Biju Patnaik University of Technology, Orissa

Syllabus

for

M.Tech

in

Biotechnology

From 2010 -2011 Academic Session

Biju Patnaik University of Technology, Orissa

M.Tech in Biotechnology

Code	Title	Hours	Credit
Semester-I			
BTPC101	Biomolecules and Metabolic regulations	4-0-0	4
BTPC102	Bioprocess and Bioseparation Technology	4-0-0	4
BTPC103	Genetic Engineering	4-0-0	4
BTPE101	Plant Biotechnology	3-0-0	3
BTPE102	Animal Biotechnology		
BTPE103	Environmental Biotechnology		
BTPE104	Advanced Microbiology & Immunology	3-0-0	3
BTPE105	Food Process Biotechnology		
BTPE106	Pharmaceutical Biotechnology		
BTPR101	Techniques in Genetic Engineering	0-0-3	2
BTPR102	Microbial Biotechnology & Immunotechniques	0-0-3	2
BTPT101	On Research Paper & Pre Thesis review		2
			24
Semester-II			
BTPC201	Advanced Biochemical Engineering	4-0-0	4
BTPC202	Applied Bioinformatics	4-0-0	4
BTPE201	Genomics & Proteomics	3-0-0	3
BTPE202	Computational Biology		
BTPE203	Process control and Instrumentation		
BTPE204	Nanobiotechnology	3-0-0	3
BTPE205	Bioreactor design and optimization		
BTPE206	Metabolic engineering & metabolomics		
BTPE207	Protein Engineering	3-0-0	3
BTPE208	Molecular Modelling and Drug Designing		
BTPE209	IPR, Bioethics and Biosafety		
BTPR201	Bioinformatics	0-0-3	2
BTPR202	Bioreactor design and operations	0-0-3	2
BTPT201	Pre Thesis work		2
BTCV201	Comprehensive viva voce		2
			25

Semester-III			
Project	Thesis Part-I		14
Open elective (anyOne)	Data mining and Data ware housing	3-0-0	3
	Research Methodology		
	Human Resource management		
	Enterprise Resource Planning		
			17
Semester-IV			
BTPT401	Submission of Completed project		20
BTCV401	Presentation of the project		2
BTCV402	Evaluation of the Project		2
			24
			90

Total Credit = 90

Biomolecules and Metabolic regulations

Module-I

Macromolecular structure and dynamics: Configurations and conformations of macromolecules; interaction of biological macromolecules with water and non-aqueous environments; non-covalent (weak) forces that stabilize protein and nucleic acid structure; simulation of the structure of biological macromolecules including energy minimization, molecular dynamics and free energy methods.

Statistical thermodynamics of biological macromolecules: Partition functions, structural transitions in polypeptides and proteins including coil helix transitions, Structural transitions in polynucleic acids and DNA including melting and annealing of polynucleotide duplexes, helical transitions of double stranded DNA, prediction of helical structures in genomic DNA.

Biophysical techniques for analysis of biomolecules – Chromatography, X-ray crystallography, NMR, Mass spectrophotometry and UV spectrometry.

Module-II

Carbohydrate and lipid metabolism-Glycolysis, Krebs cycle, ETS, Energetics and regulation of these pathways, HMP pathway and its importance, Gluconeogenesis, Mechanism of Oxidative Phosphorylation, Fatty acid oxidation and their metabolic routes of carbon, biosynthesis of lipids (fatty acids and sterols), Glycogen metabolism.

Protein metabolism: Oxidative deamination, decarboxylation,and transamination reactions, Urea cycle, Aminoacid synthesis by microorganisms. Central role of Glutamine. Synthesis of Nucleotides, and salvage pathways.

Module-III

Integration of metabolism and concept of metabolic regulation: Elucidation of metabolic pathways; Logic and integration of central metabolism; Major pathway and strategies of energy metabolism, entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers.Organ (Brain, Muscle, Liver) specialization, Metabolic adaptation, Metabolic changes associated with plant development and senescence and its regulation.

Bioprocess and Bioseparation Technology

Module-I

Concepts of Bioprocess and its parameters: Introduction to bioprocess, Instrumentation and operation of bioreactor; Culture-specific design aspects: Plant/Mammalian cell culture reactors. Biomass clarification and disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography

Kinetic models: Stoichiometric analysis; Unstructured Models of growth, substrate utilization and product formation, Transient growth Kinetics, Structured kinetic Models of growth and product formation.

