

Department of Biochemical Engineering and Biotechnology

BBL131 Principles of Biochemistry

4.5 Credits (3-0-3)

Introduction-aims and Scope; Non-covalent interactions in biological systems, Carbohydrates-structure and function; Proteins-structure and function; Nucleic acids-structure and function Protein purification techniques; Introduction to enzymes; Vitamins and coenzymes; Lipids and biological membranes; Transport across cell membrane; Design of metabolism; Metabolic pathways for breakdown of carbohydrates-glycolysis, pentose phosphate pathway, citric acid cycle, electron transport chain, Photo-phosphorylation; Oxidation of fatty acids; Gluconeogenesis and control of glycogen metabolism, Signal transduction.

Laboratory: Estimation of proteins and nucleic acids; Extraction of lipids; Separation of lipids using thin layer chromatography, Gel filtration and ion exchange chromatography; Gel electrophoresis, Determination of enzymatic activities and determination of K_m , V_{max} . Identification of intermediates of EMP pathway.

BBL132 General Microbiology

4.5 Credits (3-0-3)

The topics include introduction to prokaryotic and eukaryotic cell structure; different groups of microorganisms; microbial nutrition and growth; metabolism including important pathways; reproduction and recombination; preservation and control of microbial cultures; viruses; microbial pathogenicity.

Laboratory: Preparation and sterilisation of culture media, isolation of bacteria, Staining, Biochemical tests for identification of microorganisms, Antibiotic sensitivity, Bacterial growth curve, effect of environmental factors on bacterial growth, microbial diversity in environmental samples.

BBL133 Mass and Energy Balances in Biochemical Engineering

3 Credits (3-0-0)

Overlaps with: CLL111

Stoichiometric relations and yield concepts, Maintenance coefficient, Mass balance based on available electron concept; Units and dimensions, Fundamentals of material balance, Balance on unit processes and reactive systems, Behaviour of ideal and real gases, vapour pressure, humidity and saturation. Energy balance, Heat capacity of gases, liquid and solids, Latent heat, Heat of reaction, formation and combustion, solution and dilution. Energy balance of reactive and non-reactive processes. Unsteady state material and energy balance in bioprocess. Case studies.

BBL231 Molecular Biology and Genetics

4.5 Credits (3-0-3)

Pre-requisites: BBL131, BBL132

Historical development and essentials of Mendelian genetics. Chromosomal theory of inheritance. Evolution and development of molecular biology. DNA model and classes. Organization of eukaryotic chromosome – the chromatin structure. Gene structure and Genome. Transposon. Genetic Information and its perpetuation – DNA replication, damage and repair. Telomere and Aging. Transcription, translation. Molecular biology of bacteriophage lambda. Gene exchange in bacteria. Gene regulation in prokaryotes. The operon model – lac, ara, trp operons and gene regulation. Gene Regulation in Eukaryotes. DNA Methylation and Genomic Imprinting.

Laboratory: Isolation of genomic and plasmid DNA, Agarose Gel Electrophoresis of DNA, Restriction digestion of DNA, RNA isolation, Primer design, PCR, RT-PCR, Competent cell preparation and Transformation, Gene Induction.

BBL331 Bioprocess Engineering

3 Credits (3-0-0)

Pre-requisites: BBL132, BBL133

Microbial growth, substrate utilisation, and product formation kinetics; simple structured models; batch, fed-batch, repeated fed-batch,

CSTR, CSTR with recycle, multistage CSTRs, and PFR; aeration and agitation; rheology of fermentation fluids; mixing and scale-up; air sterilization; media sterilization; design of fermentation media; aseptic transfer.

BBP332 Bioprocess Engineering Laboratory

1.5 Credits (0-0-3)

Pre-requisites: BBL131, BBL132

Laboratory: Design and execution of simple laboratory scale experiments on the following topics: Estimation of cell mass; different phases of microbial growth; Mass and energy balance in a typical bioconversion process; Concept of limiting nutrient and its effect on cell growth; growth inhibition kinetics; product formation kinetics in a fermentation process; aerobic and anaerobic bioconversion process; power consumption in a fermentation process and its correlation with rheology of the fermentation fluid; different agitator types; mixing time in a bioreactor; quantification of K_La in a fermentation process; Heat balance across a batch sterilization process; Assembly and characterization of pH/DO electrodes.

