotrophs and autotrophs, Reproduction and growth, Growth measurement and growth yields, factors affecting growth, synchronous growth continuous culture.

Microbial Physiology: Metabolic diversity among microorganisms, Aerobic and anaerobic respiration, Fermentation, Bacterial photosynthesis.

Preservation and Control of Microorganisms: Culture collection and maintenance and preservation, Cryopreservation and lyophilization, Physical and chemical agents for the control of microbial growth, Antimicrobial agents, Antibiotics and their mode of action, Biosafety and levels of biosafety, Types of microbiological safety cabinets, GLP and GMP.

Microbial diseases: Major diseases in plants and animals, food and water borne diseases; emerging and resurgent infectious diseases.

Microbial Genetics: Transfer of genetic material in bacteria - Transformation, conjugation and transduction, Plasmid biology, Transposons, Sources of variation, Mutation and induced mutagenesis, Strain improvement, Ames test.

Laboratory Work :Cell morphology and cell identification, Cell counting, Measurement of cell dimension, Microscopic observations of stained cell preparations, Media preparation and enumeration of microorganisms in air soil and water, Identification of various sources of contamination in aseptic microbiological work, Isolation of pure cultures (aerobic and autotrophic bacteria) and culture techniques, Bacterial growth curve, Growth measurement, Plasmid isolation and transformation, Induced mutagenesis and replica plating technique.

Recommended Books

1. Cappuccino, J.G. and Sherman, N., *Microbiology- a Laboratory Manual*, Pearson Education (2006).
2. Pelczar Jr. M.J., Chan E.C.S. and Krieg R., *Microbiology*, McGraw Hill (1998).
3. Stainer R.Y., Ingraham J.L., Wheelis M.L. and Pamler P.R., *General Microbiology*, MacMillan (2003).
4. Tortora G.J., Funke B.R., and Case C.L., *Microbiology, An Introduction*, Pearson Education (2009) 10th ed.
5. Madigan, M., Martinko, J., Dunlap, P. and Clark, D., *Biology of Microorganisms*, Pearson Education (2008).

PBT103 BIOCHEMISTRY

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Chemical Foundations of Biology: Molecular basis of life, Biological chemistry – Biomolecules, Metabolism – Basic concepts and Design, Biological thermodynamics - Entropy, Biochemical equilibria, Dissociation and association constants, pH and buffers.

Biocatalysis: The basis of metabolism, Nomenclature of enzymes, Enzyme kinetics, Mechanism of enzymatic catalysis, Active site, Activators and inhibitors, Coenzymes, Isoenzymes, Michaelis-Menten equation, Km and Vmax value, Regulation of enzyme activity (single-substrate and multi-substrate reactions).

Signal Transduction and Regulation: Hormones and their classification, Hormone analogs, Agonists and antagonists, Endocrine, Receptors and hormones, Receptor classification and signaling pathways (metabotropic/ionotropic/steroid/peripheral and cellular receptors), Signal transduction and metabolism, Signaling in plants and their function.

Metabolism of Carbohydrates: Glycolysis, Gluconeogenesis, Pentose phosphate pathway, TCA cycle, Minor pathways of glucose metabolism, Electron transport system, Oxidative phosphorylation and bioenergetics, C3 and C4 photosynthesis.

Lipids Metabolism: Fatty acids, Phospholipids, Cholesterol and related steroids, Complex lipids, Oxidation of fatty acids, Biosynthesis of fatty acids and cholesterol.

Proteins and Nucleotide Metabolism: Amino acids, Conformation and configuration of proteins and peptides, Catabolism of amino acids and amino-acid derived products, Nucleotides, Nucleic acid and protein metabolism.

Integration of Metabolism: Inter-relationships between carbohydrate, protein, lipid and nucleic acid metabolism.

Laboratory Work: Preparation of buffer solutions, Determination of pK values, Estimation of reducing sugars, total carbohydrates, amino acids and proteins, Quantitative analysis of lipids, Enzyme assays from microbes and eukaryotes, Basic strategies for enzyme purification, Enzyme kinetics, Estimation of total and available nitrogen, phosphorous and sulphur, Estimation of chlorophyll and other photosynthetic pigments.

Recommended Books

1. Metzler, D.E., *Biochemistry - The Chemical Reactions of Living Cells, Vol. I & II, Elsevier (2002) 2nd ed.*
2. Berg, J.M., Tymoczko, J.L., Stryer, L., *Biochemistry, WH Freeman and Company (2006) 6th ed.*
3. Nelson, D.L., Cox, M.M., *Lehninger's Principles of Biochemistry, McMillan Publishers (2008) 4th ed.*

PBT104 CELL AND MOLECULAR BIOLOGY

L	T	P	Cr
3	0	3	4.5

Prerequisite(s): None

Membrane Structure and Function: Structure and function of membranes, Dynamics of membrane components, Electrical properties of membranes, Transport of nutrients, ions and macromolecules across membranes, Mechanism of sorting and regulation of intracellular transport.

Structural Organization and Function of Intracellular Organelles: Cell wall, Mitochondria, Chloroplast, Nucleus and other organelles, Cytoskeleton and its role in motility.

