UBT201 INTRODUCTORY BIOLOGY

L	T	P	Cr
3	0	0	3.0

Prerequisite(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 harmones, 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.

Text Books

1. *Bhatia, K.N. and Tyagi, M.P., Elementary Biology, Vol.2 Trueman Book Company (2007).*
2. *Dhami, P.S., Srivastava, H.N. and Chopra, G., A Textbook of Biology, Pradeep Publications (2008).*
3. *Campbell, N.A. and Reece, J.B., Biology, Pearson Education (2007) 8th ed.*

UEN001 ENVIRONMENTAL STUDIES

L	T	P	Cr
3	0	0	3.0

Prerequisite(s): None

Definition and Scope: Importance, Public awareness and education.

Natural Resources: Introduction, Renewable and non-renewable, Forest, water, mineral, food, energy and land resources, Individual and conservation of resources, Equitable use of resources.

Ecosystems: Concept, Structure, Function, Energy flow, Ecological succession, Forest, grassland, desert and aquatic ecosystems - Introduction, characteristic features, structure and function.

Biodiversity: Genetic, Species and ecological diversity, Biogeographical classification of India, Value and hot spots, Biodiversity at global, national and local levels, India as mega-biodiversity nation, Threats to biodiversity, Endangered and endemic species of India, Conservation of Biodiversity, Endangered and endemic species, Conservation of biodiversity.

Pollution: Definition, Causes, effects and control measures of the pollution – Air, soil, Noise, Water, Marine and Thermal and Nuclear Pollution, Solid waste management, Role of Individual in Prevention of Pollution, Pollution case studies, Disaster management.

Social Issues: Sustainable development, Water conservation, Environmental ethics, Climatic change, Wasteland reclamation, Environmental protection acts and issues.

Human Population and the Environment: Population growth, Environment and human health, Human rights, HIV/AIDS, Value education, Women and child welfare, IT in human health and environment, Case studies.

Text Books

1. *Bharucha, E., Textbook of Environmental Studies for undergraduate courses, Universities Press (2005).*
2. *Chapman, J.L. and Reiss, M.J., Ecology - Principles and Application, Cambridge University Press (LPE) (1999).*
3. *Joseph, B., Environmental Studies, Tata McGraw Hill (2005) 2nd ed.*

Reference Books

1. *Miller, G.T., Environmental Science - Working with the Earth, Thomson (2006).*
2. *Wright, R.T., Environmental Science -Towards a sustainable Future, Prentice Hall of India (2008) 10th ed.*

UBT301 MICROBIOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

History and Background: Brief history of Microbiology, Classification of microorganisms, Microbial taxonomy-criteria used for including molecular approaches, Microbial phylogeny and current classification of bacteria, Stains-Simple, Differential and Special stains.

Microbial Diversity: Prokaryotes and Eukaryotes, Structure and functions of cellular components of bacteria, fungi, algae, protozoa and virus.

Microbial Control: Sterilization and disinfectants, Antimicrobial chemotherapy- antibiotics, source and mode of action, Antimicrobial resistance- tests for sensitivity to antimicrobial agents.

Microbial Physiology: Nutrition- autotrophs, heterotrophy, chemotroph and lithotroph, Types of culture media, Methods of enumeration of microorganisms, Preservation techniques, Growth curve- synchronus and asynchronus culture, Factors affecting the growth.

Microbial Reproduction: Sexual and asexual reproduction (taking example of each group), Formation of endospores and mechanism of sporulation**.**

Microbial Metabolism: Bacterial metabolism- respiration, intermediate metabolism, Fermentation and photosynthesis.

Microorganisms and Diseases: Microbial pathogenicity, Important bacterial, fungal, viral and parasitic diseases of man, Food borne diseases, Common bacterial, viral, fungal disease affecting plants of economic significance.

Laboratory Work

Sterilization techniques, Preparation of culture media, Culturing of Microroganisms-Streak and Pour plate, Isolation and preservation of bacterial culture, Identification of microorganisms, Staining, Mortality, Biochemical methods, Environmental Sample analysis, Methylene blue reduction test, ImVic, MPN method, Cell counting.

Text Books

1. *Pelczar Jr., M.J., Chan, E.C.S. and Krieg, Noel R., Microbiology, McGraw Hill (2003) 5th ed.*
2. *Stainer, R.Y., Ingraham, J.L. and Wheelis, M.L., General Microbiology, MacMillan (2007) 5th ed.*
3. *Tortora, G.J., Funke, B.R., and Case, C.L., Microbiology- An Introduction, Pearson Education (2007)8th ed.*

Reference Book

1. *Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D., Biology of Microorganisms, Benjamin Cumming (2009) 12th ed.*

UBT401 BIOCHEMISTRY

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

Chemical Foundations of Living Systems: Chemical composition of various biomolecules and their characteristic features.

Physical and Biological Chemistry: Dissociation of water and ion product, pH, pK, Weak acid and bases, Buffers, Weak bonds, Covalent bonds, Classes of organic compounds and functional groups, Different biomolecules and their precursors.

Structure and Function of Biomolecules: Carbohydrates, Amino acids and proteins, Enzymes, Vitamins and co-enzymes, Nucleic acid and their components, Lipids, Hormones.

Enzymology: Introduction to enzymes, Classification and nomenclature, Properties of enzymes, Enzyme kinetics, Enzyme inhibitors, Mechanism of enzyme action, Evidence of enzyme-substrate complex, Regulation of enzyme activity, Allosteric interactions, Ribozymes, Abzymes, Artificial enzymes.

Bioenergetics and Metabolism: Concepts of energy and energy change in biochemical processes, Factors affecting free energy changes in biochemical reactions, Group transfer potential and the concept of the high energy phosphate bond, ATP as universal currency of free energy, Role of high energy phosphates in biological systems. Basic concept and design of metabolism, Regulation of metabolic pathways, Basic carbohydrate metabolism: glycolysis and gluconeogenesis, citric acid cycle, pentose phosphate pathway, glycogen metabolism, electron transport and oxidative phosphorylation, photosynthesis, Fatty acid and lipid metabolism, Biosynthesis of amino acids, Nucleotides, Purines and Pyrimidines, Integration of metabolic pathways.

Laboratory Work

Basic concepts and use of instruments in biochemical analysis, pH and Buffers, Standard Curve, Qualitative and quantitative analysis: Amino acids and proteins, Carbohydrates, Lipids, Isolation of photosynthetic pigments, Enzyme purification.

Text Books

1. *Jain, J.L., Jain, S. and Jain, N., Fundamentals of Biochemistry, S. Chand and Company Ltd. (2005).*
2. *Nelson, D.L. and Cox, M.M., Lehninger Principles of Biochemistry, W.H. Freeman (2008) 5th ed.*
3. *Rao, B.S. and Deshpande, V., Experimental Biochemistry: A student companion. Anshan Publication (2005).*
4. *Wilson, K. and Walker, J., Practical Biochemistry, Principles and Techniques, Cambridge University Press (1995) 5th ed.*

Reference Books

1. *Berg, J.M., Tymoczko, J.L. and Stryer, L., Biochemistry, W. H. Freeman (2006) 6th ed.*
2. *Campbell, M.K. and Farrell, S.O., Biochemistry, Brooks Cole (2006) 5th ed.*
3. *Switzer, R.L. and Garrity, L.F., Experimental Biochemistry, W. H. Freeman (1999) 3rd ed.*

UBT402 CELL AND MOLECULAR BIOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

Cell Biology: Structure, function and arrangement of various membrane proteins, Transport of nutrients, ions and macromolecules across membranes, Brief introduction to cytoskeletal elements, intracellular compartments and protein trafficking, Cell cycle and growth regulation, Cellular responses to environmental signals-mechanism of signal transduction, Cellular basis of differentiation and development.

