M.Sc. Biotechnology: Syllabus

PROGRAM PREREQUISITE: Students should have graduation degree in Biological and Allied Sciences with understanding of Physics and Chemistry in life governing processes.

DURATION OF PROGRAM: 4 SEMESTERS (IN 2 YEARS).

MINIMUM CREDIT REQUIRED TO BE EARNED TO GET M.Sc. DEGREE: 80 CREDITS.

SEMESTER ACADEMIC PLANNING MASTER SHEET

Semester	Course type	Course title	Course code	Credits (L-T-P)
Sem I	Core course	Biochemistry and Metabolic Regulation	BIOT4001	4-0-0
	Core course	Microbiology and Microbial Technology	BIOT4002	4-0-0
	Core course	Cell and Cancer Biology	BIOT4003	4-0-0
	Core course	Bioanalytical Techniques and Biophysics	BIOT4004	4-0-0
	Core course	Lab I	BIOT4005	0-0-4
Sem II	Core course	Genetics and Molecular Biology	BIOT4006	4-0-0
	Core course	Enzymology and Enzyme technology	BIOT4007	4-0-0
	Core course	Immunology and Stem cell	BIOT4008	4-0-0
	Core course	Genetic Engineering and Gene therapy	BIOT4009	4-0-0
	Core course	Lab II	BIOT4010	0-0-4
Sem III	Core course	Bioprocess and fermentation technology	BIOT4011	4-0-0
	Core course	Plant and animal Biotechnology	BIOT4012	4-0-0
	Elective course (compulsoril y any 2)	Bioinformatics and Computational Biology	BIOT4201	4-0-0
		Environmental Biotechnology	BIOT4202	4-0-0
		Pharmaceutical Biotechnology and drug designing	BIOT4203	4-0-0
	Core course	Lab III	BIOT4013	0-0-4
Sem IV	Core course	**Major Project-Dissertation**	BIOT4101	0-0-8
	Elective course (compulsoril y any 3)	Genomics and Proteomics	BIOT4204	4-0-0
		Research Methodology and Biostatistics	BIOT4205	4-0-0
		Medical biotechnology	BIOT4206	4-0-0
		IPR and Bioethics	BIOT4207	4-0-0

BIOT4001-BIOT4099= CORE COURSES.

BIOT4101-BIOT4199= TRAINING AND PROJECT WORKS IN CORE COURSES.

BIOT4201-BIOT4299= ELECTIVES.

EVALUATION SCHEME

THEORY COURSES

Components	Continuous Internal Assessment (40)				End Semester Examination (60)
	Attendance	Test 1	Test 2	Mid semester	
Associated Marks	5	7.5	7.5	20	60

PRACTICALS

Components	Continuous Internal Assessment (40)				End Semester Examination (60)			
	Attendance	Test 1	Test 2	Mid semester	Practical Record	Minor Experiment	Major Experiment	Viva-Voce
Associated Marks	5	7.5	7.5	20	10	10	20	20

BIOCHEMISTRY AND METABOLIC REGULATION

COURSE CODE: BIOT4001 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENTS:

Unit - I: Introduction and protein structure

Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; structure of proteins: protein folding and mis-folding, primary and higher order structures; structure-function relationships in model proteins : ribonuclease A, myoglobin, hemoglobin, chymotrypsin.

Unit - II: Carbohydrates and lipids

Carbohydrates; mono, di, and polysaccharides; suitability in the context of their different functions-cellular structure, energy storage, glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids structure and properties of important members of storage and membrane lipids; lipoproteins.

Unit – III: Membranes and Nucleic acids

Biomembrane organization - sidedness and function; Membrane bound proteins - structure, properties and function; membrane transport, nucleic acids - structure, diversity and function.

Unit – IV: Bioenergetics

Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation.

Unit – V: Secondary metabolism

Terpenes (sesquiterpenes, carotenoids), alkaloids, flavonoids, targeting mevalonic acid pathway/MEP pathway in bacteria, phenolic compounds, shikimic acid pathway, importance of secondary metabolites.

TEXT AND REFERENCES:

- Principles of Biochemistry, A.L. Lehninger, D.L. Nelson, M.M. Cox. , Worth Publishing.
- Harper's Biochemistry K. Robert, M.D. Murray, D.K. Granner, P.A. Mayes and V.I. Rodwell, McGraw Hill/ Appleton and Lange.
- Biochemistry (Fifth Edition), Lubert Stryer.
- V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.

MICROBIOLOGY AND MICROBIAL TECHNOLOGY

COURSE CODE: BIOT4002 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENT:

Unit I: Introduction to microbiology

Microbes and their types, Viruses, Bacteria, fungi and protozoans – Morphology and classification. Abnormal forms of bacteria, archaebacteria, mycoplasma and PPLO, cultivation of bacteria – nutritional requirements of bacteria, physical requirements, different types of media & their preparations. Koch's postulates, Axenic culture, Isolation of pure cultures, maintenance and preservation of the pure cultures. Culture characteristics, bacterial growth kinetics, enumeration of cells by direct and indirect methods.