Measurement and control of Bioprocess: On and off-line sensors for a modern bioreactor, Analysis of cell and medium composition,

Module-II

Bioreactor Design, Analysis and Applications: Ideal and Non-Ideal reactors, mixing and residence time distribution studies in a bioreactor. Packed Bed, Bubble columns, fluidized bed and trickle bed bioreactors, Immobilized cell based bioreactor; Bioreactor design for animal cell culture, Bioreactor design for waste treatment.

Bioseparation-I: Theory, Numericals and Applications of Separation of cells and other insolubles from fermented broth. Microfiltration, Ultrafiltration and Nanofiltration, Centrifugation (batch, continuous).

Module-III

Bioseparation-II: Theory, Numericals and Applications of

1. Chromatography: Adsorption chromatography, Ion- exchange, gel-filtration, affinity, high pressure / performance liquid chromatography (HPLC), hydrophobic interaction chromatography. Reverse phase (RP) and thin layer chromatography (TLC).

2. Separation of soluble bio-products: Liquid-liquid extraction, aqueous two-phase extraction, precipitation, adsorption.

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Genetic Engineering

Module-I

Restriction enzymes, modification enzymes, DNA and RNA markers, Linker, adapter, MCS and its application in r-DNA technology, Gene cloning vectors- Plasmids, Bacteriophages, Phagemids, Cosmids, Artificial chromosomes (BAC, PAC, YAC). cDNA synthesis and cloning-mRNA entrapping and reverse transcription, , c-DNA Library construction and screening. Genomic DNA library- construction and screening. Alternative strategies of Gene cloning- Cloning interacting genes, Two and three hybrid systems. Cloning differentially expressed genes.

Module-II

Nucleic acid purification, yield analysis, Nucleic acid amplification and its applications, Restriction mapping of DNA fragments and Map construction, Nucleic acid sequencing- strategies and methodologies, Nucleic acid micro arrays and DNA Chips, DNA Finger printing and Footprinting. Gene regulation analysis-DNA transfection, Northern blot, Primer extension, SI mapping, RNase protection assay, Reporter assays and Phage display

Module-III

Protein Engineering- strategies and applications, Processing recombinant proteins-purification and refolding, characterization of recombinant proteins, stabilization of proteins. Site-directed mutagenesis, Expression strategies for Heterologous genes-Vector engineering and codon optimization, Cassette construction, host-engineering, in vitro transcription and translation, expression in bacteria, expression in yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants. T-DNA and transposon tagging, Gene knockout technologies- Targeted gene replacement, chromosome engineering. Gene therapy-Vector engineering, Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Professional Electives:

Plant Biotechnology

Module-I

Plant Genomics and Molecular Mapping: Introduction Genome mapping; Identification of candidate genes using: genetic information (positional cloning); biochemical and expression analysis (microarray analysis, proteomics, metabolomics); Characterization and functional analysis of candidate genes using: transformation, mutant populations, knockout systems; Heterologous expression systems. Structural and Functional genomics; application of sequence based and structure-based approaches to assignment of gene function. Molecular marker and its type (RFLP, RAPD, AFLP, SSR, STS, EST, SNP); Constructing molecular maps; Molecular tagging and mapping of genes/traits; Marker assisted selection of qualitative and quantitative traits. Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning; Nucleic acid and Protein arrays: basic principles, instrumentation and applications in plant genomics, Identification of disease genes.

Module-II

The Gene transfer Techniques for the production of Transgenic: Overview of different gene transfer methods , plant vectors for transformation, transgene analysis and expression. Indirect Gene transfer Methods: structural features of Ti plasmid, mechanism of gene transfer to plants Integration of T-DNA into plant genome, Molecular events in Agrobacterium mediated gene transfer. Direct gene transfer methods: Particle bombardment mediated transformation, Mechanism, Particle gun design, parameter for effective transformation; silicon carbide fiber mediated transformation and alternative methods. Reporter genes, Selectable and scorable markers, Binary and Co-integrative vectors, Removal of marker genes, Applications and limitations of Agrobacterium gene transfer, Concept of marker free transgenic plants. Plastid engineering: Introduction, importance, scope and technique.

Module-III

Crop Improvement and Agro-industrial biotechnology: Genetic Engineering for Herbicide resistance; Genetic Engineering for Biotic and Abiotic Stress Resistance/Tolerance; Genetic engineering for Improvement of crop yield and quality: Protein, lipids, carbohydrates, vitamins & mineral nutrients; Applications in Agro-industry: Microbes in agriculture , Production and utilization of essential amino-acids, chemicals from micro-algae. Agro-waste utilization; Mycorrhiza in agriculture and forestry.