Molecular Biology: Structure and properties of nucleic acids, Organization of prokaryotic and eukaryotic genomes, Mechanisms of DNA replication in prokaryotes and eukaryotes, Mutagenesis and processes of DNA repair, Mechanisms of DNA recombination, Transcription, RNA splicing and processing, Translation - Genetic code, Degeneracy of genetic code, Prokaryotic and eukaryotic translation, Co- and post-translational modification of proteins, Regulation of gene expression, Molecular events involved in transfer of genetic material in bacteria-Transformation, Conjugation and transduction, Extrachromosomal elements, Plasmids, Episomes, Transposons, Programmed cell death, Genes in differentiation and development, Oncogenes.

Laboratory Work

Morphological studies of prokaryotic and eukaryotic cells, Isolation of DNA, RNA and proteins: their estimation and purification; Chemical and UV mutagenesis; Transfer of genetic materials in bacteria, Studies on gene regulation, Isolation of antibiotic resistant and auxotrophic mutants and their screening.

Text Books

1. *Channarayappa, Molecular Biotechnology, Principles and Practices, Universities Press (2006).*
2. *Lewin, B., Genes VIII, PHI (2008) 8th ed.*
3. *Primrose, S.B. and Twyman, R., Principles of Gene Manipulation and Genomics, Wiley-Blackwell (2006) 7th ed.*

Reference Books

1. *Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Molecular Biology of the Cell, Garland Science Publishing (2008) 5th ed.*
2. *Glover, D.M. and Hames, B.D., DNA Cloning I and II, IRL Press Oxford University Press (1995).*
3. *Fritsch, J., Sambrook, J. and Maniatis, E.F., Molecular Cloning, A laboratory Manual, Cold Spring Harbor Laboratory (1999).*

UBT403 UNIT OPERATIONS – I

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Conduction Heat Transfer: Introduction to heat transfer, Conduction, Convection and radiation, Heat diffusion equations, Thermal conductivity for solids, liquids and gases, Conduction heat transfer laws, Conduction through wall, Cylinder, Sphere, Optimum thickness of insulation, Conduction with heat source, Unsteady heat transfer.

Convection Heat Transfer: Convection heat transfer – Basic concepts, Boundary layers concept, Dimensionless numbers, Various equations related to heat transfer during laminar and turbulent flow for flat plate as well as pipe flow, Convection without phase change and basic empirical equations, Convections with phase change, Condensation and boiling.

Radiation Heat Transfer: Radiation heat transfer-basic laws, Emissivity, Absorption, Black and gray body, Shape factor, Shape factor calculations for different bodies, radiation exchange between surfaces.

Heat Exchangers: Heat transfers equipments, Classifications, LMTD, Double pipe heat exchanger, Shell and tube, Basic concepts about design, fouling and its effects, Plate heat exchangers.

Evaporators: Classification of evaporators, Enthalpy balance, Steam economy, Single effect and multiple effect evaporators (MEE).

Fluid Particle Mechanics: Stoke's law, Free and hindered settling, Classifiers and thickeners, settling chambers, Tube settlers, Bag filters, Electrostatic precipitators, Floatation, Magnetic separation, Centrifugation separation, Fluidization, Membrane separation processes, Theory of dialysis, Reverse osmosis, Ultrafiltration, Mixing, Grinding, Pneumatic conveying.

Laboratory Work

Experiment on heat transfer through composite wall, Lagged pipe, Lagged sphere, Emissivity, Stefan's Boltzmann constant calculations, Natural and forced convection, LMTD calculations for parallel and counter flow, Filmwise and dropwise condensations, Sedimentation.

Text Books

1. *Holman, J.P., Heat Transfer, Tata McGraw-Hill (2002) 9th ed.*
2. *Incropera, F.P. and Dewitt, D.P., Fundamentals of Heat and Mass transfer, John Wiley (2007) 5th ed.*
3. *McCabe, W., Smith, J. and Harriott, P., Unit Operations in Chemical Engineering, McGraw-Hill (2005) 5th ed.*

Reference Books

1. *Foust, A.S., Wenzel, L.A., Clump, C.W., Andersen, L.B. and Maus, L., Principles of Unit Operations, John Wiley and Sons (1980).*
2. *Aiba, S., Humphery, A.E. and Mills, N.F., Biochemical Engineering, Academic Press (1973).*

UBT611 CONCEPTS IN BIOTECHNOLOGY

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Introduction: Introduction to Biotechnology, Organization of cells, Biomolecules, Chromosomes, cell division and sexual reproduction, Public perception of Biotechnology- Biotechnology in the developing world.

Genetics and Biotechnology: Replication, transcription and translation, Protoplast and cell fusion technologies, Genetic engineering, Potential lab biohazards of genetic engineering, PCR.

Bioprocess and Fermentation Technology: Introduction, Principles of microbial growth, The bioreactors/fermentor, scale-up, media design for fermentation processes, solid substrate fermentation, downstream processing, Enzymes and their applications, Technology of enzyme production, immobilized enzymes, Genetic engineering and protein engineering of enzymes, Single cell protein and its production from agricultural crops and algae.

Biological Fuel Generation: Photosynthesis, Sources of biomass, Ethanol, Methane and hydrogen from biomass.

Biotechnology and Medicine: Introduction to immunology, Pharmaceuticals and bio-pharmaceuticals, Antibiotics, Vaccines and monoclonal antibodies, Gene therapy.

Environmental Biotechnology: Microbial ecology/environmental biotechnology, Wastewater and sewage treatment, Landfill technologies, Composting, Bioremediation, Microbes and the geological environment, Sustainability.

Agricultural Biotechnology: Introduction, Plant tissue culture, Biological control of pests, Biofertilizers.

Food Biotechnology: Introduction, Food and beverage fermentation, Enzymes and food processing, sweeteners, Food waste, Microbial derived food products, Rapid diagnostics, Public acceptance and safety of new biotechnology foods.

Text Books

1. *Smith, J.E., Biotechnology, Cambridge Press (2009) 3rd ed.*
2. *Kumar, H.D., Modern Concepts of Biotechnology, Vikas Publishing House Pvt. Ltd. (2003).*
3. *Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., Concepts in Biotechnology, Universities Press (2007).*

Reference Books

1. *Gupta, P.K., Elements of Biotechnology, Rastogi Publications (2008).*
2. *Bourgaize, D., Jewell, T.R. and Buiser, R.G., Biotechnology: Demystifying the Concepts, Benjamin Cummings (1999).*

UBT501 Genetic and Metabolic Engineering

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Introduction: Scope of genetic engineering, Milestones in genetic engineering: isolation of enzymes, DNA sequencing, synthesis and mutation, molecular cloning, gene expression, cloning and patenting of life forms, genetic engineering guidelines.