Unit II: Control of micro-organisms

Concept of sterilization and disinfection. Physical and chemical methods of microbial control.

Chemotherapeutics, susceptibility test (broth procedures and diffusion methods), mode of action of antibiotics, narrow and broad spectrum(Penicillin, ampicillin, sulfonamide, vancomycin, tetracycline, chloramphenicol), antifungals (clotrimazole, fluconazole), antiretroviral (tenofovir, AZT).

Unit III: Microbial genetics

Molecular classification of microbes, The Basics of microbial genetics, prokaryotic gene organization, The basic principles of microbial DNA, replication, transcription and translation. Microbial regulation of gene expression: the *trp* and *lac* operon.

Unit IV: Microbial genetic change and viral genetics

Basics of microbial gene transfer: transformation, transduction, conjugation, plasmids, transposons. Viral Genetics Reproductive cycles of bacteriophage, M13 and lambda.

Unit V: Soil and Agricultural Microbiology

Normal microflora of soil, host parasite interactions, allelochemistry and mechanisms of pathogenesis, agricultarally-important pathogenic microorganisms (bacteria, fungi and viruses), applications of the basic principles of microbiology in effective diagnosis, treatment and prevention of infectious disease.

TEXT AND REFERENCES:

- Microbiology VI Edition, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill.
- General Microbiology, R.Y. Stanier, J.L. Ingraham, M. L. Wheelis and P.R. Painter, Macmillian.
- The microbes – An Introduction to their Nature and Importance, P.V. Vandenmark and B.L. Batzing Benjamin Cummings.
- The Microbial World, Roger Y. Stanier, Prentice Hall.
- Microbiology, Tortora, Funke and Chase, Benzamin & Cummings.

CELL AND CANCER BIOLOGY

COURSE CODE: BIOT4003 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENTS

Unit I: Introduction

Cell types (prokaryotes/ eukaryotes), cell organelles, cell wall, cell membrane, cytoplasmic organelles, structure of nuclear envelope, nuclear pore, complex, transport across envelope, regulation of nuclear import.

Unit II: Protein trafficking

Targeting proteins to endoplasmic reticulum, signal recognition particle, signal recognition particle receptor, protein folding and processing in ER, protein export from ER, Protein sorting and export from golgi apparatus; SNARE hypothesis; Protein import into Mitochondria, Import and sorting of chloroplast protein.

Unit III: Cytoskeleton

Structure and organization of cell skeleton; Microfilaments and Microtubule-structure and assembly, actins, myosin muscle contraction, cilia, flagella-structure and function.

Unit IV: Cell signaling

Cell-cell interaction, modes of cell signaling, steroid hormone receptors, peptide hormones and growth factor, plant hormones, G-protein coupled receptors; receptor –protein tyrosine kinase, c- AMP pathway of signal transduction; c GMP, phospholipids and calcium ions, MAP kinase pathway, JAK – STAT pathway, Integrin signaling , Hedgehog and Wnt pathways.

Unit V: Cell division and cancer biology

Cell Cycle: Interphase and M phase (mitosis and meiosis), Cell cycle regulation, checkpoints in cell cycle; regulators of cell cycle, Apoptosis: intrinsic and extrinsic pathways.

Cancer biology: types of cancer; development of cancer**,** cells; Oncogenes, protooncogenes , function of oncogene products , tumor suppressor genes , function of tumor suppression gene products, role of oncogene and tumor suppressor gene in development, molecular diagnosis of cancer.

TEXT AND REFERENCES

- Molecular Cell Biology by Bruce Albert
- Molecular Biology by Lodish, Darnell and Baltimore
- Molecular Biology of the gene by Watson et al 4th ed.
- Cell and molecular biology by Gerald Karp
- Cell biology by Pollard and Earnshaw

BIOANALYTICAL TECHNIQUES AND BIOPHYSICS

COURSE CODE: BIOT4004 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENT:

Unit I : Spectroscopy and X –ray crystallography

Principles of colorimetry and UV-Vis spectrophotometry, Mass spectrometry, MALDI, X-Ray Crystallography, SPR.

Unit II: Electrophoresis and chomatography

Agarose and polyacrylamide gel electrophoresis (native and denaturing), Immuno-electrophoresis, Isoelectric Focusing, Capillary electrophoresis.

Planner chromatography and column chromatography (ion exchange, gel permeation, affinity), GLC and HPLC.

Unit III: Membrane Biophysics

Genesis of membrane potential in nerve & membrane, Nerst & Goldman equation, electrophysiology Patch Clamp and Voltage –Clamp techniques for measuring membrane potential.

Unit IV: Radiation Biophysics and tracer techniques

Principles of fluorescence, Tracer Technology, Dose response relationship, Radioisotopes in Diagnostics and Biotechnology, Geiger-Mueller Counter, Scintillation Counters. Non-Radioactive tracer Technology

Metabolic and physiological tracer techniques, non-radioactive labels (fluorescence and nonradioisotopes), labeling and detection methods using fluorescent molecules.

Unit V: Blotting techniques:

Southern blotting, northern blotting, western blotting, South western bloting.