BBL341 Environmental Biotechnology

3 Credits (3-0-0)

Pre-requisites: CVL100 and EC 80

Principles and concepts of ecosystem; Energy transfer in an ecosystem; Nutrient cycling; Basics of Environmental Microbiology, Environmental health: Ecotoxicology – Heavy metals, pesticides and their effects, Indices of toxicity, Measurement of pollution (techniques and instrumentation), Dose-response relationship. Microbial biosensors in environmental monitoring, Environmental technologies: Microorganisms and renewable sources of energy, Biodegradation and bioremediation (phyto and microbial), Energy and nutrient recovery during waste treatment, Risk assessment: Life cycle analysis, Molecular tools in Environmental Biotechnology, Role of biotechnology in environmental protection.

BBL342 Physical and Chemical Properties of Biomolecules

3 Credits (2-1-0)

Pre-requisites: BBL131

Characteristic features of Biological system, Structure-function relationships. Characterization of biomolecules by molecular shape, size and molecular weight. Properties of biomolecules in solution: Diffusion, ultra-centrifugation and electrophoresis. Optical properties of biomolecules; Spectroscopic methods: IR, NMR, Optical rotary and circular dichroism & imaging methods: Bright, darkfield and fluorescence imaging.

BBL343 Carbohydrates and Lipids in Biotechnology

3 Credits (2-1-0)

Pre-requisites: BBL131 and EC 60

Introduction, Molecular structure of polysaccharides, Enzymes degrading polysaccharides, Physical properties of polysaccharides, Production of microbial Polysaccharides, Food usage of exopolysaccharides, Industrial Usage of exopolysaccharides, Medical applications of exopolysaccharides Molecular structure of lipids, Physical properties of lipids, Oleaginous microorganisms and their principal lipids, Production of microbial lipids, Modification of lipids for commercial applications, Extracellular microbial lipids and biosurfactants, Micelles and reverse micelles in biology, Liposomes in drug delivery.

BBV350 Special Module in Biochemical Engineering and Biotechnology

1 Credit (1-0-0)

BBD351 Mini Project (BB)

3 Credits (0-0-6)

Pre-requisites: EC 60

BBL431 Bioprocess Technology

2 Credits (2-0-0)

Pre-requisites: EC25

Chemical vs biochemical processing; Substrates for bioconversion processes; Process technology for production of primary and secondary metabolites such as ethanol, lactic acid, citric acid, amino acids, biopolymers, industrial enzymes, penicillin, recombinant glutathione and insulin.

BBL432 Fluid Solid Systems

2 Credits (2-0-0)

Pre-requisites: CLL231

Size reduction; crushing and grinding; equipment for size reduction; screening; design procedure; Flow of fluids past a stationary particle for low, medium and high Reynolds numbers; sedimentation and sedimentation theory; thickeners and classifiers; flow through packed beds; flow distribution, packing and pressure drop calculations; fluidization; filtration theory and its application in plate and frame and rotary vacuum filters; solid-liquid separation using centrifugation; 'Δ' concept in centrifugation for scale-up; different types of centrifuges and their design; application for biological suspensions.

BBL433 Enzyme Science and Engineering

4 Credits (3-0-2)

Pre-requisites: BBL431

Introduction and scope; Chemical and functional nature of enzymes; Application of enzymes in process industries and health care; microbial production and purification of industrial enzymes; kinetics of enzyme catalysed reactions; immobilization of enzymes; stabilization of enzymes. Bioreactors for soluble and immobilized enzymes, mass transfer and catalysis in immobilized reactors. Enzyme based biosensors; enzyme catalysed process with cofactor regeneration; Enzyme reactions in micro-aqueous medium and non-conventional medium. Laboratory: Assay of enzyme activity and specific activity; kinetic analysis of an enzyme catalysed reaction; Immobilization of enzymes by adsorption and covalent binding; salt precipitation of an enzyme; immobilization of microbial cells by entrapment; effect of water and solvent on the lipase catalysed esterification reaction.