Principles and techniques of recombinant DNA technology: Basic techniques, Different hosts for molecular cloning, Restriction and other enzymes, Cloning vectors: plasmid, bacteriophage and other viral vectors, cosmids, yeast artificial chromosome, Restriction mapping of DNA fragments, Genomic and cDNA libraries, Molecular techniques for cloning, screening, expression & regulation studies of genes, DNA and protein sequencing, Polymerase chain reactions, DNA fingerprinting, RAPD, Site-directed mutagenesis, Expression strategies for heterologous genes in bacteria, yeast, insect cells and mammalian cells, Molecular markers, Detecting protein-protein interactions, High-throughput techniques, Gene therapy

Metabolic Engineering: Introduction, Molecular strategies for rerouting of metabolic pathways in microbes, plants and animals, Various case studies, Directed production of novel molecules in microbes & other organisms having therapeutic & industrial value.

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.

Text Books

1. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*
2. *Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T., Lewin's GENES X, Jones and Bartlett Publishers (2011).*

Reference 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. *Fritsch, J. and Maniatis, E.F., Molecular Cloning, A laboratory Manual, Cold Spring Harbor Laboratory (1999).*

UBT502 Immunotechnology

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Immune System: Overview and History, Innate and Adaptive Immunity, Hematopoiesis, Lymphocytes, Monocytes and Granulocytes, Primary and Secondary lymphoid organs

Antigens and Antibodies: Factors responsible for immunogenicity, Epitopes, Adjuvants, Superantigens, Structure and function of Antibody, Antibody classes, Passive Antibody therapy, Monoclonal Antibody, Antibody engineering, Generationof Antibody diversity, antigen-antibody interactions

Major Histocompatibility Complex (MHC): Major class of MHC, Histocompatibility genes, HLA complex in humans, Structure of MHC molecules, MHC-peptide interaction, Antigen Processing and Presentation, transplantation Immunology, tumor immunology.

Immune effector mechanism: Complement system and their function, Different pathways of Complement activation, Common properties of cytokines, Cytokine types, Biological activities of cytokines, Chemokines, Hypersensitive reactions

Immune system in Health and Disease: Immune response to Infectious disease, Vaccines, AIDS and other Immunodeficiencies, Tolerance and Autoimmunity, Cancer and the immune system, introduction to regenerative medicines.

Immunological techniques: General principles, Precipitation and Agglutination reaction, Immuno-Diffusion (ID), Radio Immuno Assay (RIA), Enzyme Linked Immunosorbent Assay (ELISA), Fluorescent Immuno Assay (FIA), Westen blot, Immunoprecipitation, FACS, RIA, immunoflorescence, Antibody affinity and avidity, Flow cytometry

Laboratory work: Serum and Plasma isolation, Blood film preparation and identification of cells, Immuno-diffusion, Agglutinaton, Western blotting, ELISA, Peripheral blood mononuclear cell isolation from blood, Epitope prediction using Immunoinformatics tool

Text Books

1. *Goldsby, R.A., Kindt, T.J., Osborne, B.A. and Kuby, J., Immunology, WH Freeman & Company (2006).*
2. *Roitt, I.M., Brostoff J. and Male, D., Immunology, Elsevier (2004).*

Reference Books

1. *Khan, F.H., The Elements of Immunology, Pearson Education (2009).*
2. *Chakravarty, A.K., Immunology and Immunotechnology, Oxford University Press (2006).*
3. *Travers, P., Walport, M., Capra J.D. and Janeway, C., Immunobiology: The Immune System in Health and Disease, Garland Science Publishing (2005).*

UBT503 Industrial Biotechnology

L	T	P	Cr
3	0	0	3.0

Prerequisite(s): None

Introduction to Industrial Biotechnology. Origin and preservation of useful microbial strains, strain improvement through mutation and recombination in industrial microorganisms

Selection techniques used in screening for microbial mutants and recombinant strains, Applications of genetic modifications and metabolic engineering; Production of microbial cells.

Microbial production of pharmaceuticals, enzyme inhibitors and specialty chemicals, Microbial production of organic and amino acids, vitamins.

Microbial production of bioflavours and biopigments, Microbial enzyme production; **Bioconversion of antibiotics,** Bioconversion of steroids and sterols, Cell and enzyme immobilization, microorganisms and production of alternative energy, biofuels.

Microbial leaching, Microbial biopolymers, Biosurfactants, Bioinsecticides.

Scale up problems and safety aspects at industrial scale: (rDNA) fermentation processes; Good Large Scale Practice (GLSP); Biohazard/Biocontainment: aspects and design.

Text Books

1. *A.N.Glazer and H. Nikaido, Microbial Biotechnology: Fundamentals of Applied Microbiology, Cambridge University Press (2007).*
2. *M.A. Malden, Industrial Microbiology: An Introduction, Blackwell Science (2001).*

Reference Books

1. *H.W. Blanch, S. Drew, D.I.C.Wang and M. Moo-Young, Comprehensive Biotechnology: The Practice of Biotechnology: Current Commodity Products, Pergamon Press (1985).*
2. *C. Vogel and C.L. Tadaro, Fermentation and Biochemical Engineering Handbook: Principles, Process, Design and Equipment, Noyes Publications (1996).*
3. *P.F. Stansbury and A. Whitaker, Principles of Fermentation Technology: An Introduction to Current Concepts, Pergamon Press (1993).*

UBT504 Food Processing

L	T	P	Cr
2	0	2	3.0

Prerequisite(s): None

Fundamentals of process development: Selection, handling and storage of foods, microbial and physical parameters for process development, simulation based process designing.

Concepts of processing: Thermal processing: types and concept, history, application and future, dehydration and freezing.

Non-thermal technologies: Non-thermal /minimal processes, types, functions, application examples.

Functional foods: Beyond normal functions of body- prebiotic and probiotic foods, nutraceuticals, their role in disease alleviation, production and commercial outlook

Nutritional aspects of foods: Nutritive values of animal and plant foods, estimation of food intake and vital body functions affected by basic food components

Guidelines and recommendations for safe foods: National and international laws, regulatory agencies, industrial practices, GMP, HACCP, ISO and tracaeability.

Packaging and labeling: Microbial pathogenicity, important bacterial, fungal, viral and parasitic diseases of man, Food borne diseases, Common bacterial, viral, fungal disease affecting plants of economic significance.

Laboratory work: Demonstration of non thermal processes for microbial inactivation, designing foods with functionality, measurement of food composition, Identification of nutraceuticals in foods, Identification of food borne pathogens- conventional and rapid, Process modeling of an animal/plant food, development of probiotic foods and substantiation of claims, calculation of D value and fermented food production.

Text Books

1. *Ramaswamy, H.S., Food Processing: Principles & Applications. CRC Press (2008).*
2. *Gould, G.W., Innovations in Food Processing, CRC press (2000).*

Reference Books

1. *Rahman, S. Handbook of food preservation, Taylor & Francis (2009).*
2. *Gonsalvez-Taylor, S., Emerging Techniques in Food Processes, Wiley (2009).*

UBT505 Unit Operations II

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Introduction: Diffusion, Diffusion in Fluids, Molecular diffusion, Equation of continuity for binary system, Fundamental concepts of extraction, Leaching, Crystallization, Humidification and Dehumidification.

Mass Transfer Coefficients: Basic definitions, Turbulent mass transfer and eddy diffusion, Theories of mass transfer, Equilibrium curve, Overall mass transfer coefficient.