Cell Division and Cell Cycle: Cell Division, Cell cycle, Regulation of cell cycle.

Cell Signaling and Cellular Communication: Cell surface receptors, Signaling molecules, Paracrine and autocrine signaling, Signal transduction pathways and their regulation, Second messengers, Two-component signaling systems, Cell adhesion, Extracellular matrix, Integrins.

Molecular Biology: Introduction, Chromosomal structure and organization, Nucleic acids, DNA replication in prokaryotes and eukaryotes, DNA damage and repair, Recombination, Transcription - Mechanisms of transcription of prokaryotes and eukaryotes, RNA processing, Ribosomes, Structure of mRNA, Genetic code, Protein synthesis, Regulation and fidelity of protein synthesis, Post-translational modifications, Regulation of gene expression in phages, viruses, prokaryotes and eukaryotes, Transfer of genetic material in microorganisms - Molecular mechanisms, Regulatory sequences and transacting factors, Gene silencing, Oncogenes, Genetic and Metabolic disorders, Programmed cell death, Aging and senescence.

Laboratory Work: Subcellular fractionation and marker enzymes, Histochemical techniques, Isolation of genomic DNA and total RNA, Quantitation of nucleic acids, Agarose gel electrophoresis, Expression of inducible genes, -galactosidase assay, mutagenesis, Isolation of auxotrophic mutants and their characterization.

Recommended Books

1. *Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Molecular Biology of the Cell, 5th Edition, Garland Science Publishing (2008).*
2. *Becker, W.M., Kleinsmith, L.J. and Haldin, J., The World of the Cell, Seventh Edition, Pearson Education (2008).*
3. *Glover, D.M. and Hames, B.D., DNA Cloning I & II, IRL Press Oxford University Press (1995) 2nd ed.*
4. *Lewin, B., Genes VIII, International Edition, Pearson Education International (2004).*
5. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006) 7th ed.*

PBT105 BIO-TECHNIQUES

L	T	P	Cr
3	0	3	4.5

Prerequisite(s): None

Sampling and Bioanalytical Sample Preparation Techniques: Sample Processing, Fixation, Extraction and isolation methods of organic compounds, Purification of bio-macromolecules.

Bioanalytical Techniques: Separation of biomolecules, Chromatographic techniques- Principles and Applications, Column, Thin-layer, Paper, Ion-exchange and Affinity Chromatography, High performance liquid chromatography (HPLC), Gas Chromatography (GC), High performance thin-layer chromatography (HPTLC), Detection and Interpretation.

Electrophoretic Techniques: Theory and application of electrophoresis, Polyacrylamide gel electrophoresis, Isoelectric focusing, Capillary electrophoresis, Microchip electrophoresis, 2D gel Electrophoresis.

Centrifugation Techniques: Theory and principle of sedimentation, Centrifuges and their uses, Preparative and analytical centrifugation, Rotors types and safety aspects of centrifugation.

Spectrophotometric Techniques: Electromagnetic radiations, Radiation and matter, Theory and applications of UV-VIS, IR, Fluorescence, Atomic absorption spectrophotometry.

Spectroscopy Techniques: Electro spin resonance (ESR), Nuclear magnetic resonance (NMR) spectroscopy, X-ray diffraction, Mass spectroscopy (MS).

Radioisotope Techniques: Radioactivity and radioisotopes, Detection and measurement of radioactivity and Cerenkov counting, Applications in biological sciences - Analytical, diagnostics and metabolic studies, Safety aspects of radioactive handling.

Microscopy: Theory and principles of microscopy, Light, Dark field, Fluorescent, UV microscopy, TEM, SEM, Confocal microscopy, Atomic force microscopy, Microtomy, Ultramicrotomy, Freeze fracturing, Flowcytometry.

Laboratory Work : Paper chromatography, Thin layer chromatography (preparative, analytical, reverse phase), Column chromatography, Gas chromatography, HPLC, UV-Vis spectroscopy, Atomic absorption spectroscopy, Microscopy, PAGE, SDS-PAGE, Agarose Gel electrophoresis.

Recommended Books

1. Harrison, R.G., Todd, P., Rudge, S.R. and Petrides, B.B. *Bioseparations: Science and Engineering*, Oxford University Press (2006).
2. Wilson K and Walker J., *Principles and Techniques of Biochemistry and Molecular Biology*, Cambridge University Press (2005) 6th ed.
3. McHale, J.L., *Molecular Spectroscopy*, Prentice Hall (1998).
4. Marimuthu, R., *Microscopy and Microtechniques*. MJP Publishers (2008).

PBT201 BIOPHYSICS AND BIOSTATISTICS

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

BIOPHYSICS

Interactions in biological systems: Intra and intermolecular forces, Electrostatic interactions and Hydrogen bonding interactions, Disulfide bridges, Hydrophobic and hydrophilic molecules and forces, Water and weak interactions.

Theories and Applications: Debye-Hückel theory, Monte Carlo method, Molecular Dynamics method.

Protein Structure and Conformation: Configuration and confirmation, Nonbonded and dipolar interaction, Protein and polypeptides - secondary and tertiary structures, Conformational analysis, Ramachandran plot, Hydration of proteins.