Animal Biotechnology

Module- I

Animal cell culture: Basic concepts animal cell culture; Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Somatic cell cloning and hybridization; Transfection and transformation of cells; Commercial scale production of animal cells; Stem cells and their application; Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal vaccines and pharmaceutical proteins.

Module-II

Animal health Biotechnology: Introduction to the concept of vaccines; Conventional methods of vaccine production; Recombinant approaches to vaccine production; Hybridoma technology; Phage display technology for production of antibodies; Antigen-antibody based diagnostic assays including radioimmunoassay and enzyme immunoassays; Immunoblotting; Nucleic acid based diagnostic methods including nucleic acid probe hybridization; Restriction endonuclease analysis; PCR, Real time PCR; Nucleic acid sequencing; Commercial scale production of diagnostic antigens and antisera; Animal disease diagnostic kits; Probiotics.

Structure of sperms and ovum; Cryopreservation of sperms and ova of livestock; Artificial insemination; Super ovulation; *in vitro* fertilization; Culture of embryos; Cryopreservation of embryos; Embryo transfer; Embryo-splitting; Embryo sexing; Micromanipulation of animal embryos; Transgenic animal technology and its different applications; Ethical, social and moral issues related to cloning.

Module-III

Animal genomics: Introduction to different breeds of cattle, buffalo, sheep, goats, pigs, camels, horses, canines and poultry; Genetic characterization of livestock breeds; Marker assisted breeding of livestock and poultry; Introduction to animal genomics; Different methods for characterization of animal genomes, SNP, STR, QTLS, RFLP, RAPD, proteomics, metobolomics; Genetic basis for disease resistance; Gene knock out technology and animal models for human genetic disorders.

DNA Forensics: Immunological and nucleic acid based methods for identification of animal species; Detection of adulteration in meat using DNA based methods; Detection of food/feed adulteration with animal protein; Identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts confiscated by anti-poaching agencies; Human forensics; Microbial forensics; Bioterror agents; Biocrimes and Bioterrorism.

Environmental Biotechnology

Module- I

Introduction: Environment; Basic concepts; Resources; Eco system: plants, animals, microbes; Ecosystem management; Renewable resources; Sustainability; Microbiology of degradation and decay; Role of Biotech in environmental protection; Control and management of biological processes

Alternate source of energy: Biomass as source of energy; Bioreactors; Rural biotechnology; Biocomposting; Biofertilizers; Vermiculture; Organic farming; Bio-mineralization; Biofuels; Bioethanol and biohydrogen; Energy management and safety

Module-II

Pollution: Enviromental pollution; Source of pollution; Hydrocarbons, substituted hydro carbons; Oil pollution; Surfactants; Pesticides; Measurement of pollution; Water pollution; Biofilm; Soil pollution; Radioactive pollution; Radiation; Ozone depletion; Green house effect; Impact of pollutants; Measurement techniques; Pollution of milk and aquatic animals

Pollution Control, remediation and management: Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques; Anaerobic processes; Anaerobic filters; Anaerobic sludge blanket reactors; Bioremediation of organic pollutants and odorous compounds; Use of bacteria, fungi, plants, enzymes, and GE organisms; Plasmid borne metabolic treatment; Bioaugmentation; Bioremediation of contaminated soils and waste land; Bioremediation of contaminated ground water; Macrophytes in water treatment; Phytoremediation of soil metals; Treatment for waste water from dairy, distillery, tannery, sugar and antibioticindustries; Solid waste management.

Module-III

Environment and health in respect to genetics: Gene and environment; Effect of carbon and other nanoparticles upon health; Gene mutation; Genetic testing; Genetic sensors; Environmental pollution and children; Human biomonitoring Metagenomics, environmental genomics. Bioprospecting, Biomicroelectronics and Nano-biotechnology. Metabolic pathways for biodegradation of hydrocarbon compounds and other organic pollutants. Microbial interaction with metals and radionuclides, mechanisms. Nitrate and phosphate removal.

Advanced Microbiology and Immunology

Module-I

Microbial Diversity & Systematics: Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

Module-II

Microbial processes and its optimization: Microbial growth and its kinetics, Models of growth kinetics; Microbial processes-production, optimization, screening, strain improvement, factors affecting down stream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc.

Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell based biotransformations of steroids, antibiotics, alkaloids, Enzyme based and cell based biosensor.

Module-III

Advanced Immunology: Fundamental concepts of Immune system; components of innate and acquired immunity; phagocytosis; complement system; MHC – structure, genetic organization; HLA typing; graft versus host reaction; Antigens – immunogens, hapten, adjuvant, carrier. Molecular basis of immune responses: Primary and secondary immune response; kinetics of immune response; Immunoglobulins – class, subclass and structure, Ig superfamily; affinity, avidity, allotype, isotype, idiotype; Antibody genes and antibody diversity.

Immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, Immunoflourescence, flow cytometry and immunoelectron microscopy, lymphoprofileration assay, mixed lymphocyte reaction, cell cytotoxicity assays, microarrays, transgenic mice, gene knock outs.

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Food Process Biotechnology

Module – I

Biotechnology for food production: History; Developments and current status of transgenic crops for: Crop improvement & enhanced agronomic performance; Food products with enhanced shelf-life; Processing and functional quality; Nutritional enhancement-macro and micro-nutrients; Plant vaccines and antibodies

Applications of enzymes in food processing: Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; HFCS; Interesterified fat, hydrolyzed protein etc. and their downstreamprocessing; Baking by amylases; Deoxygenation and desugaring by glucoses oxidase; Beer mashing and chill proofing; Cheese making by proteases and various other enzyme catalytic actions in food processing.

Module –II

Applications of Microbes in food process operations and production: Fermented foods and beverages; Food ingredients and additives prepared by fermentation and theirpurification; Fermentation as a method of preparing and preserving foods; Microbes and their use in pickling; Producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

Bioprocessing of food for nutraceuticals –Lipid based nutraceuticals , polar lipid, PUFA, protein.Polysaccharide,nucleotide, other small molecular weight compounds Functional Food production - Dietary fibre, Food Gum, Emulsifier & Surfactant, Artificial Butter, Favoring agent , Alternative Sweetener , Antioxidant , Preservatives.

Module –III

Biotechnology applications in the production of additives / ingredients: Enzymes, carotenoids, amino acids, organic acids, vitamins, antibiotics, colouring, flavours and nutraceuticals; Biotechnology applications in the production of new protein foods- Single cell proteins (SCP) mushroom, food yeasts, algal proteins

Safety assessment of genetically modified (GM) foods: International and National guidelines; Regulations & safety issues related to production, consumption, import/export and labeling of GM foods.

Pharmaceutical Biotechnology

Module- I

Introduction History of pharmacy; The pharmaceutical industry & development of drugs; Economics and regulatory aspects; Quality management; GMP.

Drug kinetics and biopharmaceutics Mechanism of drug absorption, distribution, metabolism and excretion – factors affecting the ADME process; Bioequivalence; Pharmacokinetics.

Module- II

Principles of drug manufacture Liquid dosage forms – solutions, suspensions and emulsions; Topical applications – ointments, creams, suppositories; Solid dosage forms – powders, granules, capsules, tablets, coating of tablets; Aerosols; Preservation; Packing techniques.

Advances in drug delivery Advanced drug delivery systems – controlled release; Transdermals, Liposomes and drug targeting.

Module-III

Biopharmaceuticals Understanding principles of pharmacology, pharmacodynamics; Study of a few classes of therapeutics like Recombinant therapeutics, Monoclonal Antibodies, Vaccines, Gene therapy, Antibiotics and Hormones.

Immunogenicity of biopharmaceuticals: Immunogenicity; Factors contributing to immunogenicity (product related factors, host- related factors), Consequence of immunogenicity to biopharmaceuticals; Measurement of immunogenicity. Case studies: Erythropoietin, Insulin, Somatotropin, Interleukin-2, Interferon Granulocyte-macrophage-CSF, DNase, Factor VIIa, Factor IX, Factor VIII, Activated protein C, Tissue plasminogen activator, Monoclonal antibodies etc.

Techniques in Genetic Engineering Lab

1. Cloning of Gene and screening of recombinants
2. Cloning of PCR products (T-A cloning)
3. Cloning in expression vector
4. Induction and expression of recombinant protein
5. Purification of recombinant protein using his tag
6. Quantitative expression analysis using real time PCR
7. Site directed mutagenesis
8. Demonstration of microarray technique and instrumentation
9. FISH
10. Agrobacterium based genetic transformation
11. Biolistic based genetic transformation
12. Analysis of transgenic using molecular markers

Microbial Bioechnology & Immunotechniques Lab

1. Microbial strain development, identification and screening
2. Ribotyping of microbial strains
3. Marker based genotyping of microbial strains
4. Production and optimization of ethanol using different strains
5. Production and optimization of citric acid using difeerent strains of Aspergillus
6. Antibody production
7. 2-D GE based characterization of immunoglobulins
8. ELISA
9. Flow Cytometry
10. Counter Current Immunoelectrophoresis

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