Distillation: Vapour-liquid equilibrium data for binary mixtures, Principles of distillation, Differential distillation, McCabe-Thiele method: number of plates, plate efficiency; Distillation columns: bubble cap, sieve plate, valve tray, and packed bed, Principles of azeotropic and extractive distillation.

Absorption and Adsorption: Absorption columns: packed columns, plate columns, Gas Absorption, Choice of solvents, Adsorption equilibria, Batch and continuous adsorption.

Drying: Mechanism and rate of drying, Batch and continuous drying, Equilibrium curve, Types of dryers.

Screening: Types of screens, Material balance over screen, Capacity and Effectiveness of screen, Particle separation efficiency, Particle size analysis.

Filtration: Theory of filtration, Constant rate and constant pressure filtration; Batch and continuous filtration, Filtration equipment: filter press, leaf filter, rotary drum filter, basket centrifuge.

Size Reduction: Principles of size reduction, Crushing efficiency, Rittinger's, Kick's and Bond crushing laws, Energy and power requirement, Size reduction equipments: crushers and grinders.

Laboratory work: Experiments on steam distillation, solid-liquid extraction, adsorption, diffusion and mass transfer coefficients, drying, absorption in packed bed, crystallization, Ball mill, Jaw crusher, Vibrating screens, Filter press.

Text Books

1. *Foust, A.S., Wenzel, L.A., Clump, C.W., Maus L. and Anderson, L.B., Principal of Unit Operations, John Wiley (2008).*
2. *McCabe W.L. and Smith, J.C., Unit Operations of Chemical Engineering, McGraw Hill (2001).*

Reference Books

1. *Treybal, R.E., Mass Transfer Operations, McGraw Hill (1980).*
2. *Sherwood, T.K., Pigford, R.L., and Wilke, C.R., Mass Transfer, McGraw Hill (1975).*

UBT506 Bioanalytical Techniques

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): Biochemistry

Introduction to chromatographic techniques: Column, thin layer, Paper, Ion-exchange, Affinity and Gas Chromatography, High performance liquid chromatography (HPLC)

Electrophoretic techniques: Theory and application of polyacrylamide and agarose gel electrophoresis, electrophoresis of protein and nucleic acids, Capillary electrophoresis

Centrifugation techniques: Introduction, Basic principle of sedimentation, Centrifuges and their uses, safety aspects in the use of centrifuges.

Spectroscopic techniques: Theory and application of UV-VIS, IR, NMR, Fluorescence, Atomic absorption spectroscopy; X-ray diffraction, microarray techniques.

Radioisotopic techniques: Introduction to radioisotopes, their uses and monitoring concept of counting efficiency and autoradiography

Microscopy: Principles of microscopy, Light, dark field, fluorescent, UV, transmission and Scanning electron microscopy, Confocal microscopy

Laboratory work: Paper chromatography, thin layer chromatography, column chromatography, gas chromatography, centrifugation, UV visible spectroscopy, microscopy, Ouchterlony, ELISA, identification of blood group, Agarose gel electrophoresis, SDS-PAGE

Text Books

4. *Pingoud, A., Urbanke, C., Goggett J. and Jeltsch, A., Biochemical Methods – A Concise Guide for Students and Researchers, Wiley-VCH (2002).*
5. *Stryer, A.L., Berg J.A. and Tymoczko, J.L., Biochemistry, W.H.Freeman & Co Ltd (2002).*

Reference Book

1. *Wilson K. and Walker, K., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press (2007).*
2. *Zubey, G.L., Principles of Biochemistry, Pearson-Education (2007).*

UBT601 Bioprocess Engineering

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Introduction: Introduction to Bioprocesses Historical development of bioprocess technology, Basic concepts of bioreactor system design, Importance of bioprocess engineering, Various (upstream and down stream) unit operations involved in bioprocess

Principles of Biochemical Reaction Kinetics: Enzymatic reaction kinetics mass and energy balance in biological system, Kinetics of substrate utilization, Product formation and biomass production in cell cultures, Balance equations for batch and continuous growth with special reference to Monod Chemostat,

Sterilization: Thermal death kinetics for cell and spores, Design criteria for sterilization, Design of batch and continuous sterilization, Filter sterilization for media and air, Design concepts of air sterilization, Design of depth filters.

Transport Phenomena: Transport phenomena in Bioprocess systems, Mass transfer with special importance to oxygen transfer in submerged fermentation, Diffusional mass transfer concepts in immobilized enzymes.

Design and Analysis of Biological Reactors: Basic design and construction of fermenter and ancillaries, Main parameters to be monitored and controlled in fermentation processes, Classification of bioreactors, solid-substrate, slurry fermentation and its applications, Process analysis, design and control.

Downstream Bioprocessing: Importance of downstream processing, Physical separation processes, Separation techniques for intracellular and extracellular products, Chromatography, Membrane processes, Modern Biotechnological applications.

Laboratory: Parts and design of bioreactors, In situ sterilization of fermenters in batch mode, Thermal death kinetics of microorganisms, Growth curves for microorganisms, Batch production of microbial products at lab scale, Scale up production using lab fermemter (3L), $K_L a$ determination for a STR

Text Books

1. *Shuler, M.L. and Kargi, F., Bioprocess Engineering: Basic Concepts, Prentice Hall (2002).*
2. *Aiba, S., Humhery, A.E. and Mills, N.F., Biochemical Engineering, Academic Press (1993).*

Reference Book

1. *Stansbury, P.F. and Whitaker, A., Principles of Fermentation Technology: An Introduction to Current Concepts, Pergamon Press (1993).*

UBT602 Plant Biotechnology

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): 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.

Features of Plants Relevant to their Genetic Engineering: Plant nuclear, chloroplast and mitochondrial genome, Structure of plant genes, Regulation of gene expression, transposons, Cytoplasmic male sterility, Molecular marker.

Genetic Engineering and Manipulation of Phenotypic Traits: Strategies of molecular cloning of plant genes, Methods of plant genetic transformation, *Agrobacterium*-mediated genetic transformation of plants (Ti and Ri-plasmid 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.

Plant Metabolic Engineering: 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. Molecular farming: Production of secondary metabolite and other important compounds using plant cell cultures.

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.

Text Books

1. *Slater, A., Scott, N.W. and Fowler, M.R., Plant Biotechnology, Oxford University Press (2008).*
2. *Cullis, C.A., Plant Genome, Wiley-Liss Publication (2004).*
3. *Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J. and Jayaraman, K., Concepts on Biotechnology, Universities Press (2007).*

Reference Books

1. *Razdan, M.K., Introduction to Plant Tissue Culture, Oxford & IBH Publication (2007).*
2. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics. Blackwell Publishing (2006).*
3. *Satyanarayana, U., Biotechnology, Allied Publishers (2005).*

UBT603 Animal Biotechnology

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, Application, Culture Environment, Cell Adhesion, Cell Proliferation, Differentiation.