Nucleic Acid Structure and Confirmation: Backbone torsional angle, Sugar confirmation, Base-pairing and base stacking, DNA and RNA conformational structures.

Biological Membranes: Membrane transport and fluidity, Concepts in multiple equilibrium.

BIOSTATISTICS

Introduction: Biology and statistics, Variables and data, Sampling and sampling errors in biological data, Sampling techniques, Probability and distribution.

Hypothesis Testing: Test of hypotheses, One and two sample analysis, Paired sample analysis, Non-parametric statistics and limitations. Confidence limits and tests of confidence, Single, Two and Multifactorial analysis, Non-parametric Analysis of Variance, Multiple comparison tests – Tukey, Newman-Keul, Scheffe tests, Goodness of fit test.

Regression and correlation analysis: Simple, linear and multiple regression, Simple and multiple correlation.

Design of Experiments and Data Presentation: Response Surface Methods, Cantor Plots, Survivalship curves, Graph plotting and significance of Curves, Data representation.

Laboratory Work: MS Excel and Graphpad Prism software, Data entry and graphical representation, Equation formulation and analysis for sample testing, correlation and regression, ANOVA, Multiple comparisons, Survivalship tests.

Electrophysiology, Optical tweezers, Ultrasonic imaging, Mass spectrometer, Viscosity measurements, Computational tools for macromolecular dynamics (Biomed Cache).

Recommended Books

1. Rosner, B., *Fundamentals of Biostatistics, Cengage Learning (2005).*
2. Zar, J.H., *Biostatistical Analysis, Pearson Education (2009) 5th ed.*
3. Daune, M, *Molecular Biophysics, Oxford University Press (1999).*
4. Glaser, R, *Biophysics, Springer (2004).*

PBT202 BIOINFORMATICS

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Biological Databases: Biodiversity information, Sequence databases, Protein and nucleic acid databases, Structural and cluster data, Basics of sequence analysis, Similarity searches and related algorithms, Comparison and scoring, Statistical interpretations, Motifs and domains.

Biological Data Computation: Datamining and data security, Identification of protein primary sequence, Practical aspects of multiple sequence alignment, CLUSTALW, MULTALIN, BLOCKS, ALSCRIPT, Macbox, Phylogenetic analysis, Tree building, Evaluation of trees and blocks, Detection of functional sites, Repeat analysis, AAcompdent and AAcompsin; Propsearch, Sequence, Physical property interpretation, nnPredict, ssPred, SOPMA.

Modelling Softwares: GCGsequence analysis, Oligoprimmer analysis, Rasmol, Chemical Drawing Softwares, Molpac, MDL systems, MOLSCRIPT, ALSCRIPT, TREEVIEW.

Machine Learning and Bioprogramming: Development of Algorithms, Algorithms on strings, trees and sequences, Hidden Markov Models, Artificial Neural Networks.

Laboratory Work: Sequence analysis, Biodiversity informatics and phylogenetic analysis, Protein visualization and structural elucidation, Comparative genomics and proteomics, Chemical graphic visualization and informatics, Introduction to machine learning techniques – Perl based and Visual C++.

Recommended Books

1. Dwyer, R.A., *Genomic Perl: From Bioinformatics Basics to Working Code*, Cambridge University Press (2004).
2. Leach, A.R., *Molecular Modeling: Principles and Applications*, Pearson-Education (2001) 2nd ed.
3. Mount, D.W., *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbor Laboratory Press (2001).
4. Higgins, D. and Taylor, W., *Bioinformatics: Sequence, Structure and Databanks – A Practical Approach*, Oxford University Press (2000).
5. Bishop, M.J. and Rawlings, C.J., *DNA and protein sequence analysis - A Practical approach* Oxford University Press (1997).

PBT203 FOOD PROCESSING

L	T	P	Cr
2	0	2	3.0

Prerequisites: None

Non-Conversion Operations: Food raw materials, Physical, Functional and other properties, Cleaning of raw materials - Methods and contamination, Sorting, Grading of food materials on the basis of size, Buoyancy, Photometry, Size.

Food Conversion Operations: Size reduction and screening of solids - Equipment, Modes of operation, Disintegration of materials, Mixing and emulsification, Filtration and membrane separation, Centrifugation, Solid-liquid extraction and expression, Heat processing - Modes of heat transfer, Methods of applying heat to food.

Preservation Operations: Microbiological considerations, Methods of heat sterilization in containers, Pasteurization by heat processing, Evaporation - Evaporation principles and equipment, Dehydration, Water in food, Drying, Freezing, Food storage - Storage conditions and packaging, Food products processing primer - Dairy products, Meat products, Juice, Vegetables.

Labelling and Packaging in Foods: Structures of packages, Degradability, Reusability and regulations, Types of packages and future packages, Labeling guidelines of foods.

Non-thermal Processing Operations in Foods: Advantages/disadvantages of thermal technologies, Nutritional and consumer considerations, advanced non-thermal operations, Operational criteria and applications.

Conversion Operations for Food Wastes: Characteristics of food/agro industry wastes, Current treatment options – Overview, Feasibility of reuse and conversion processes for value added products.