TEXT & REFERENCES:

- Practical Biochemistry, Principles & Techniques, Keith Wilson and John Walker.
- Bioinstrumentation, Webster.
- Principles & Practice of Bioanalysis, Richard F. Venn.

LAB COURSE I

COURSE CODE: BIOT4005 **ASSOCIATED CREDITS (L-T-P): 0-0-4**

COURSE CONTENTS:

Unit I:

1. Demonstration of good laboratory practices.
2. Functioning and calibration of pH meter.
3. Preparation of buffers.
4. Determination of isoelectric point.
5. Estimation of reducing sugars.
6. Estimation of amino acids.
7. Estimation of nucleic acids.
8. Estimation of enzyme activity.

Unit II:

9. Sterilization of media and instruments.
10. Isolation of bacteria from soil and its qualitative characterization.
11. Gram's staining of bacteria.
12. Bacterial growth curve and its analysis.
13. Bacterial transformation/ conjugation.
14. Antibiotic sensitivity test

Unit III:

15. Microscopic examination of cell division and stages.
16. Qualitative estimation of cell wall properties by histo-chemical staining.
17. Isolation and separation of cell organelles and their assay.

Unit IV:

18. Cell disruption using grinding and homogenizing.
19. Centrifugation for fractionation of homogenate.
20. Spectrophotometric/ colorimetric estimation of proteins.
21. Chromatographic separation of proteins.
22. Visualization of chromatographic separation of protein by PAGE.
23. Fluorescence detection of nucleic acids.

GENETICS AND MOLECULAR BIOLOGY

24.

COURSE CODE: BIOT4006 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENT:

Unit I: Classical Vs modern genetics:

History of genetics, Mendelian principles, monohybrid and dyhybrid crosses, dominance, codominance and incomplete dominance, gene interaction and epistasis, concept of gene and cistron, cis-trans complementation experiment, lethal, selfish and pseudogenes, gene concept, structure of genes.

Unit II: Structural and numerical aberrations:

Ploidy level, euploidy and aneuploidy, INDELs, inversion and replacement mutations, spontaneous and induced mutation, mutagens, crossing over and linkage.

Unit III: Chromosome organization and replication

Organization of eukaryotic chromosome, gene concept, eukaryotic and prokaryotic gene architecture, Replication of DNA in prokaryotes, DNA damage and repair, Comparison of DNA replication between prokaryotes and eukaryotes.

Unit IV: Expression of gene.

Gene expression in eukaryotes: Transcription, general and specific transcription factors, regulatory elements and mechanism of regulation, processing of transcripts and translation (initiation, elongation and termination) Operon concept in prokaryotes, *Trp* attenuation, comparison of gene expression mechanism between eukaryotes and prokaryotes.

Unit V: Gene silencing and gene expression analysis

Gene silencing approaches: cosuppression, antisense RNA techniques, ribozyme (Hammer head, hairpin ribozymes) mediated methods, dsRNA (microRNA and small interfering RNA).

TEXT AND REFERENCES:

- Molecular Cell Biology by Bruce Albert
- Molecular Biology by Lodish, Darnell and Baltimore
- Molecular Biology of the gene by Watson et al 4th ed.
- Cell and molecular biology by Gerald Karp
- Principles of genetics by Gardener
- Genetics by P.K. Gupta

ENZYMOLOGY AND ENZYME TECHNOLOGY

COURSE CODE: BIOT4007 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENT:

Module I: Enzymes

Introduction and scope, nomenclature and classification of enzymes, basic mechanism of catalysis, enzyme catalysis in organic media and ionic liquids, Industrial applications.

Module II: Enzyme Kinetics

Single substrate- steady state kinetics, King-Altman's method, Inhibitors and activators, Multi-substrate systems, Effect of pH and temperature, Allosteric enzymes.

Thermodynamic explanation for transition complex formation, reaction mechanisms, Michaelis – Menten equation and its limitations, presentation of enzymatic data (direct and semilogrithmic), LB plot method to study enzyme kinetics, effect of substrate, pH and temperature on kinetics, allosteric enzyme kinetics.

Module III: Purification and immobilization of Enzymes

Enzyme isolation, disruption, fractionation, purification and concentration methods, Methods of purity estimation, purification related data presentation, advantages, Carriers, adsorption, covalent coupling, cross-linking and entrapment methods, Micro-environmental effects.

Module IV: Industrial production of enzymes

Basic concept of industrial scale and optimization, amylase, glucose oxidase, lipase, protease, production and their uses.

Module V: Challenges and future trends

Catalytic antibodies and Non-protein biomolecules as catalysts, Biocatalysts from extreme thermophillic and Hyperthermophilic Archaea and Bacteria, application of enzymes in research diagnostics and industry.

TEXT AND REFERENCES:

- Enzyme Technology, M.F. Chaplin and C. Bucke, Cambridge University Press.
- Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis, R.A. Copeland, John Wiley and Sons Inc.
- Enzymes Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer
- Enzyme Kinetics: Behaviour and Analysis of Rapid Equilibrium and Steady State Enzyme Systems, I.H. Segel, Wiley-Interscience
- Industrial Enzymes & their applications, H. Uhlig, John Wiley and Sons Inc

IMMUNOLOGY AND STEM CELL

COURSE CODE: BIOT4008 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENT:

Unit I: Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility.