BBL434 Bioinformatics

3 Credits (2-0-2)

Pre-requisites: BBL131, BBL132

The topics include introduction to bioinformatics - resources and applications, Biological sequence analysis, sequence alignment, molecular phylogenetic analysis, genome organization and analysis, protein analysis, molecular modeling and drug design.

BBL441 Food Science and Engineering

3 Credits (3-0-0)

Chemical constituents of foods, their properties and functions; Characteristic features of natural and processed foods; Chemical/biochemical reactions in storage/handling of foods; Units operations in food processing- size reduction, evaporation, filtration etc.; Methods for food preservation; Rheology of food products; Flavour, aroma and other additives in processed foods; case studies of a few specific food processing sectors, cereals, protein foods, meat, fish and poultry, vegetable and fruit, milk products; legislation, safety and quality control.

BBL442 Immunology

4 Credits (3-0-2)

Pre-requisites: BBL131, BBL132, BBL231

Historical background, Innate and acquired immunity. Cells and organs of immune system. Molecules of immune system – immunoglobulins, MHCs, Cytokines, T cell receptors. Generation of antibody and T cell receptor diversity. Complement system. Humoral and Cell mediated immunity. Immune regulation. Vaccines. Hybridoma. Immunodeficiencies and AIDS. Transplantation immunity and cancer.

BBL443 Modelling and Simulation of Bioprocesses

4 Credits (3-0-2)

Pre-requisites: BBL331

Types of kinetic models, Data smoothing and analysis, Mathematical representation of Bioprocesses, Parameter estimation, Numerical Integration techniques, Parameter Sensitivity analysis, Statistical validity, Discrimination between two models. Case studies Physiological state markers and its use in the formulation of a structured model, Development of compartment and metabolic pathway models (Software Probe) for intracellular state estimation. Dynamic Simulation of batch, fed-batch steady and transient culture metabolism, Numerical Optimization of Bioprocesses using Mathematical models.

BBL444 Advanced Bioprocess Control

3 Credits (3-0-0)

Pre-requisites: CLL261

The course begins with an overview of classical control theory leading to a detailed analysis of the stability of biological systems. Lyapunov stability is introduced followed by concepts of nonlinear control theory and applications to bioreactors. Control loops in metabolic and protein networks are discussed in the background evolution and motifs selected by natural systems. This leads to the introduction of large protein interaction networks and study of their architectures. Applications of these ideas in apriori analysis of synthetic circuits are examined. The course ends with case studies from the literature.

BBL445 Membrane Applications in Bioprocessing

3 Credits (3-0-0)

Milk/cheese processing, Fruit/sugarcane juice processing, Pharmaceuticals/ Therapeutic drugs processing and membrane coupled separation of biomolecules; Membrane based bioreactor for cell/enzyme recycle; Mammalian/plant cell culture; Case studies.

BBL446 Biophysics

3 Credits (3-0-0)

Pre-requisites: PYL101, BBL131

Spectroscopic methods in biophysics, conformational changes in biological processes, biological energy conservation and transduction, photosynthesis, transport across biomembranes, the biophysics of motility, the biophysics of the nerve impulse, single molecule biophysical studies.

BBL447 Enzyme Catalyzed Organic Synthesis

3 Credits (2-0-2)

Pre-requisites: BBL131 and EC 90

Enzymes as biocatalysts. Various reaction media for enzyme catalyzed reaction [water, water poor media such as organic solvents, ionic liquids] and mixed solvents. Advantages of medium engineering. Fundamentals of non-aqueous enzymology [pH memory, molecular imprinting]. Improving biocatalysis in water and water poor media [chemical modification, immobilization, applications of protein engineering/directed evolution]. Enzyme promiscuity and its applications in organic synthesis. Biocatalytic applications in organic synthesis, hydrolytic reactions, oxidation reduction reactions, formation of C-C bond, addition and elimination reactions, glycosyl transfer reactions, isomerization, halogenation/dehalogenation reactions.