Laboratory Work : Microbial and other quality tests of fluid milk/meat/fish, Preparation of casein and fermented milk; Dehydration of fruits and vegetables, Preparation of tomato products, Determination of thermal process time, Pickling of meat, Use of hurdle concept for preservation of foods, Qualitative analysis of processed food samples, Microbiology of raw produce and processed foods, Microbiology of processing areas, Compositional analysis of food plant wastes and their reusability, Visit to mechanized food-processing Industries.

Recommended books

1. *Fellows, P.J., Food Processing Technology: Principles and Practice, Woodhead Publishers Ltd. (2005) 2nd ed.*
2. *Mariott, N.G., Principles of Food sanitation. Kindle Publication (2005) 5th ed.*
3. *Jay, J.M., Modern Food Microbiology, Kindle Publication (2006) 7th ed.*

PBT204 GENETIC AND METABOLIC ENGINEERING

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Principles and techniques of gene manipulation: Introduction, Outline and scope of recombinant DNA technology, Different hosts for molecular cloning, Restriction and other enzymes, Nucleic acid purification, Cloning vectors, Restriction mapping of DNA fragments, Genomic and cDNA libraries, Molecular techniques for cloning, screening, gene expression and regulation studies, DNA and protein sequencing, Nucleic acid amplification and its applications, Site-directed mutagenesis, Expression strategies for heterologous genes in bacteria, yeast, insect cells and mammalian cells, Processing of recombinant proteins, Antisense and ribozyme technologies; Molecular markers, Detecting protein-protein interactions, High-throughput techniques.

Applications of Gene Technology: Production of useful molecules and pharmaceuticals, Diagnosis of diseases, Recombinant vaccines, Monoclonal antibodies, Gene therapy.

Metabolic Engineering: Directed production of small molecules in microorganisms, Production of novel compounds and diverse chemical structures, Case studies on re-routing of metabolic pathways in microbes, plants and animals.

Laboratory Work : Bacterial transformation, Isolation of plasmid/bacteriophage DNA, Restriction analysis of DNA, Cloning in plasmid vectors, Construction and screening of gene library, Different PCR techniques, Gene expression in bacterial hosts and analysis of gene products, Reporter gene assay.

Recommended Books

1. Primrose, S.B. and Twyman, R.M., *Principles of Gene Manipulation and Genomics*, Blackwell Publishing (2006) 7th ed.
2. Lewin, B., *Genes VIII, International Edition*, Pearson Education (2003).
3. Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., *Molecular Biology of the Cell*, 5th Edition, Garland Science Publishing (2007).
4. Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., *Concepts in Biotechnology*, Universities Press (2007).
5. Satyanarayana, U., *Biotechnology*, Books and Allied (P) Ltd. (2005).
6. Fritsch, J. and Maniatis, E.F., *Molecular Cloning, A laboratory Manual*, Cold Spring Harbor Laboratory (1989).

PBT205 IMMUNOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Immune System: Introduction and overview, General features of immune response, Clonal selection hypothesis, Lymphocytes, Macrophages, Dendritic cells, Other non-lymphoid cells, Primary and secondary lymphoid tissues and organs.

Antigens and Antibodies: Factors responsible for immunogenicity, Epitopes, Adjuvants, Superantigens, Structure and function of immunoglobulins, Immunoglobulin superfamily, Monoclonal antibodies, Immunoglobulin genes, Antibody genes and generation of diversity.

Antigen-antibody Reactions: Molecular mechanism of Antigen-Antibody binding, Precipitation reaction, Immuno-electrophoresis, Agglutination, Immunofluorescence, ELISA, Western-blotting.

Cytokines and Regulation: Common properties of cytokines, Cytokine types, Molecular mechanism of regulation, Biological activities of cytokines, Pro-inflammatory cytokines, Chemokines, Cytokine diseases and therapies.

B-Cell and T-Cell Activation: Antibody responses, Cell interactions in antibody response, B cell activation, Synthesis and secretion of immunoglobulins, T-cell receptor, T-cell maturation, Activation, Differentiation.

Major Histocompatibility Complex: Histocompatibility genes, Genomic map of H-2 complex in mouse, HLA complex in humans, Structure of MHC molecules, MHC-peptide interaction, Minor Histocompatibility loci, Antigen processing and presentation.

Tolerance and Autoimmunity: Tolerance, Mechanism of self tolerance, Autoimmunity.

Antibody and Cell-mediated Effector Responses: CTL, NK, DH, Immune responses to infection, vaccines, Leukocyte recirculation and inflammation, Neutralization, Opsonization, ADCC, Complement systems, Hypersensitive reactions, Immunopathologies, AIDS and other immunodeficiencies, Autoimmunity, Transplantation - Tissue and organ grafting, Cancer and the immune system.

Laboratory Work : Blood film preparation and identification of cells, Lymphoid organs and their microscopic examination, Immunization and collection of serum, Immuno-diffusion, Western blotting, ELISA, Immunodiagnosics (with commercial kits).