Design, Layout and Equipment: Planning, Construction, Layout, Essential, Equipments, Aseptic Technique, Objectives, Elements, Sterile Handling, Safety, Risk Assessment, General Safety, Fire, Radiation, Biohazards

Media: Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Serum-Free Media, Disadvantages of Serum, Advantages of Serum-Free media

Primary Culture: Isolation of Tissue, Steps involved in primary cell culture, Cell Lines, Nomenclature, Subculture and Propagation, Immortalization of cell lines, Cell line designations, Routine maintenance

Characterization & Quantitation of Cell Line: Need for characterization, Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Transformation, Immortalization, Aberrant Growth Control, Tumorigenicity, Cell Proliferation, Plating Efficiency, Labeling Index, Generation Time.

Contamination: Source of contamination, Cross-Contamination; Type of microbial contamination, Monitoring, Eradication of Contamination

Cryopreservation: Need of Cryopreservation, Preservation, Cell banks, Transportation of cell lines.

Transgenic Animals: Methodology, Embryonic Stem Cell method, Microinjection method, retroviral vector method, Applications of transgenic animals

Laboratory work: Laboratory Design & Instrumentation in ATC, Quality Assurance in Animal tissue culture facility, Preparation of animal cell culture media, Isolation and Culturing Peripheral Blood Lymphocytes, Isolation of Chick embryo and establishing primary cultures, Subculturing and maintenance of Cell line, *In vitro* anti-cancer assay (MTT Assay), Handling laboratory mice.

Text Books

1. *Davis, J.M., Basic Cell Culture, Oxford University Press (2005).*
2. *Shenoy, M., Animal Biotechnology, Laxmi Publications (2007).*

Reference Books

1. *Gangal, S., Principles and Practices of Animal Tissue Culture, Universities Press (2007).*
2. *Mathur, S., Animal Cell and Tissue Culture, Agrobios (2009).*

UBT604 Pharmaceutical Technology

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

Introduction to drugs and pharmacy: An overview and history of pharmaceutical industry. The business and the future of Biopharmaceuticals. Drug regulation and control. Scope and applications of biotechnology in pharmacy.

New drug development and approval process: Strategies for new drug discovery, rational drug design, finding a lead compound, combinatorial approaches to new drug discovery, molecular modeling of drugs, pre-clinical and clinical trials. The investigational new drug application and approval process.

Drug pharmacokinetics & pharmacodynamics: Routes of drug administration, membrane transport of drugs, absorption, distribution, metabolism and excretion of drugs. Factors modifying drug action, mechanism of drug action on human beings, receptor theory of drug action, pharmacogenomics, adverse effects of drugs and toxicology.

Pharmaceutical manufacturing: Drug dosage forms and their classification. Sterile dosage forms-parenterals and biologics, novel dosage forms and targeted drug delivery systems. Current good manufacturing practices and issues. Packaging material and packing techniques. Quality control of pharmaceutical products as per pharmacopoeia. Microbial assays of vitamins and antibiotics.

Biotechnology derived pharmaceuticals. Production of pharmaceuticals by genetically engineered cells-hormones, interferons, vaccines. Vacccines-classification, preparation, standardization, analysis and final storage. Methods involved in the production of different vaccines (BCG, DPT). Monoclonal antibodies, DNA vaccine, gene therapy, proteomics in drug development. Blood products and therapeutic enzymes. Regulatory issues in biotechnology products.

Text Books

1. *Gennaro, A.R., Remington: The Science and Practice of Pharmacy. Lippincott Williams and Wilkins (2005).*
2. *Tripathi, K.D., Essentials of Medical Pharmacology, Jaypee Brothers Medical Publishers (2008).*

Reference Books

1. *Allen, L.V., Popovich, N.G. and Ansel, H.C., Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams and Wilkins (2005).*
2. *Walsh, G., Biopharmaceuticals: Biochemistry and Biotechnology, Wiley (1998).*

UBT605 Bioinformatics and Biostatistics

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

Statistics – Introduction to statistics, sampling, variables and data; sampling techniques; probability and distribution; test of hypotheses; confidence limits and tests of confidence; introduction to ANOVA; design of experiments; correlation and regression; basics of cluster and principle component analyses

Bioinformatics – Introduction to bioinformatics; biological databases and search engines; bibliographic databases; sequence analysis; sequence alignment; phylogenetic analysis; protein structure and prediction; functional genomics; fundamentals of algorithms, datamining and bioprogramming; ethical issues in bioinformatics

Laboratory work: Bibliographic searches, Work sheet formulation and data analysis, Statistical softwares, Biological database information search and retrieval, DNA and protein sequence analysis, Phylogenetic analysis, protein databases and visualization programs.

Text Books

1. *Ghosh Z. and Mullick, B., Bioinformatics Principles and Applications, Oxford University Press (2008).*
2. *Zar, J.H., Biostatistical Analysis, Pearson-Prentice Hall (2007).*
3. *Lesk, A., Introduction to Bioinformatics, Oxford University Press (2008).*

Reference Books

4. *Mount, D.W., Bioinformatics Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press (2005).*
5. *Pagano, M. and Gauvreau, K., Principles of Biostatistics, Thomson Learning (2005).*

UBT702 Industrial Waste Management

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Prevention and control in industrial pollution: Environmental analysis of industrial facilities; Preparation of waste inventory and identification of environmental aspects; Waste minimization through source reduction and through recycling and reuse of wastes; Housekeeping activities and their role in the industrial wastes management; US EPAs waste management hierarchy; and Pollution prevention programs.

Wastewater collection, treatment and disposal systems: Segregation and mixing schemes; Pretreatment and its role in the industrial wastewater management; Overview of wastewater treatment technologies and development of wastewater treatment schemes; Operation and maintenance of effluent treatment plants; and Case study of an industrial wastewater management system.

Collection, treatment and disposal of industrial emissions: Overview of industrial emissions; Air pollution control systems and overview of air pollution control technologies; Development of schemes for the collection, treatment and discharge industrial emissions; Operation and maintenance of air pollution control devices; a case of a system for the collection, treatment and discharge of industrial emissions. Solid and hazardous waste handling and management: Facilities and organization setup for the collection, treatment, storage, transportation and disposal of hazardous wastes; handling and disposal of wastes like packaging waste, fly ash, lime sludge, and other non-hazardous wastes.

Regulatory requirements and environmental functions of industrial facilities: Consents, clearances and authorizations; Mandatory reports and returns to be prepared and submitted; Environmental standards; Requirements related to the handling and management of hazardous materials and hazardous wastes; Environmental management systems (EMS) and ISO 14000 series of standards; and Environmental audits.

Text Books

1. *Pichtel, J., Waste Management Practices: Municipal, Hazardous and Industrial, Taylor and Francis (2005).*
2. *Buclet, N., Municipal Waste Management in Europe, Springer (2002).*

Reference Book

1. *Liu, D.H.F. and Liptak, B.G., Environmental Engineers' Handbook, Chapman Hall – CRC Press (1999).*

UBT703 Integrated Pest Management

L	T	P	Cr
3	0	0	3.0

Prerequisite(s): None

Pest-Definition and Concept: Concept of Pest Status, Categories of Pest, Agricultural Insect pests, Non-insect pests (plant parasitic nematodes, phytophagous mites, rodents, birds, plant pathogenic microbes and weeds), Pests associated with human health.