BBD451 Major Project Part 1 (BB1)

3 Credits (0-0-6)

BBD452 Major Project Part 2 (BB1)

8 Credits (0-0-16)

BBL731 Bioseparation Engineering

4.5 Credits (3-0-3)

Pre-requisites: BBL331, BBL432, BBL433

Characteristics of bio product, flocculation and conditioning of

fermented medium, Revision of mechanical separation (filtration, Centrifugation etc.), cell disruption, Protein precipitation and its separation, Extraction, Adsorption Desorption processes, Chromatographic methods based on size, charge, shape, biological affinity etc., Membrane separations- ultrafiltration and electrodialysis, Electrophoresis, Crystallization, Drying, Case studies. Laboratory: Conventional filtration batch & continuous, Centrifugation in batch and continuous centrifuge, Cell disruption, Protein precipitation and its recovery, Thin Layer Chromatography (TLC), Membrane based filtration- ultrafiltration in cross. Flow modules and microfiltration, electrodialysis, Adsorption Column Studies and Freeze Drying Studies.

BBL732 Bioprocess Plant Design

4 Credits (3-0-2)

Pre-requisites: APL100 CLL251 CLL252 BBL331 BBL432

Introduction; General design information; Mass and energy balance; Flow sheeting; Piping and instrumentation; Materials of construction for bioprocess plants; Mechanical design of process equipment; Vessels for biotechnology applications; Design considerations for maintaining sterility of process streams and processing equipment; Selection and specification of equipment for handling fluids and solids; Selection, specification and design of heat and mass transfer equipment used in bioprocess industries; Utilities for biotechnology production plants; Process economics; Bioprocess validation; Safety considerations; Case studies.

Laboratory: Design of the complete process plant for an identified product or service. Each student to choose a separate product/industry

BBL733 Recombinant DNA Technology

3.5 Credits (2-0-3)

Pre-requisites: BBL131, BBL132, BBL231 or Masters' degree in Bioscience

Restriction and other modifying enzymes, Cloning vectors (plasmid, (-based, phagemids, high capacity) and expression vectors, Expression in bacterial, yeast and mammalian systems, Construction of genomic and cDNA libraries, DNA Sequencing, Polymerase chain reaction, Invitro mutagenesis, Genome mapping, Stability of recombinant cells in production of biochemicals.

BBL734 Metabolic Regulation and Engineering

3 Credits (3-0-0)

Pre-requisites: BBL331, BBL431

Regulatory mechanisms for control of enzyme synthesis - an overview; Control of enzyme activity- proteolysis, covalent modification and ligand binding; Metabolic control theory and metabolic flux analysis; Metabolic regulation of a few major metabolic pathways especially those relevant to bioprocess industries; Pathway engineering; Application of gene cloning in re-directing cellular metabolism for over-production of a few industrial products; Strategies to overcome regulatory mechanisms for over-production of several industrially important primary and secondary metabolites such as alcohols, organic acids, amino acids, enzymes and therapeutic compounds.

BBL735 Genomics and Proteomics

3 Credits (2-0-2)

Pre-requisites: BBL231, BBL733

Introduction to -omes and -omics; GENOMICS - Genome sequencing and assembly; Next-generation sequencing; Studying gene expression and function; High throughput gene expression and analysis. PROTEOMICS - Sample preparation; Separation methods; Mass Spectroscopy and de novo sequencing; Comparative Proteomics; Protein-protein interactions.

BBL736 Dynamics of Microbial Systems

3 Credits (3-0-0)

Pre-requisites: BBL331, BBL432, BBL433

Stability analysis; analysis of multiple interacting microbial populations; stability of recombinant cells; Structured models of gene expression and growth, Cell cycle and age-dependent (segregated) models, Single-cell (stochastic) models of gene expression.

BBL737 Instrumentation and Analytical Methods in Bioengineering

3 Credits (2-0-2)

Pre-requisites: BBL131

Introduction to methods used in Analytical Bioengineering, Electrophoretic methods, Principles and applications of chromatography (GC, HPLC, FPLC, HPTLC), Spectrophotometry (UV-visible), Fluorescence methods, FTIR, Circular dichroism, Mass spectrometry (GC-MS, LC-MS, ICP-MS), Immunology based analytical methods (ELISA), qPCR, Advanced Microscopy techniques (Electron Microscopy, Confocal Microscopy).