Recommended Books

1. Chakravarty, A.K., *Immunology and Immunotechnology*, Oxford University Press (2006).
2. Edward, K, W and Mastinez J. H., *Basic Virology*, Wiley-Blackwell (2007) 3rd ed.
3. Kindt, T.J., Osborne, B.A., Goldsby, R.A., *Immunology*, W. H. Freeman & Co. (2006) 6th ed.
4. Paul, W.E, *Fundamental of Immunology*, Raven Press (1999).
5. Riott. I., *Essentials of Immunology*, Blackwell Scientific Publications (2006) 11th ed.

PBT206 MICROBIAL TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Microbial Systems: Introduction to microbial activities in nature (soil, water, industry, food and environment), Importance and industrial applications.

Beneficial Soil Microbes: The soil-plant-microorganism system, Rhizosphere and phyllosphere microorganisms, Rhizosphere engineering, Microbial interactions; Symbiotic and non-symbiotic nitrogen fixation; Microbes involved in improving soil fertility (biofertilizers) and pest control (biopesticides).

Biogeochemical Cycling: Microbial transformations, Nitrogen (ammonification, nitrification, denitrification), Phosphorus, Sulphur and Iron cycling, Organic matter Degradation, Microbes as activator's in rapid decomposition, Humus formation and its benefits.

Biotransformation: Industrially important primary and secondary metabolites and their production (alcohol, organic acids, amino acids, antibiotics), Microbiology of production of wine, beer, vinegar and distilled beverages, Non-ribosomal peptides and polyketides, Utilization of microbial biomass as food/feed, Fuel, Chemicals.

Microbial food products: SCP, Microbes in fermented dairy products, Mushroom cultivation.

Innovative Microbial Approaches in Remediation: Soils, sediments and aquatic systems contaminated with metals, pesticides and PAHs.

Microbes and Alternative Sources of Energy: Biogas production and its advantages, Production of bioethanol.

Laboratory Work: Isolation and enumeration of free living and symbiotic nitrogen fixers, Phosphate solubilizers and plant growth promoting bacteria, Organic matter decomposition, Estimation of soil pH, EC, organic carbon, N, P, K, Whc and soil texture, Preservation of cultures, Microbiological assays of vitamins and hormones, Ethanol production from sugars and molasses, Fermentative production of enzymes, amino-acids and organic acids.

Recommended Books

1. *Stainbury, P. F., Whitaker, A. and Hall, S.J. Principles of Fermentation Technology, Elsevier Science (2007).*
2. *Maier, R.M., Pepper, I.L. and Gerba, C.P., Environmental Microbiology. Academic Press. (2006).*
3. *Alexander, M., Introduction To Soil Microbiology, Wiley (1985).*
4. *Atlas, R.M. and Bartha, R. Microbial Ecology-Fundamentals and Applications, Pearson Education (2005).*

PBT301 ANIMAL BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, Application, Culture environment, Cell adhesion, Cell proliferation, Differentiation.

Layout and Equipment: Layout, Essential equipments, Aseptic technique, Objectives, Elements, Sterile handling, Safety, Risk assessment, General safety, Fire, Radiation, Biohazards.

Media and Primary Culture: Physicochemical properties, Balanced salt solutions, Complete Media, Serum, Serum-free media, Isolation of tissue, Steps involved in primary cell culture, Cell lines, Nomenclature, Subculture and propagation, Immobilization of cell lines, Cell line designations, Routine maintenance.

Characterization of Cell Line: Need for characterization, Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Tumorigenicity, Cell counting, Plating Efficiency, Labeling Index, Generation Time.

Contamination and Cryopreservation: Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Need of cryopreservation, Cell banks, Transporting cells, Viability assay, Survival assay.

Transgenic Animals and Gene Therapy: Methodology, Embryonic stem cell method, Applications of transgenic animals, *Ex-vivo* gene therapy, *In-vivo* gene therapy, Nucleic acid based therapeutic agents, Protein production by genetically engineered mammalian cell lines, Optimization of animal cells growth in bio reactors.

Stem Cell Biology: Introduction to stem cells, Embryonic stem cells, Haemopoietic stem cells, Adult stem cells, Molecular basis of pluri-potency, Niches of stem cells, general methods of characterization of stem cells, tissue and organ development, Applications of stem cells in medicine, Biosafety and Stem cell research, Regulatory considerations and FDA requirements for stem cell therapy.

Ethical issues and Concerns: Introduction, Issues in use of GMO and their impact on environment, Ethical issues related to human cloning, prenatal diagnosis, use of animals in research, Animal cloning, testing of drugs on human volunteers, Organ transplantation, Ethics of human stem cell research.

Recommended Books

1. Bhatt, S.M., *Animal Cell Culture - Concept and Application*, Narosa (2008).
2. Ranga, M.M., *Animal Biotechnology*, Agrobios (2007) 2nd ed.
3. Masters, J. R.W., *Animal Cell Culture*, Oxford (2000) 3rd ed.
4. Morgan, S.I., *Animal Cell Culture*, Bio-Scientific Publishers (1993).
5. Gangal, S., *Principles and Practice of Animal Tissue Culture*, Universities Press (2007).