Unit II: Immune responses generated by B and T lymphocytes

Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Basis of self –non-self discrimination; memory; B-cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system.

Unit III: Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasmon resonance, Biosenor assays for assessing ligand –receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Microarrays, Transgenic mice, Gene knock outs

Unit IV: Immunization

Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Catalytic antibodies and generation of immunoglobulin gene libraries.

Unit V: Clinical Immunology

Immunity to Infection : Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology – Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency-Primary immunodeficiency, Acquired or secondary immunodeficiency.

TEXT AND REFERENCES:

- Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
- Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
- Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
- Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
- 5. Goding, Monoclonal antibodies, Academic Press. 1985.

GENETIC ENGINEERING AND GENE THERAPY

COURSE CODE: BIOT4009 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENT:

Unit I: Basic cloning techniques

Enzymes used in cloning (Nucleases including restriction endonucleases, Polymerases, methylases, ligases, phosphatases and topoisomerases.

Vectors used in cloning and expression-Cloning vectors: Plasmids and Phage (Lambda and M13 derived) Vectors, phagemids, cosmids, artificial chromosome vectors (YAC, BAC), Animal virus derived vectors - SV40 and retroviral vectors and transposons.

Unit II: Transformation and related techniques:

Competent cell preparation methods, Transformation methods for bacteria, plant and animal cells. Screening of transformants- selection markers (antibiotic resistance and genes of essential metabolism), alpha complementation for recombinant selection, reporter genes (GUS assay, luciferase), strategies for heterologous expression of genes and guiding principles.

Unit III: PCR and related techniques:

Polymerase chain reaction: Thermal profile and reaction components: Optimization (touch down/ hotstart and gradient PCR)

Types of PCR and their applications: Conventional PCR, AP-PCR, Anchored-PCR, Inverse-PCR, Multiplex-PCR, Reverse Transcription-PCR, DDRT-PCR and Real Time-PCR. PCR based cloning: T/A cloning, TOPO cloning and gateway cloning.

Unit IV: Construction of libraries, screening and sequencing:

Construction of gene libraries: genomic DNA, subgenomic DNA, EST and cDNA libraries.

Methods of library screening: Types of probes and their construction methods, hybridization based (using radiolabelled and nonradiolabelled probes) and Immuno-screening methods.

DNA sequencing methods: Conventional and Next Generation sequencing approaches. Maxum Gilbert chemical degradation method, Sanger's dideoxy chain termination method, Nanopore sequencing, pyrosequencing, Ion torrent method.

Unit V: Applications of genetic engineering:

Gene downregulation-using antisense RNA, dsRNA and cosuppression, CRISPR- cas 9. Site directed mutagenesis (PCR based methods) Assessment of gene functional boundary, transgenic animals (knockout mice) and plants (Flavr savr tomato), production of recombinant pharmaceuticals (insulin and somatostatin), DNase foot printing, gene therapy (*in vitro* and *in vivo* methods). Biosafety regulation: Physical and biological containments

TEXT AND REFERENCES:

- Molecular Cloning: Meniates et al
- Gene cloning and DNA analysis by T.A. Brown
- Principles of gene manipulation by Old and Primrose.
- Genetic engineering: Smita Rastogi and Neelam Pathak, Oxford press.

LAB COURSE II

COURSE CODE: BIOT3010 **ASSOCIATED CREDITS (L-T-P): 0-0-4**

COURSE CONTENTS:

Unit I

1. Squash preparation for chromosome staining for mitosis (onion root tip).
2. Visualization of chromosomal translocation in *Rhoeo discolour*.
3. Visualization of meiosis stages (Grasshopper testes and *Vicia faba*).
4. Study of gene expression using blotting or RT-PCR.

Unit II

5. Isolation of enzyme from plants/ bacteria.
6. Estimation of enzyme activity and ammonium sulphate fractionation/ centrifugation based size fractionation.
7. Determination of pH optima for an enzyme.
8. Effect of temperature on enzymatic activity.
9. Enzyme immobilization.

Unit III

10. Blood cell counting.
11. Blood group determination.
12. Immunoprecipitation.
13. ELISA
14. Examine the cells comprising immune system.
15. Trypan blue cell exclusion test for viability.

Unit IV

16. Isolation of genomic and plasmid DNA.
17. PCR based amplification of DNA.
18. Cloning of PCR product in vector using T/A cloning strategy.
19. Preparation of competent cells and its transformation with PCR product ligated in vector.
20. Screening of recombinant transformants using blue white selection and confirmation of clone.

BIOPROCESS & FERMENTATION TECHNOLOGY

COURSE CODE: BIOT4011 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENTS

Unit I: Basic principles of Bioprocess Technology

Introduction to concepts of bioprocess engineering, Overview of bioprocesses with their various components, Isolation, screening and maintenance of industrially important microbes; Strain improvement for increased yield and other desirable characteristics, Microbial growth and death kinetics with respect to fermenters, optimization of bioprocesses, yield coefficient, doubling time, specific growth rate, metabolic and biomass productivities, effect of temperature, pH and salt concentration on product formation.