BBL740 Plant Cell Technology

4 Credits (3-0-2)

Pre-requisites: BBL331

Special features and organization of Plant cells. Totipotency, regeneration of plants, Plant products of Industrial importance. Biochemistry of major metabolic pathways & products. Autotrophic and heterotrophic growth, Plant growth regulators and elicitors. Cell suspension culture development: nutrient optimization, growth and production kinetics, Two stage cultivation. Cell Characterization. Optimization strategies using suspension cultures for some plant metabolites. Biological and technological barriers-hydrodynamic shear assessment and its quantification, mixing and impeller design aspects. Novel designs of Plant cell reactors: comparison of reactor performances. Plant cell Immobilization protocols & their advantages. Immobilized plant cell & cell retention reactors. Design of spherical immobilized cell aggregates. Hairy root induction, Mass propagation in gas/liquid phase bioreactor configurations with case studies. Use of mathematical model based optimization for different cultivation strategies. Endophytes: In vitro platforms for production of plant secondary metabolites with case histories.

Laboratory: Importance of nutrients, role of different media in growth of different plants parts, Preparation of media; Development of callus of a plant; Development of homogenous shake flask suspension culture of plant cells; Study of growth, product formation kinetics of suspension culture; Study of shear sensitivity of plants cells by viability assessment; Propagation of plant cells in bioreactors and assessment of key kinetic parameters; Hairy root induction of a plant; Analysis of plant cell/hairy root metabolites.

BBL741 Protein Science and Engineering

3 Credits (3-0-0)

Pre-requisites: BBL131 BBL231 or Masters' degree in Bioscience

Introduction and aim; Basic structural principles of proteins-amino acids; Motifs of protein structure and their packing: alpha domain, alpha/Beta domain, Antiparallel B structures; Protein folding and assembly - protein folding pathways for single and multiple domain proteins; Recovery of active proteins from inclusion bodies; Structure prediction-structural classes, secondary and tertiary protein structure prediction; Sequence homology searches; Strategies for protein engineering - random, site-directed, case studies; Drug-protein interactions and design, Rational protein design.

BBL742 Biological Waste Treatment

4 Credits (3-0-2)

Pre-requisites: BBL132, BBL331 or Bachelor's degree in Engineering or Masters' degree in Science

Qualitative and quantitative characterization of wastes; Waste disposal norms and regulations; Indian regulations; Principles of biological treatment; Aerobic and anaerobic biological wastewater treatment systems; Suspended and attached cell biological wastewater treatment systems; Biological nutrient removal; Treatment plant design calculations; Treatment and disposal of sludge; biological means for stabilization and disposal of solid wastes; Treatment of hazardous and toxic wastes; Degradation of xenobiotic compounds; bioremediation. Laboratory: Characterization of wastes; Design calculations for various types of wastes using various types of biological processes.

BBL743 High Resolution Methods in Biotechnology

3 Credits (2-0-2)

Pre-requisites: BBL131, BBL331 or Masters' degree in Bioscience

Need for high resolution separation for biologicals; Difficulties with traditional methodologies; Affinity precipitation and partitioning; MF/UF/NF for high resolution separation; chromatography techniques; Affinity chromatography and electrophoresis, Separation by gene amplification (PCR), Molecular imprinting.

BBL744 Animal Cell Technology

4 Credits (3-0-2)

Characteristic of animal cell, metabolism, regulation and nutritional requirements; Kinetics of cell growth and product formation and effect of shear force; Product and substrate transport; Perfusion bioreactors, Hollow fiber bioreactor, Operational strategies and integrated approach; Micro and macro carrier culture; Hybridoma technology; Genetic engineering in animal cell culture; Scale-up and large scale operation; Case studies.

Laboratory: Cell culture in static phase (T-flask), quantification of cell growth, monolayer culture, determination of critical shear stress, micro carrier, Cell viability assay. Case studies to understand growth kinetics and product kinetics in actual cell culture system.