Socio-economic impact of pests: Nature of Damage and Distribution of Pests, Socio-economic Impact of Pests, Historical development of pest management, Pest management strategies, Concept of Integrated Pest management(IPM), Pest Management Decisions–Decision Making System, Major IPM Strategies, IPM Tactics, Quantitative Basis of Pest Management (Sampling, Pest Forecasting, Crop Losses), Decisions in Pest Management, Simulation Models in Pest Management, Remote Sensing in Pest Management, Scope of Traditional Knowledge on Pest Management in Modern Agriculture, Indigenous Practices and Natural Products for Pest Management, Myths and Beliefs about Pest Management.

Pest management strategies: Methods in Pest management (Physical Control, Mechanical Controls, Cultural Control, Behavioral Control,) Pesticides and their nomenclature, Registration of the Pesticide and the Pesticide Label, Pesticide Formulations, Pesticide Application Equipments, Merits and Demerits of Chemical Control, Pesticide Management Issues, Pesticide Management Strategies, Management of Pesticide Resistance.

Ecofriendly methods of pest management: Application of Semiochemicals in IPM, Integration of Pesticides with other Methods, Concept of Biological Control, History of Biological Control, Types of Biological Control, Biopesticides, Quality Control and Registration of Biopesticides, Merits and Constraints in Biological Control, Integration of Biological Control with Other Control Methods.

Role of biotechnology and regulatory issues: Concept of Host Plant Resistance, Integration of Genetic Methods into Pest Management Programmes, Genetic Engineering and its Role in Pest Management, Legislative Control in India, Plant protection and quarantine, Misbranding and Mishandling of pesticides, International Regulations, Pest Risk Analysis, Goals of IPM, IPM Strategies, Levels of IPM and their Integration, IPM Programme Development–Planning, Research Status Analysis, Implementation, Adoption of IPM Programmes, Limitations to IPM Tactics.

Text Books

1. *Dent, D. and Elliott, N.C., Intergrated Pest Management, Springer (1995).*
2. *Peshin, R., Integrated Pest Management, Springer (2009).*

Reference Books

1. *Koul, O. and Dhaliwal, G.S., Biopesticides and Pest Management, Campus Books International (2003).*
2. *Mishra, S.R., Plant protection and Pest Management , Discovery Publishing House (2005)*

UBT704 Trends in Food Biotechnology

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): Microbiology & Basic food sciences

Consumer and food: perception, organoleptics and relation of nutrition to health, nutragenomics.

Food hazards: microbial, parasitic and viral, chemicals; engineered hazards- threats; methods for detection and documentation

Functional foods: Nutritional benefits of functional molecules, molecular nutrition, antioxidants, prebiotics, probiotics, symbiotic foods.

Functional foods: Beyond normal functions of body- human gut , prebiotic, probiotic foods, nutraceuticals, their role in disease alleviation, processing options for functional foods, functionality of foods in the real time scenario, production and commercial outlook.

Regulations: National and international norms, traceability, HACCP, GMP and ISO.

Geneticallymodified foods: Plant and animal GM foods, consumer perception, risks of GM foods, analysis and tracking of GM foods, national and international status, case studies.

Food designing and processes: advanced and conventional processing, packaging and labeling, designing safe and nutritious foods, prediction based approach for designing and production of foods.

Text Books

1. *Shetty, K., Plaiyath, G., Pometto, A. and Levin, R.E., Functional Foods & Biotechnology, CRC Press (2006).*
2. *Shetty, K., Plaiyath, G., Pometto A. and Levin, R.E., Food Biotechnology, CRC press, (2005).*

Reference Books

1. *Weabel, L.H., Inside the controversy of GM foods, Amacom books (2009).*
2. *Noleet, Y., Toldra, M. and Hui, H., Advances in Food diagnostics, Wiley-Blackwell (2007).*

UBT801 Biosafety, Bioethics and IPR

L	T	P	Cr
2	1	0	2.5

Prerequisites: None

Biosafety: History, evolution and concept of Biosafety; need and application of Biosafety in laboratories and industries; International and National norms regarding Biosafety; Bio-medical wastes; transportation of biological materials; bio-terrorism – routes and intervention strategies Classification and Description of Biosafety levels; Design of clean rooms and Biosafety labs; Biosafety regulations to protect nature, growers and consumers interest and nation interest; Risk for animal/human/agriculture owing to GMOs; Risk for environment owing to GMOs

BioEthical issues in Biotechnology: Introduction, types of risk associated with GMM, maintaining of GMM in environment, ethics related to human cloning, agriculture and animal rights concerns, data privacy of citizens health**;** Ethical Issues involving GMOs; Ethical Issues in India and Abroad

Patenting in Biotechnology: Introduction to IPR, Patent, Patent law, Legislations covering IPR's in India, product planning and development, filing patent etc.

Biosafety guidelines: ICMR and DBT guidelines; stem cell research

Text Books

1. *Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)*
2. *Singh I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).*
3. *Srinivasan, K. and Awasthi, H.K., Law of Patents, Jain Book Agency (1997)*

Reference Books

4. *Narayan, P., Patent Law, Eastern Law House (1975).*
5. *Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).*
6. *Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).*

UBT802 Nanobiotechnology

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Basic Concepts of Nanoscience: Dimensions of nanoscience, Size of bulk versus nanomaterials, Speciality of nanomaterials. Quantum dots and size effect, Classification and properties of nanomaterials, Morphology of nanoparticles: Microscopic composites; macroscopic composites. Nanocrystalline phase, Electronic structure of nanoparticles, Physics of small systems & theoretical principles, Effects of surface functionalisation and optical properties, Role of surfaces in nanotechnology devices, Micelles, Colloids Surface active agents, Critical micellar concentration (CMC), Nanoparticle synthesis techniques.

Crystal Structure and Characterization: Metal, Ceramics, Semiconductors, Band gap energy, Size and shape dependent physical, chemical properties and applications of Au, Ag, Cu, TiO_2, CdS, CdSe nanoparticles, Graphite, Graphene, Fullerenes and Carbon nanotubes, Optical Microscope and operational principle and analysis of nanomaterials, UV-Visible, Fluorescence Spectrophotometers X-ray diffraction, Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Transmission Electron Microscope (TEM), EDAX analysis.

Biomaterials Science: Microorganisms for synthesis of nanomaterials, Role of plants in nanoparticle synthesis, Classification of biomaterials, Biocompatibility, Interaction between bimolecules and naoparticle surface Natural Biomaterials, Biopolymers & Ceramics, Some nanocomposite biomaterials, teeth and bone substitution, Natural nanocomposite systems as spider silk, bones, shells; Metallic, Ceramic and Polymeric implant materials, Bio-nanosensors and Orthopaedic Biomaterials, Biomaterials in Tissue Engineering.

Biomedical Applications: Current status of nanobiotechnology, Nanotechnology in Diagnostics applications, Materials used in Diagnostics and Therapeutic application, Anti bacterial activity Future perspectives of Nanobiology, Developing of Nanomedicines, Biomaterials in Tissue Engineering, DNA fingerprinting & forensics, DNA-Based Nanomaterials as Biosensor of various types, Drug Carriers & Delivery System, Cancer treatment, Phodynamic therapy, Probes for bioimaging, Cardiovascular medical devices. Toxicological health effects caused by nanoparticles.