PBT302 BIOPROCESS TECHNOLOGY

L	T	P	Cr
3	1	2	4.5

Prerequisites: None

Introduction and Basic Concepts: Units and dimensions, Principles of bioprocesses, advantages over chemical process, bioprocess control, types of reactors and the relation between chemical and biochemical process.

Sterilization Concepts: Sterilization principles and practices, Media sterilization, thermal-death batch and continuous sterilization systems, Sterilization of air fibrous filters, Design of continuous sterilization.

Cell and Enzyme kinetics: Cell number and Cell mass calculations, Material and Energy balance, Continuous and batch fermentation, Microbial growth kinetics, Growth and non-growth synthesis, Cell and enzyme immobilization, Production of biomass and important extracellular products, Product synthesis kinetics, Submerged and solid state fermentation.

Bioreactor Studies: Study of Batch, CSTF (Continuous stirred tank fermenter) and Plug flow reactor (PFR), Calculations for steady state substrate, Product concentration, External and internal feedback system, Airlift bioreactors.

Aeration and Agitation: Aeration and agitation systems for bioreactors and their design, Microbial growth kinetics, Mass transfer in microbial system, Gas liquid transfer, Biological heat transfer, Energy and material balance.

Down stream processing: Product isolation and recovery, Disruption of microbial cells, Filtrations, Reverse osmosis, Spray drying methods, Quality control and bioprocess economics-Scale-up considerations of bioprocesses, Freeze drying.

Laboratory Work : To study different types of bioreactors, Fermenter sterilization, Medium preparation, sterilization and checking sterility by thermal death kinetics, Surface culture fermentation to study the production of lactic acid using sucrose and lactose as the raw material, Production of citric acid, Growth kinetics for some industrially useful organism, Immobilization of cell on a matrix, Estimate the mass transfer coefficient in a fermenter by sulphite oxidation method, Study solid state fermentation, Production of yeast cells, Industrial visits.

Recommended Books

1. Shuler M.L. and Kargi F., *Bioprocess Engineering: Basic Concepts*, Prentice-Hall (2001) 2nd ed.
2. Stanbury, P.F., *Principles of Fermentation Technology*, Book News, Inc. (1992) 2nd ed.
3. Vogel H. C. and Haber C. C., *Fermentation and Biochemical Engineering Handbook*, Noyes Publications (2001) 2nd ed.
4. Bailey, J.E. and Ollis, D.F., *Biochemical Engineering Fundamentals*, McGraw-Hill (1986).
5. Wang D.C. and Humphrey, L, *Fermentation and Enzyme Technology*, John Wiley (1989).

PHU301 ENTREPRENEURSHIP AND IPR

L	T	P	Cr
3	1	0	3.5

Prerequisites: None

Entrepreneurship: Entrepreneurship and principles of entrepreneurial development, Qualities of an entrepreneur, Functions and types of entrepreneur.

Project Management: Formulation, Identification and selection based on size, Technological assessment, Project cost and market potential and marketing concepts.

Project Appraisals: Technical reports and feasibility reports with commercial viability, Break-even analysis, Depreciation, Sources of funding.

Financing: Sources of finance, Initial capital, Capital structure, Venture capital and Institutional finance.

Economics: Demand-supply-pricing, Business ethics, Industrial laws, Women entrepreneurs – Role, problems and development.

Industrial Sickness: Symptoms, control and rehabilitation of sick units.

Introduction to Intellectual Property: Intellectual property and IPR, patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs, Patent law, Legislations covering IPR's in India, product planning and development, filing patent, provisional and complete specification, patentable and non-patentable items, Valuation & business concerns.

Recommended Books

1. Desai, V., *Dynamics of Entrepreneurial Development and Management*, Himalaya Publishing House (2007).
2. Singh, I. and Kaur, B., *Patent law and Entrepreneurship*, Kalyani Publishers (2006).
3. Sateesh, M.K., *Bioethics and Biosafety*, IK International (2008).

PBT303 PHARMACEUTICAL TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Discovery and Development of drugs: Introduction to drug discovery, Finding a lead compound, combinatorial chemistry, SAR and rational drug design, New drug development.

Drug Pharmacokinetics: Routes of drug administration, Membrane transport, Absorption, Distribution, Metabolism and Excretion of drugs.

Drug Pharmacodynamics: Mechanism of drug action on human beings, Receptor pharmacology, Factors modifying drug action, Rational use of medicines, Pharmacogenomics, Adverse effects of drugs and toxicology, The new drug approval process and clinical trial design.

Natural Products: Natural products from animal, plant and microbial origin having pharmaceutical importance, Principles of pharmacognosy, Composition, Physical and chemical properties, Occurrence and uses of carbohydrates, glycosides, proteins, peptides and amino acids, sterols, saponins, alkaloids, phenols, volatile oils.

Pharmaceutical Manufacturing: Drug formulation and their classification - Oral solid dosage forms, Coating of pharmaceutical dosage forms, Parenteral preparations, Ophthalmic preparations, Medicated topicals, Novel drug delivery systems, Good laboratory practices and Good manufacturing practices - Issues, Packing techniques.

Pharmaceutical Testing, Analysis and Control: Analysis of medicines using physical, chemical and biological methods, Quality assurance and control, Stability of pharmaceutical products, Bioavailability and bioequivalence testing, Quality control and testing as per Indian/US Pharmacopoeia.