BBL745 Combinatorial Biotechnology

3 Credits (3-0-0)

Solid phase synthesis, solution phase synthesis, encoding technologies, deconvolution methods, Tools for Combinatorial Biotechnology, Display libraries, Applications.

BBL746 Current Topics in Biochemical Engineering and Biotechnology

3 Credits (3-0-0)

Pre-requisites: BBL131, BBL331

BBL747 Bionanotechnology

3 Credits (3-0-0)

Pre-requisites: BBL131 or Masters' degree in Bioscience

Introduction, Self-assembly of biomolecules in nanotechnology; Bacterial S-Layer, Biomimetic Ferritin, Biodegradable nanoparticles for drug delivery to cells and tissues, Polymer Nanocontainers, Ion channels as molecular switches, Patch clamp technique, Protein based nanoelectronics, Bacteriorhodopsin and its technical applications, Carbon Nanotubes: Towards next generation biosensors, Molecular Lego: Design for molecular actuators, Biological Membranes, Magnetosomes: Trapping nano-magnetite in biological membranes, Biomolecular Motors, Techniques used in Bionanotechnology Nanoanalytics: Fluorescent Quantum Dots for Biological Labelling, Nanoparticle Molecular Labels.

BBL748 Data Analysis for DNA Microarrays

4 Credits (3-0-2)

Pre-requisites: BBL131, BBL231, BBL733

Microarray technology, Basic digital imaging and image processing, Probabilities, common distributions, Bayes' theorem, Analyzing microarray data with classical hypothesis testing, Analysis of variance, Experimental Design, Analysis and visualization tools: Box plots, Scatter plots, Histograms, Cluster Analysis: one-way, two-way, Graphic, Methods for selection of differentially regulated genes, Hypothesis driven experiments using focused microarrays, Biological interpretation, Commercial software available.

BBL749 Cancer Cell Biology

4.5 Credits (3-0-3)

Pre-requisites: BBL131 BBL132 BBL231

This course provides students with a deeper understanding of cancer biology and is heavily focused on experiments: Topics include: Cancer Biology Overview, Types of Cancer, Causes for cancer, Oncogenes and Tumor suppressors, Cell Cycle and Regulation, Cell Differentiation, Cell

Death Pathways (Apoptosis, Autophagy), Necrosis, Cell Senescence, Cell Adhesion and Motility, Cancer Epigenetics and sRNAs, Cancer Genome instability, Tumor Immunity, Growth Signaling pathways, Tumor angiogenesis, Cancer Stem Cell, Diagnosis, prognosis and treatment of cancer.

Laboratory: Experiments on Cell cycle, Differentiation, Necrosis and Apoptosis, Senescence, Anchorage Independence, Cell Migration and Invasion, MicroRNAs, Stem cell, Fluorescence Microscopy.

BBL750 Genome Engineering

3 Credits (2-0-2)

Genome engineering methods for bacteria, yeast, plants and mammalian cells, Newer gene delivery methods, Next generation cloning technologies.

BBL751 Biotechnology Entrepreneurship

2 Credits (2-0-0)

Introduction to biotechnology. Agri, Medical and Environment sectors. Role of innovation, evaluating business idea and potential, Legality behind company formation, team for delivery, business plan, IPR issues, licensing, capital and investors, regulatory approvals and good manufacturing principles.

BBL752 Microbial Ecology

3 Credits (3-0-0)

Pre-requisites: BBL132

Microbial diversity, interactions, communities; Microbial community structure vs. function; Microbiomes in natural ecosystems: terrestrial and aquatic, extreme environments; Interactions of microbiomes with higher organisms (Humans and Plants); Microbial functions in biogeochemical cycles; Methodological advances in Microbial Ecology: Novel strategies for culturing the "unculturable", Era of "Omics", Quantitative and qualitative methods for characterization of microbial communities; Role of microbial ecology in crucial environmental issues, viz. climate change, sustainability, pollution.