Text Books

1. *Lindsay, S.M., Introduction to Nanoscience, Oxford University Press (2010).*
2. *Niemeyer C.M. and Mirkin, C.A., Nanobiotechnology: Concepts, Applications and Perspectives, Wiley-VCH (2004).*
3. *Balaji, S., Nanobiotechnology, MJP Publishers (2010).*

Reference Books

1. *Wang, Z.L., Characterization of Nanophase Materials, Wiley-VCH (2000).*
2. *Rao, C.N.R., Muller, A. and Cheetham, A.K., The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. 1&2, Wiley-VCH (2004).*
3. *Kumar, C.S.S.R., Hormes, J. and Carola, L., Nanofabrication towards biomedical applications, Wiley-VCH (2005).*

UBT803 Reaction Engineering and Enzyme Technology

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Introduction to Reaction Engineering : Classification of reactions, Kinetics of chemical reactions, Definition of reaction rate and rate constant, Determination of rate constant by graphical and initial rate method.

Kinetic data interpretation: Constant volume batch reactor, Differential and integral methods of analysis, Rate equations for irreversible first and second order reactions, Autocatalytic reactions, Series and parallel reactions, Reversible reactions, Variable volume system.

Ideal reactors: Introduction to reactor design, Ideal reactors, Performance equations for batch, semi-batch, plug flow and mixed flow reactors; Comparison of different types of reactors, Multiple reactor systems, Reactor of different types in series, recycle reactors; Introduction to non – ideality in Reactors, RTD, Conversion in non – ideal reactors.

Heterogeneous Reactions: Rate equations, Selection of Model, Progressive conversion model, Un-reacted-core model, Diffusion through gas film, ash layer and chemical reaction controls.

Introduction to Enzyme Technology: Introduction to enzyme reactions, applications of enzymes in food industry, pharmaceutical, medical and analytical applications of enzymes.

Kinetics of Free Enzyme Reactions: Single substrate steady state kinetics; Michaelis-Menten and Brigg's-Haldane Kinetics; King-Altman's method; competitive, non-competitive and substrate inhibition; effect of pH and temperature.

Immobilized Enzyme reactions: Free versus immobilized enzyme systems; types of immobilization – carriers (matrix), adsorption, covalent coupling, cross-linking and entrapment; mass transport, effectiveness factor. Effect of organic media on enzymatic reactions.

Enzyme Reactor System: Ideal reactor – batch, plug flow and mixed flow; Kinetics determination using flow reactors, Enzyme stabilization by selection of genetic and protein engineering, enzyme production and purification, operational strategies for maximizing production in enzyme reaction systems.

Laboratory work: Order of Reaction and rate constant; Effect of temperature; Batch reactor, CSTR, CSTR series; Packed bed; Kinetics of enzymes; Immobilization; Influence of substrate concentration, pH and temperature on the rate of enzymatic reaction.

Text Books

1. *Buchholz, K., Kasche, V. and Bornscheuer, U.T., Biocatalysts and Enzyme Technology, Wiley-VCH (2005).*
2. *Bailey, J.E. and Ollis, D.F., Biochemical Engineering Fundamentals, McGraw-Hill (1986).*
3. *Levenspiel, O., Chemical Reaction Engineering, John Wiley & Sons (1998).*

Reference Book

1. *Atkinson, B. and Marituna, F., Biochemical Engineering and Biotechnology Handbook, Macmillan-Stockton (1991).*

UBT821 Biomanufacturing

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Biotechnology: Introduction to the biotechnology industry, Variety of biotechnological products, Product selection, Role of industrial microbiology, recombinant DNA technology, cell culture and Bioprocess technology in biotechnology product development. Optimization strategies for large scale biomanufacturing processes i.e with respect to organisms, media, fermentation and downstream processing for product recovery.

Regulatory Aspects & QA: Good laboratory Practices (GLP), Good manufacturing Practices (GMP); FDA regulations on Pharmaceutical and Biopharmaceutical manufacturing; Quality Assurance and Quality Control; Standard Operating procedures (SOP) and documentation.

Manufacturing requirements: Facilities and Operations, Aseptic handling procedures and validation; upstream and downstream processing; CIP and SIP theory; Quality Control and Validation; Preclinical and Clinical considerations.

Manufacturing Processes: Paclitaxel Production (Plant Cell Culture Technology); production of Monoclonal antibody by hybridoma technology; Vaccine technology- bacterial and viral vaccines produced by classical and recombinant methods, Erythropoietin production, Production of–penicillin; microbial biopolysaccharides viz. Xanthan, Dextran, Streptokinase- therapeutic enzyme, Glucose isomerase; Fermentative Production of Polyesters,.

Technoeconomics of Biotechnology Industries: Plant Design and Cost; Fermentation: economics and process appraisal; Legal, social and ethical aspects of biotechnology; Legal implications and public concerns in usage of genetically modified organisms for bioproduct/ product biomanufacturing.

Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad, Biosafety assessment of biotech pharmaceutical products such as drugs/vaccines etc.

Laboratory work: bench scale optimization - Citric acid production; Penicillin production; Mutational improvement of Aspergillus for citric acid production; Protoplast isolation and fusion of Aspergillus for strain improvement of fungi; Isolation and optimization of amylase production in shake flask; Bench scale optimization for amylase production; Isolation and partial purification of amylase.

Text Books

1. *Walsh, G., Biopharmaceuticals : Biochemistry and Biotechnology, John Wiley & Sons (1998).*
2. *Zhong, J.J., Advances in Biochemical Engineering and Biotechology: Biomanufacturing, Springer Verlag (2004).*

Reference Books

1. *Rick, N.G., Drugs: From Discovery to Approval, Wiley-Blackwell (2009).*
2. *Vogel, C. and Tadaro, C.L., Fermentation and Biochemical Engineering Handbook: Principles, Process, Design and Equipment, Noyes Publications (1996).*

UBT822 Environmental Biotechnology

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

Introduction to Environment. Basic concepts and issues.

Industrial Wastewater Management: Microbiology of waste water treatment unit operations: Aerobic process(Activated sludge, Oxidation ditches, Trickling filters, towers, rotating discs, rotating drums, oxidation ponds). Anaerobic processes: anerobics- digester dynamics, Anaerobic filters, Up flow anaerobic sludge blanket reactors, emerging biotechnological processes in waste – water treatment. Treatment schemes for waste waters of Dairy, pulp, dye, leather and pharmaceuticals

Solid waste: Sources and management (Composting, wormiculture and methane production).

.**Biofuel**: Plant derived fuels, Energy crops, Biogas, Bioethanol, biohydrogen

Biodegradation of xenobiotic compounds: Hydrocarbons, substituted hydrocarbons, polyaromatic hydrocarbons oil pollution, surfactants, pesticides, Microbial biotransformation of pesticides and xenobiotics in environment.

Bioremediation and Biorestoration: Bioremediation of contaminated soils and waste land Concepts of bioremediation (in-situ and ex-situ), Bioremediation of toxic metal ions – biosorption and bioaccumulation principles. Concepts of phytoremediation.

Environmental genetics: Degradative plasmids, release of genetically engineered microbes in environment. Biosafety and Bioethics in Biotechnology**.**

Environmental laws and policies.

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, Toxicity Assessment, Biosensors.