Unit II: Concepts of basic mode of fermentation processes

Bioreactor designs; Types of fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Solid substrate, surface and submerged fermentation; Fermentation media; Design and types of culture/production vessels- Batch, Fed batch, CSTBR, airlift, packed bed and bubble column fermentor; Impeller, Baffles, Sparger.

Unit III: Upstream and downstream processing:

Media formulation; Inocula development and Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process. Bioseparation techniques; Cell disruption methods; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultrafiltration, drying, crystallization, storage and packaging; Treatment of effluent and its disposal.

Unit IV: Applications of enzymes in food processing

Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes and their downstream processing; baking by amylases, deoxygenation and desugaring by glucose oxidase, beer mashing and chill proofing; cheese making by proteases.

Unit V: Applications of Microbes in food process operations and production

Fermented foods and beverages; cheese and bread production, food ingredients and additives prepared by fermentation and their purification; 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, probiotics, prebiotics and symbiotics.

TEXT AND REFERENCES:

- Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
- Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition, Panima Publishing Co. New Delhi.
- Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
- Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.

- Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
- Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
- Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
- Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.
- Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.
- Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.

PLANT AND ANIMAL BIOTECHNOLOGY

COURSE CODE: BIOT4012 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENT:

Unit I: Introduction

Importance and history of *in vitro* culture, nutritional requirements, media components (MS and White's media; Basal and supplemented animal cell culture media for normal and cancer cells), sterilization techniques, culture lab architecture.

Unit II: Micropropagation and haploid production

Micropropagation, axillary bud, shoot-tip and meristem culture, callus culture. Haploid production and their applications. Somaclonal variations and applications,

Unit III: Protoplast culture and cybrids

Principles of protoplast isolation and applications. Testing of viability of isolated protoplasts. Various steps in the regeneration of protoplasts. Introduction of somatic hybridization, various methods for fusing protoplasts, chemical and electrical, cybrids- definition and application,

Unit IV: Animal Cell culture

Introduction of animal cell culture substrate, culture media, preservation and maintenance of cell lines, Transgenic animals. Test tube baby, *In vitro* fertilization and embryo transfer.

Unit V: Applied plant and animal biotechnology

Growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1, IL-2, NGF, erythropoietin). Production of monoclonal antibodies. Bioreactors for large scale culture of animal cells.

Transgenic plants for abiotic and biotic stress tolerance (virus, herbicide, salt) delay in fruit ripening, fortified crops, plants as therapeutic factories. Cytoplasmic male sterility, somatic embryos and artificial seeds, elite germplasm screening by molecular biology tools.

TEXT AND REFERENCES:

- An Introduction to Plant Tissue Culture, M.K. Razdan, Oxford and IBH Publishing
- Experiments in Plant Tissue Culture, J.H. Dodds and L.K. Roberts, Cambridge University Press
- Plant Biotechnology and Transgenic Plants, K.M.O. Caldenty, W.H. Barz and H.L. Wills, Marcel Dekker
- Plant Biotechnology, J. Hammond, P. McGarvy and V. Yusibov, Springer Verlag.
- Plant Cell & Tissue Culture for the production of Food Ingredients, T-J Fu, G. Singh and W.R. Curtis, Kluwer Academic/Plenum Press
- Plant Tissue Culture: Theory & Practice, S.S. Bhojwani and M.K. Razdan, Elsevier Health Sciences
- Animal Cell Culture – A Practical approach, J.R.W. Masters, Oxford.
- Animal Cell Culture Techniques, M. Clynes, Springer Verlag.
- Cell Culture Lab Fax, M. Butler and M. Dawson, Bios scientific Publications Ltd.
- Cell Growth and Division – A Practical approach, R. Basega, IRL Press.

BASIC BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

COURSE CODE: BIOT4201 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENT:

Unit I: Introduction and history of bioinformatics

Introduction to genomic research and data generation, Genome projects, requirement of computational biology and bioinformatics, contribution of bioinformatics in biotechnology.

Basic programming in bioinformatics

Unit II: Introductory bioinformatics

Information Resources: NCBI, EBI, ExPasy Entrez & SRS System

Primary Sequence & Structure Databases: Genbank, SwissProt/Uniprot, EMBL, PIR, PDB, KEGG etc.;

Derived (Secondry) Databases of Sequences and structure:

Prosite, Pfam,

ii. SCOP, CATH, DSSP, FSSP, RNAbase,

Genome Databases (at NCBI, EBI), High-throughput genomics sequence (EST, STS, GSS), ENSEMBL.

Unit III: Sequence analysis

Sequence File formats: fasta, genbank, embl, Swiss-prot, pdb, nbrf, pir and multiple sequences formats (Aln, Mega, Pileup, phylip etc.)