Biotechnology and Drugs – Biotechnology derived therapeutics- approved and in development, Drug registration and regulatory affairs.

Laboratory Work : Quality assurance of antibiotic/non-antibiotic formulations using titrimetric, Spectrophotometric and chromatographic and biological methods as per Indian/US Pharmacopoeia, Sterility testing of pharmaceutical products (intra-venous injections, antibiotics and vitamins), Assays for screening antimicrobial/antifungal agents from plants as well as pure drugs.

Recommended Books

1. *Beringer, P., DerMarderosian, A., Felton, L., et al., Remington-The Science and Practice of Pharmacy, Lippincott Williams and Wilkins (2005).*
2. *Tripathi, K.D., Essentials of Medical Pharmacology, Jaypee Brothers Medical Publishers (2004).*
3. *Klefenz, H., Industrial Pharmaceutical Biotechnology, Wiley –VCH Verlag GmbH., (2002).*
4. *Walsh, G., Biopharmaceuticals-Biochemistry and Biotechnology, John-Wiley (2003) 2nd ed.*

PBT304 PLANT BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Plant Tissue Culture and Plant Breeding: Introduction and scope of plant biotechnology, Plasticity and totipotency, Plant cell culture media, Plant growth regulators, Callus and suspension cultures, Micropropagation, Organogenesis and somatic embryogenesis, Haploid plants and homozygous lines, Embryo culture and rescue, Protoplast isolation, culture and fusion, Selection of hybrid cells and regeneration of hybrid plants, Bioresource conservation, Principles of plant breeding.

Features of Plants Relevant to their Genetic Engineering: Architecture of the plant nuclear genome, Structure of plant genes, Organization of chromatin, C-value paradox, Regulation of gene expression in plants, transposons, chloroplast and mitochondrial genomes, Cytoplasmic male sterility and mitochondria.

Genetic Engineering and Manipulation of Phenotypic Traits: Strategies of molecular cloning of plant genes, *Agrobacterium*-mediated genetic engineering in plants (Ti and Ri-plasmid vectors), Plant viruses as vectors, Direct transformation of plants, rDNA approaches for introducing resistance to herbicides, virus, pest and fungal pathogens, Abiotic & biotic stress tolerance, Improvement of plant oils, Starch and storage proteins, Genetic engineering of chloroplast, Molecular marker-aided breeding.

Plant Metabolic Engineering: Phytochemicals from plant cell cultures, Secondary metabolites, Control mechanisms and manipulation of phenylpropanoid pathways, Shikimate pathway, Production of useful compounds - Alkaloids, Useful enzymes, polyhydroxy butyrate, Therapeutic proteins, Antibodies, Edible vaccines.

Transgenics-Issues and Concerns: Biosafety, Societal and ethical concerns on genetically modified foods and crops.

Laboratory Work : Plant tissue culture media, Explant preparation, Callus induction, Regeneration and morphogenesis, Meristem culture for virus free plants, Protoplast isolation, Micropropagation and green house hardening, Isolation and purification of plant DNA and RNA, restriction analyses, Cloning and manipulation of plant genes, Transfer of Ti plasmid into *Agrobacterium*, *Agrobacterium*-mediated transformation of plants, Electroporation techniques.

Recommended Books

1. Slater, A., Scott, N.W., and Fowler, M.R., *Plant Biotechnology*, Oxford University Press (2008) 2nd ed.
2. Primrose, S.B. and Twyman, R.M., *Principles of Gene Manipulation and Genomics*, 7th Edition, Blackwell Publishing (2006) 7th ed.
3. Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., *Concepts in Biotechnology*, Universities Press (1999).
4. Satyanarayana, U., *Yeast Biotechnology: Diversity and Applications*, Springer (2009).
5. Razdan, M.K., *Introduction to Plant Tissue Culture*, Science Publishers (2003) 2nd ed.

PBT305 GENOMICS AND PROTEOMICS

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

The Organization and Structure of Genomes: Prokaryotic genomes, Prokaryotic gene structure, Open reading frames, Conceptual translation, Termination sequences, GC content in prokaryotic genomes, Prokaryotic gene density, Eukaryotic genomes, Eukaryotic gene structure and open reading frames, GC content in Eukaryotes.

Genome Mapping and Sequencing: Sequence tags, RFLP, SNP, Pedlock probes, Radiation hybrid mapping, HAPPY mapping, Sequencing genomes-High throughput sequencing, clone-by-clone approach, Whole genome shot gun approach, The quality of genome sequence.

Comparative Genomics: Comparative genomics of bacteria, Comparative genomics of organelles, Comparative genomics of eukaryotes, Large scale mutagenesis and interference.

Analysis of transcriptomes: Introduction, DNA microarray technology, Functional genomics, ESTs and SAGE, Allele mining and SNPs, Applications of genomics.

Proteomics: Introduction to proteomics, Proteomics Technologies - Protein Arrays, Protein Chips and their application, 2D Gel Electrophoresis and its application, Mass Spectrometry and Protein identification, Role of Bioinformatics in Proteomics, Proteomics Databases, Protein-Protein Interactions - Concepts and Databases, Proteomics Analysis Tools at ExPaSy , Applications of Proteomics in Life Sciences.