Text Books

1. *Scargg, A., Environmental Biotechnology, Longman (1999).*
2. *Wainwright, M., An Introduction to Environmental Biotechnology, Kluwer Academic Press (1999).*

Reference Book

1. *Rittmann, B. and McCarty, P., Environmental Biotechnology: Principles and Applications, McGraw-Hill (2006).*

UBT823 Genomics and Proteomics

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

Genome Characterization: Introduction to Genome Organization, Genome size, Complexity of genome, Organellar genomes, Physical and genetic maps

Genome Mapping, Sequencing and Analysis: Repeat Sequences and Centromeric sequence, Satellite DNA, LINES and SINES, Alu repeats, Transposons RFLP, AFLP, EST and RAPD, Sequencing genomes and annotation, Human genome project, Annotation and Genome structure, Comparative genomics of bacteria, organelles and eukaryotes

Transcriptomics: Patterns of gene expression, Differential Gene Expression and profiling, SAGE, Microarrays, functional genomics, Real Time PCR

Expression Analysis of Proteome: Introduction to Proteomics, Differential Protein Expression, 2D Electrophoresis – Technique, Mass spectroscopy, Expression analysis of Proteins, High throughput protein annotation, Protein modification analysis

Protein Interactions: Expression libraries and Y2H system, Protein-protein interaction studies, Systematic analysis of Protein complexes, Human protein network, Interactome, Applications of Genomics and Proteomics

Laboratory work: dbSNP at NCBI with OMIM, Genome databases in NCBI, The Kyoto Encyclopedia of Genes and Genomes (KEGG), Protein Interaction Databases (BioGRID), Gene expression database (ATLAS) in EMBL-EBI, Comparative Genomics related problems

Text Books

1. *Lesk, A.M., Introduction to Genomics, Oxford University Press (2007).*
2. *Ghosh, Z. and Mullick, B., Bioinformatics Principles and Applications, Oxford University Press (2008).*

Reference Books

1. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell (2007).*
2. *Campbell, A.M. and Heyer, L.J., Discovering Genomics, Proteomics and Bioinformatics, Pearson Education Inc. (2007).*
3. *Mount, D.W., Bioinformatics Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press (2005).*

UBT831 Advanced Bioinformatics

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): 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, MULTALLIGN, BLOCKS, ALSCRIPT, Macbox, Phylogenetic analysis, tree building, evaluation of trees and blocks, detection of functional sites, repeat analysis, AAcompledent and AAcompsin; Propsearch, Sequence, Physical property interpretation, nnPredict, ssPred, SOPMA.

Modelling Softwares: GCGsequence analysis, Oligoprimer 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, Comparative genomics and proteomics, Biodiversity informatics and phylogenetic analysis, Chemical graphic visualization and informatics, introduction to machine learning techniques

Text Books

1. *Dwyer, R.A., Genomic Perl: From Bioinformatics Basics to Working Code, Cambridge University Press (2003).*
2. *Higgins D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks – A Practical Approach, Oxford University Press (2000).*

Reference Books

1. *Gusfeld, D., Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology, Cambridge University Press (1997).*
2. *Mount, D.W., Bioinformatics Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press (2005).*
3. *Leach, A.R., Molecular Modelling: Principles and Applications, Pearson-Education, Singapore (2001).*

UBT832 Concepts in Biomedical Instrumentation

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Introduction: Man-instrument systems, Origin of bio-signals, Classification of biomedical instruments, Performance parameters of instruments, static & dynamic characteristics, classification of errors, statistical analysis, speed of response, Physiological systems.

Transducers, Electrodes and signal conditioners: Principles and classification of transducers for bio-medical applications, Electrode theory, Different types of electrodes; Selection criteria for transducers and electrodes. Bioelectric amplifiers, isolation amplifiers, and instrumentation amplifiers.

Cardiovascular System Measurements: Measurement of blood pressure, Blood flow, Cardiac output, Cardiac rate, Heart sounds; Electrocardiograph, Phonocardiograph, Plethysmograph, Echocardiograph, Holter monitor and Cardiac stress test

Respiratory System Measurements: Measurement of gas volume, Flow rate, Carbon-dioxide and oxygen concentration in exhaled air, Spirometery

Instrumentation for Clinical Laboratory: Measurement of pH value of blood, Tests on blood, blood gases ESR measurement, Auto-analyzers; Biochemistry and haematology**.**

Measurement of Electrical Activity in Neuromuscular System and Brain: Neuron potential,

Muscle potential, Electromyograph, Brain potentials, Electroencephalograph

Medical Imaging: Diagnostic X-rays, CAT, MRI, Thermography, Ultrasonography, Medical use

of isotopes

Sensory and behavioral measurements: Audiometer, GSR, Biofeedback instrumentation

Patient Care, Monitoring and Safety Measures: Elements of intensive care monitoring; Basic hospital systems and components; Physiological effect of electric currents, Shock hazards from electrical equipment, Safety measures; Standards, Codes & practices. Accident prevention

Computer Applications and Bio-telemetry: Real time computer applications, Data acquisition and processing, Remote data recording and management

Prosthetics and Orthotics: Introduction to Artificial kidney, Artificial heart, Heart lung machine, Limb prosthetics and orthotics; Introduction to cardiac pacemakers, Defibrillators,ventilators, Diathermy

Lasers: Application of Lasers to Biomedical sciences

Laboratory: Study of various physiological parameters using multi-channel recorder, Study of pulse oximeter, Study of various parameters of spirometer associated with lungs capacity, Study of ECG signal for 12 lead system, EEG frequency analysis, Ultrasonic characterization study of biological samples

Text Books

1. *Carr J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Pearson Education (2004).*
2. *Webster, J. G., Bioinstrumentation, John Wiley & Sons (2007).*

Reference Books

1. *Bronzino, J.D., Biomedical Engineering Fundamentals, Taylors and Francis (2006).*
2. *Khandpur, R.S., Handbook of Biomedical Instrumentation, Tata McGraw-Hill (2008).*
3. *Enderle, J. D., Bioinstrumentation, Morgan and Claypool Publishers (2006).*

UBT833 Molecular Pharming

L	T	P	Cr
3	0	2	4.0

Prerequisites: Genetic & Metabolic Engineering

Introduction: Transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Advantages of molecular pharming in plant systems.

Strategic details of various molecular Pharming: Production of carbohydrates: amylose-free starch, high-amylose starch, cyclodextrins, fructans, trehalose; Production of lipids: medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, Production of rare fatty acids, Production of biodegradable plastics in plants.

Genetically engineered plants as protein factories: enzymes for industrial and agricultural uses, medically related proteins-antibodies (plantibodies), subunit vaccines, protein antibiotics, The oleosin system: hirudin and insulin production, production of biopharmaceuticals in plants, Economic and regulatory considerations for molecular farming.

Laboratory work: Isolation & characterization of genomic & cDNA clones relevant to molecular farming, making genetic constructs, Transient expression studies in plants, Genetic transformation of plants, Gene expression studies, studying molecular techniques/protocols related to various case studies: production of carbohydrates, lipids, proteins, antibodies, edible vaccines,

Text Books

1. *Slater, A., Scott, N.W. and Fowler, M.R., Plant Biotechnology, Oxford University Press (2008).*
2. *Barnum, S.R., Biotechnology - An Introduction, Thompson Brooks/Cole (2007).*
3. *Satyanarayana, U., Biotechnology, Books and Allied (P) Ltd. (2005).*

Reference Books

1. *Primrose S.B., and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*
2. *Primrose, S.B., Molecular Biotechnology, Panima Publishing Corporation (2001).*