Sequence Similarty Basics: Similarty, Identity, Homology, Scoring, selectivity/Sensitivity, Gap cost, Linear and Affine Gap Penalty, Basic of scoring system and matrices (PAM, BIOSUM, GONNET ClustalW and ClustalX)

Unit IV: Similarity Searching Tools:

Pairwise Sequences Aligment: Brute Force method, Dot matrix method, Global (Needleman- Wunsch) and Local Alignment (Smith-Waterman) using Dynamic programming.

BLAST and FASTA, Theory and Algorithms, variants of BLAST and FASTA, PSI-BLAST, Statistical Significance. Sequence Pattern and Profiles: Concepts of motif, pattern and profile.

Unit V: Computational Methods and applications

Phylogenetics prediction mrthods: Basics, molecular clock, Substitution Models of evolution, Tree reconstruction methods (Distance based, character based method, statistical), Bootstrapping. Software and Programmes for sequence comparison and analysis. Phylogenetic analysis software, molecular structure drawing tool Application of computational biology/Bioinformatics in Agriculture, Human health, Environment, Biotechnology, Molecular Biology, Neurobiology, Drug Designing, Veterinary Science.

TEXT AND REFERENCES:

- Bioinformatics: Sequence and genome analysis by David, W Mount, Cold Spring Harbur Press.
- Bioinformatics Computing By Bryan Bergeron, Publisher: Prentice Hall PTR.
- Bioinformatics a practical guide to analysis of genes and protein, Eds A D Baxevanis and B.F. Francis Ouellette, Wiley Interscience.

ENVIRONMENTAL BIOTECHNOLOGY

COURSE CODE: BIOT 4202 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENTS:

Unit I: Introduction to Environmental Biotechnology

Ecosystems: biotic and abiotic components, Ecological pyramids, Food chains, Food webs, Habitat and niche, Energy flow in ecosystems, Types of ecosystems, Biological Magnification. Pollutants of atmosphere, water and solid wastes, Hazardous wastes. Microbial interactions in ecosystems. Introduction to Novel biocatalysts and biomaterials, Lignocellulosic residues, Biofuel and fossil fuels, Biomining and bioleaching, Bioremediation, Biosensors in bioprocessing, ecosystem analysis and related softwares.

Unit II: Air, Water and Soil pollution

Point and non-point source pollution, Air pollution control: particulate emission, control devices, control of Sulphur dioxide pollution and vehicular pollution. Water pollution control: primary, secondary and tertiary treatment. Solid waste and soil pollution management: waste monitoring, treatment and management of non-hazardous solid waste, non-degradable solid waste, colour codes, medical solid waste.

Unit III: Biodegradation, Bioconversion and Bioabsorption

Microorganisms in lignocellulose degradation, Cellulases and xylanases, Biodegradation of starch, glycogen, pullulan, dextrins and proteins. Xenobiotic compounds: chemical properties influencing biodegradability, mechanisms of degradation, microorganisms for degrading organic pollutants (petroleum products, methane/n-alkanes, alkenes, cycloaliphatic compounds). Microorganisms in metal absorption, factors affecting bioabsorption, Phytoremediation.

Unit IV: Biotechnological Applications in Environmental Management

Carbon sequestration, Bioremediation: microorganisms and techniques, Bioenergy, Bioethanol and Biodiesel, Biomethanation (Biogas from anaerobic treatment), Biofertilizers and biopesticides, Composting: process and decomposition stages, vermicomposting, Biopolymers and Bioplastics, Bioleaching, Nanomaterials.

Unit V: Remedial Mechanisms of Industrial Problems

Pulp and paper industry: problems associated and treatment of pollutants, Tannery industry: effluent characteristics and treatment, *Ex situ* bioremediation, Distillary effluent treatment, Treatment methods for dye industry effluents, Waste reduction and treatment of effluents from pharmaceutical, petroleum and dairy industries.

TEXT AND REFERENCES:

- Environmental Science, S.C. Santra.
- Environmental Biotechnology, Pradipta Kumar Mohapatra.
- Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and
- Jesef Winter.
- Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill.

- Agricultural Biotechnology, S.S. Purohit.
- Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer.
- Introduction to Environmental Biotechnology, Milton Wainwright.
- Principles of Environmental Engineering, Gilbert Masters.
- Wastewater Engineering – Metcalf & Eddy.

PHARMACEUTICAL BIOTECHNOLOGY AND DRUG DESIGNING

COURSE CODE: BIOT4203 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENTS:

Unit I: Introduction

Introduction and History, DNA, RNA, post-translational processing, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors (monomeric transmembrane proteins), small molecule receptors, ligand-gated ion channels (oligomeric transmembrane proteins), transporters (multi-transmembrane proteins).

Unit II: Drug discovery methods

Meaning of drugs, Drug Discovery Process, biological activity directed and other types of screening, natural products, combinatorial chemistry; General overview of validation techniques, Methods of Drug Discovery and development, QSAR and SAR.

Concepts of Bio availability, Process of drug absorption, Pharmacokinetic processes, Timing for optimal therapy, Drug delivery considerations for the new biotherapeutics.