BBL754 Optics within Life Science

3 Credits (3-0-0)

Pre-requisites: BBL132

Course will cover nature of light-matter interaction, fundamentals of absorbance, fluorescence and scattering. All the components in spectroscopic and imaging technologies i.e., light source to detectors will be discussed. Properties of optical probes, various spectroscopic and imaging techniques used to study biological samples. Including; confocal, TIRF, non-linear, in vivo, super resolution and single molecule imaging.

BBL756 Plasmid Biology

3 Credits (3-0-0)

Pre-requisites: BBL231

Plasmid nomenclature, classification, replication, segregation, incompatibility, stability, host range, significance in environment, health and biotechnology.

BBV750 Bioreaction Engineering

1 Credit (1-0-0)

Pre-requisites: Undergraduate or M.Sc. level in Biochem/Biology or Chem. Engg.

Definitions of volumetric and specific rates. Yield and productivity of bioprocesses. Coupling of steady state black box stoichiometrics. Metabolic Flux Analysis. Transient operation, and the sensitivity of coupled enzymatic reactions to changes in the pathway flux. Design of bio-reactors with volumetric isotropy. The role of mixing in industrial bio-reactions. Large scale processes.

BBL810 Enzyme and Microbial Technology

3 Credits (3-0-0)

Isolation, development and preservation of industrial microorganisms;

Substrates for industrial microbial processes; Regulatory mechanisms of metabolic pathways in industrial strains; Analysis of various microbial processes used in production of biomass, primary and secondary metabolites; Microbial leaching of minerals; Microorganisms in degradation of xenobiotics and removal of heavy metals; Biotransformations. Enzymes as industrial biocatalysts; production; isolation; purification and application of industrial enzymes; immobilized enzymes; stabilization of enzymes; enzyme catalyzed organic synthesis; multienzyme systems.

BBL820 Downstream Processing

3 Credits (3-0-0)

Characteristics of biological materials; Pre-treatment; Microbial separation: Centrifugation and filtration, Cell disruption methods, Protein precipitation, Extraction, Adsorption, Electrophoresis, Chromatography, Ultrafiltration, Reverse osmosis, Isoelectric focusing, Affinity based separations, Case Studies.

BBL830 Microbial Biochemistry

3 Credits (3-0-0)

Structure and function of biomolecules amino acids, proteins, lipids, nucleotides and nucleic acids: Enzymes-structure and kinetics, Vitamins and coenzymes, Metabolic pathways: Carbohydrate metabolism: glycolysis, pentose phosphate pathway, citric acid cycle; Bioenergetics oxidative phosphorylation and photo-synthesis: Fatty acid metabolism; Amino acid metabolism; Regulatory mechanisms-feedback inhibition, induction, catabolite repression; Nucleic acid and protein biosynthesis.

BBP840 Laboratory Techniques in Microbial Biochemistry

2 Credits (0-0-4)

Estimation of carbohydrates/proteins/nucleic acids; separation of phospho-lipids by thin layer chromatography; chromatographic separation of proteins; identification and estimation of intermediates of glycolytic pathway; oxidative phosphorylation; cell fractionation; aseptic techniques; microscopic examination of bacteria & fungi; selected biochemical tests; plasmid DNA preparation; expression of cloned DNA in bacteria; isolation of auxotrophic mutants.

BBL850 Advanced Biochemical Engineering

5 Credits (3-0-4)

Kinetics of cell growth; Mathematical models for substrate uptake and product formation; Plasmid stability in recombinant cell cultures; Kinetics of enzyme-catalyzed reactions; Media and air sterilization; Cell cultivation strategies; Novel bioreactor designs; Developments in aeration & agitation in bioreactors; immobilized whole cell and immobilized enzyme reactors; RTD and mixing in bioreactors; Dynamics of mixed cultures; Scale-up and scale down of bioreactors. Laboratory: Microbial growth and product formation kinetics; enzyme kinetics; Effects of inhibitor on microbial growth; enzyme immobilization techniques; Bioconversion using immobilized enzyme preparation; Bioconversion in batch, fedbatch and continuous bioreactors; Oxygen transfer studies in fermentation; Mixing and agitation in fermenters; RTD studies; Mass transfer in immobilized cell/enzyme reactors.