Laboratory Work : Manipulation of DNA, Bioinformatic tools and resources accessible via the World Wide Web for database storage, retrieval, integration and interpretation, Structural and functional predictions, Phylogenetic construction and polymorphic characteristics.

Recommended Books

1. *Primrose, S.B. and Twyman, R.M., Principles of gene manipulation and genomics. Blackwell Publishing (2006) 7th ed.*
2. *Akay, M. Genomics and Proteomics Engineering in Medicine and Biology, John Wiley (2007).*
3. *Pennington, S.R. and Dunn, M. J., Proteomics: from protein sequence to function. Viva Books (2001).*
4. *Mount, D.W., Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press (2001).*

PBT401 DRUG DISCOVERY AND DESIGN

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Introduction: Definition of drugs, Overview of drug discovery process, Economics of drug discovery process, Trends in drug discovery process.

Rationale of Drug Discovery: Medical needs, Target identification, Target validation, receptors and assay development.

Bioresources for Small Molecule Discovery: Bioprospecting, Plant natural products, Microbial secondary metabolites, Marine natural products.

Screening Strategies: High throughput assays for antimicrobial, anticancer, anti-diabetic and anti-hypercholesterolemia, combinatorial chemogenomics.

Drug Leads: Bioassay guided isolation, Characterization of drug molecules using integrated technology (TLC, HPLC, MS, IR, NMR).

Herbal Drugs: Definition, Trade scenario, Pharmacopoeial status of herbal drugs, Phytochemical standardization and fingerprinting, Marker compounds, Polyherbal formulations.

Drug Development and Pre-Clinical Studies: *In-vitro* and *in-vivo* pharmacodynamic models, Therapeutic index, Pharmacokinetics - Microbial and animal models, Lipinski's rule, *In-vitro* and *in-silico* toxicological models, Drug formulations.

Drug Regulatory Operations: Role of Regulatory Authorities, US Food and Drug Administration, Regulatory applications viz. Investigational new drug (IND), New drug application (NDA), Abbreviated New Drug Application (ANDA).

Laboratory Work : Methods of preparation of microbial and plant extracts, *in-vitro* screening of antimicrobials from plant and microbial extracts, *in-vitro* screening of amylase inhibitors, *in-vitro* antioxidant assay, Herbal formulation and standardization by FIC index, TLC bioautography, Characterization of bioactive compounds of known medicinal plants using standard reference compounds.

Recommended Books

1. Patwardhan, B., *Drug Discovery and Development - Traditional Medicine and Ethnopharmacology*, New India Publishing (2007).
2. Larsen, P.K., Leljifore, T. and Medsan, U., *Text Book of Drug Design and Discovery*, CRC Press (2009) 4th ed.
3. Hillisch, A. and Hilgenfeld, R., *Modern Methods of Drug Discovery*, Birkhauser (2003).

PBT402 ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Basic Ecology: Environment and biota interactions, Concepts of habitat and ecological niches, Limiting factors; Energy flow; Food chain and food web, Biogeochemical cycles, Ecosystem -Dynamics and management, Principles of conservation and conservation strategies.

Environmental Pollution and Control: Types of pollution, Methods and means of measurement, Air pollution and control, Water pollution – Sources, collection and treatment systems.

Biological Processes: Biofilters, Microbiology of degradation, Aerobic and anaerobic processes, Bioremediation of pesticides and petroleum hydrocarbons, Bio-mining and bio-removal of metals and metalloids, Bio-prospecting, Bio-reclamation of contaminated soils and aquatic systems, Biological treatment of different process wastewaters, Biological tools for solid waste management, Bioscrubbing.

Biomonitoring and Biosensors: Bioindicators, Molecular approaches for environmental monitoring, Applications of GMOs in pollution mitigation, Types of biosensors and their applications.

Laboratory Work : Study of abiotic and biotic interactions in simulated environment, Study of symbiotic relationship, Pathogenicity and parasitism using bacteria, Determination of MPN, Fecal Coliform, BOD, COD, DO, TSS, TDS in different wastewaters, Selective enrichment methods for isolation of contaminant tolerant microorganisms, Analysis of metals and pesticides.

Recommended Books

1. Young, M.M., Bull, A.T. and Dalton, H., *Comprehensive Biotechnology (4 Vols.)*, Elsevier India (2004).
2. Allsopp, D., Seal, K. J. and Gaylarde, C., *Introduction to Biodeterioration*, Cambridge University Press (2004) 2nd ed.
3. Odum, E.P., Brewer, R. and Barrett, G.W., *Fundamentals of Ecology*, Brooks Cole (2004) 5th ed.
4. Metcalf and Eddy Inc., Tchobanglous, G., Burton, F.L., Stensel, H.D., *Wastewater Engineering – Treatment, Disposal and Reuse*, Tata McGraw-Hill (2002) 4th ed.
5. Rittman, B. and McCarty, P.L., *Environmental Biotechnology: Principles and Applications*, McGraw Hill Science (2000).