Unit III: Pharmacology of drugs

Physicochemical Properties in Relation to Biological Action, Effects of route of administration, Drug Targets, Validation techniques of Pharmaceutical targets, Pharmacokinetics and pharmacodynamics of drugs, Drug Toxicity.

Basic terminologies in drug delivery and drug targeting, Doses forms, Various routes of administration of drugs (just introduction), Strategies for enhanced therapeutic efficacies (Basic principles)

DNA vaccines, Vaccines & Monoclonal antibody based pharmaceuticals, Antibiotics, Characterization and Bioanalytical aspects of Recombinant proteins as pharmaceutical drugs**.**

Unit IV: Formulations

Formulation of Biotechnological Products, Drug Delivery, Examples of some Biotechnological products in clinical development.

Unit V: Regulations

Role of FDA, ICH Guidelines, The Regulation of Pharmaceutical Biotechnological Products and Ethical Issues.

TEXT AND REFERENCES:

- Drug Delivery and Targeting, A.M. Hillery, A.W. Lloyd and J. Swarbrick, Harwood Academic Publisher
- Pharmaceutical Dosage Forms and Drug Delivery Systems, H.C. Ansel, L.V. allen and N.G. Popovich, Lippincott Williams and Wilkins Publisher
- Applications of Targeted Nano Drugs and Delivery Systems, Shyam Mohapatra, Shivendu Ranjan, Nandita Dasgupta, Raghvendra Mishra and Sabu Thomas (EDs.), Elsevier, 2019.
- Introduction to Biophysical Methods for Protein and Nucleic Acid Research, J.A. Glasel and M.P. Deutscher, Academic Press.

LAB COURSE III

COURSE CODE: BIOT4013 **ASSOCIATED CREDITS (L-T-P): 0-0-4**

COURSE CONTENTS:

Unit I:

1. Isolation of industrially important microorganism from natural source.
2. Preparation of bacterial growth curve
3. Effect of temperature on bacterial growth curve
4. Effect of pH on bacterial growth curve.
5. Production of ethanol and its optimization

Unit II:

6. Sterilization techniques
7. Preparation of plant tissue culture media
8. Preparation and decontamination of explants
9. Inoculation of culture and incubation for callusing/ *in vitro* morphogenesis
10. Cell suspension culture

Unit III:

11. Preparation of animal cell culture media and sterilization
12. Separation and isolation of animal cells and their microscopic examination
13. DNA isolation from animal tissue
14. Qualitative and quantitative estimation of isolated DNA

Unit IV:

15. Retrieving data for any gene
16. Visualization of protein and nucleic acid structure
17. ORF finding using bioinformatics tools
18. Searching similar sequences using BLASTp, BLASTt and BLASTn
19. Multiple sequence alignment and finding conserved sequences.
20. Designing primers for PCR

TEXT AND REFERENCES:

- Practical Biochemistry: Wilson and Walker
- Practical Biochemistry: Rodney Boyer

MAJOR PROJECT/ DISSERTATION

COURSE CODE: BIOT4101 **ASSOCIATED CREDITS (L-T-P): 0-0-8**

COURSE DETAILS:

- Each student has to undertake a project/ dissertation work under the guidance of departmental faculty.
- The outcome will be intellectual property of the student and faculty guide which can not be published without written permission of the faculty guide.
- The project report may be presented in following sub-heads
  - ✓ Contents
  - ✓ Acknowledgements
  - ✓ Introduction
  - ✓ Review of literature
  - ✓ Material and methods
  - ✓ Results and discussion
  - ✓ References
  - ✓ Appendices
- Titles and subtitles in running text to be in 16 and 14 font size. The text to be presented in 12 font size with 1-1.5 spacing.

GENOMICS AND PROTEOMICS

COURSE CODE: BIOT4204 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENTS:

Unit I: Introductory genomics

Introduction to Genomics, Anatomy of prokaryotic and eukaryotic genome, content of genome, C-value paradox, CoT curve analysis, repetitive DNA, tools to study genome diversity (PCR/ RFLP).

Unit II: Applied Genomics

Strategies for major genome sequencing projects, approaches and assembly methods, NGS methods and advantages, gene analysis and annotation.

Unit III: Transcriptomics and expression profiling

Genome expression analysis, RNA content and profiling, genetic mapping, Microarray (cDNA and protein microarray)

Unit IV: Introductory proteomics

Importance of proteomics, strategies in analysis of proteome: 2-D PAGE, Mass spectrometry, Protein sequencing method (Edman degradation, MALDI TOF/TOF). Structure of protein and formation of oligomers, Protein solubility and interaction with solvents and solutes, activity of proteins.

Unit V: Applied proteomics

Databases and search engines in proteomics, Post translational protein modifications, protein localization

Protein: protein interaction: Yeast two hybrid system, phage display, GST pull down, affinity based methods,

Disease related proteins and drug discovery, Disease diagnosis, identification and characterization of novel proteins, protein engineering principles.

TEXT AND REFERENCES:

- Database Annotation in Molecular Biology: Principles and Practice, Arthur M. Lesk
- Bioinformatics : Sequence and genomic analysis by D. W. Mount, Cold Spring Harbour Laboratory Press.
- Recombinant DNA (Second Edition), James D. Watson and Mark Zoller
- Gene Cloning and DNA Analysis – An introduction (Fourth Edition), T.A. Brown
- Protein array, Biochips and Proteomics by Smith and Albala (Eds), Marcel Dekkar, New York.
- Introduction to proteomics: Tools for new biology by Daniel C. Liebler, Humana Press.

RESEARCH METHODOLOGY AND BIOSTATISTICS

COURSE CODE: BIOT4205 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENTS:

Unit I: Introduction and scope

Science, Scientific Field and Biological research. Role of a researcher in different stages of a project, Routes to research funding (academic and commercial)

Research, Definition, Importance of research, Characteristics of research, Types and steps in research, Identification, Selection and formulation of research problem, Research questions, Research design – Formulation of Hypothesis, Review of Literature.

Unit II: Sampling methods

Sampling theory, types of sampling, Steps in sampling, Sampling and Non-sampling error, Sample size, Advantages and limitations of sampling. Collection of Data: Primary Data, Meaning, Data Collection methods, Secondary data, Meaning - Relevance's, Limitations and cautions. Statistics in Research.

Unit III: Types of research asrticles

Type of Articles (review, letters etc). Scientific paper format (Abstract, Introduction, Materials and Methods, Results, Discussion). Writing (ethical Vs unethical), evaluating, presenting and publishing the results of scientific research in the academic press (journals, conferences etc). Choosing the appropriate journal (Sources, Information, Instructions to authors, peer review system, journal evaluation), Case studies of areas of current research. Formulating a research plan and its presentation.

Unit IV: Sampling methods

Probability Sampling and non Probability Sampling methods, Measure of central tendency and measure of dispersion, Probability (classical & axiomatic definition of probability, theorem on total and compound probability), Addition and Multiplication theorem of Probability, Random variables and Probability Distribution, Simple problems involving Binomial, Poisson and Normal variables,

Unit V: Biostatistics

Formulation of Hypothesis (One-tailed & Two-tailed), Type I and Type II errors, power of a test, Significance of a test, P-value testing, Hypothesis Testing (students T-test, Z-test, Chi-square test), Regression and correlation analysis, Analysis of variance (ANOVA).

TEXT AND REFERENCES:

- Biostatistics: A foundation for analysis in the Health Sciences, W.W Daniel. Publisher: John Wiley and Sons.
- Introduction to Biostatistics, Ronald N. Forthfer and Eun Sun Lee .Publisher: Elsevier.
- Research Methodology Methods and Techniques by C.R. Kothari
- Research Methodology Methods and statistical Techniques by Santosh Gupta

MEDICAL BIOTECHNOLOGY

COURSE CODE: BIOT4206 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENTS:

Unit I: Introduction

Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

Unit II: Genetic disorders

Genetic disease, type of inheritance, single-gene and multifactorial inheritance, example of genetic diseases. Therapeutic intervention in blood disorder by stem cell transplantation/gene therapy.

Unit III:Etiology of bacterialdiseases

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by Gram negative bacteria (*E. coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, H. influenzae,)* and Gram positive bacteria (*S. aureus, S. pyogenes, B. anthracis, C. perferinges, C. tetani, C. botulinum*):

Unit IV: Viral diseases

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses. Antigenic shift and drift.

Unit V: Fungal and protozoan diseases

Fungal and Protozoan infections. Dermatophytoses Subcutaneous infection (*Sporothrix, Cryptococcus*), systemic infection (*Histoplasma, Coccidoides)* and opportunistic fungal infections (*Candidiasis, Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

TEXTS AND REFERENCES:

- Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
- Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
- Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

IPR AND BIOETHICS

COURSE CODE: BIOT4207 **ASSOCIATED CREDITS (L-T-P): 4-0-0**

COURSE CONTENTS:

Unit I: General overview of Intellectual Property Rights and Patents

WIPO, WTO, Trade Related Intellectual Property Rights.

Basic requirements of Patentability, Patentable subject matter, Types of patent (process and product), Procedure for obtaining Patent, Provisional and Complete specification.

Unit II: Copyright and trademarks

Meaning and objectives of copyright , Rights conferred by registration of copyright , Infringement of copyright

Basic Principles of Trademark, Rights conferred by Registration of Trademark, Infringement of Trademark

Unit III : **Geographical indicators**

Geographical Indications-Objectives of Geographical Indications, Rights conferred , Infringement of Geographical Indications, International Position Indian Position, Bioprospecting and Biopiracy.

Unit IV : **Bioethics**

Ethical implications of biotechnological products and techniques: Ethical research, plagiarism, DBT regulations for biosafety and GMOs.

TEXT AND REFERENCES:

- Intellectual Property Rights by Brigitte Anderson, Edward Elgar Publishing
- Intellectual Property Rights and the Life Sciences Industries by Graham Dutfield, Ashgate Publishing
- WIPO Intellectual Property Handbook
- Intellectual Property Rights by William Rodelph Cornish, David Clewelyn

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