TECHNO INDIA
UNIVERSITY

Syllabus for M.Sc. Biotechnology

Last edited in BOS 30/08 19

M.SC. BIOTECHNOLOGY SYLLABUS TECHNO INDIA UNIVERSITY

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CORE STRUCTURE OF SYLLABUS FOR TWO YEAR (FOUR SEMESTER) M.Sc. BIOTECHNOLOGY

M.Sc. Syllabus Biotechnology 1st Year 1st Semester					
Course code	**Course Title**	**L**	**P**	**T**	**Total Credits**
TIU-PBT-T103	**Chemistry of Biomolecules**	3	0	0	3
TIU-PBT-T105	**Molecular Genetics**	3	0	0	3
TIU-PBT-T117	**Biophysics**	3	0	0	3
TIU-PBT-T115	**Cell Biology and Signaling**	3	0	0	3
TIU-PBT-T117	**Environmental Science**	3	0	0	3
TIU-PBT-L103	**Analytical Biochemistry Lab**	0	2	0	2
TIU-PBT-L111	**Molecular Techniques Lab**	0	2	0	2
TIU-PBT-L109	**Computational Biology Lab**	0	2	0	2
TIU-PES-S199	**Entrepreneurship Skill Development**	0	2	0	2
TIU-PEN-T101	**Skill Development – I (Elementary maths & Statistics)**	0	0	2	2
	Total Credit	15	8	2	25

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M.Sc. Syllabus Biotechnology 1st Year 2nd Semester					
Course code	**Course Title**	**L**	**P**	**T**	**Total Credits**
TIU-PBT-T102	**Molecular Immunology**	3	0	0	3
TIU-PBT-T114	**Bacteriology and Virology**	3	0	0	3
TIU-PBT-T120	**Plant Biotechnology**	3	0	0	3
TIU-PBT-T118	**Recombinant DNA Technology**	3	0	0	3
TIU-PBT-T120	**Bioenergetics & Metabolism**	3	0	0	3
TIU-PBT-L106	**Cell Biology and Immunology Lab**	0	2	0	2
TIU-PBT-L202	**Basic Genetic Engineering Lab**	0	2	0	2
TIU-PBT-L114	**Bacteriology and Virology Lab**	0	2	0	2
TIU-PES-S198	**Entrepreneurship Skill Development**	0	2	0	2
TIU-PEN-T100	**Skill Development – II (GIS & Remote sensing)**	0	0	2	2
	Total Credit	15	8	2	25

M.Sc. Syllabus Biotechnology 2nd Year 3rd Semester					
Course code	**Course Title**	**L**	**P**	**T**	**Total Credits**
TIU-PBT-T205	**Animal Biotechnology**	3	0	0	3
TIU-PBT-T207	**Bioprocess Engineering and Downstream Processing**	3	0	0	3
TIU-PBT-T209	**Genetics and Statistics**	3	0	0	3
TIU-PBT-T211	**Microbial Ecology**	3	0	0	3
TIU-PBT-L203	**Environmental Chemistry Lab**	0	2	0	2
TIU-PBT-L215	**Bioprocess Engineering and Downstream Processing Lab**	0	2	0	2
TIU-PBT-L217	**Project - I**	0	5	0	5
TIU-PES-S299	**Entrepreneurship Skill Development**	0	2	0	2
TIU-PBT-P299	**Skill Development – III (Food & Fermentation Technology)**	0	2	0	2
	Total Credit	12	11	2	25

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Course code	SPECIAL PAPER
	ELECTIVE 1: Environmental Pollution/ GIS & REMOTE SENSING
	ELECTIVE 2: Cellular and Molecular Immunology, Immunoproteomics & Bioinformatics
	ELECTIVE 3: Pharmaceutical Biotechnology (Phytochemistry, Phytopharmacology, Medicinal Chemistry and Nanobiotechnology)
	ELECTIVE 4: Protein Structure & Function Study
	ELECTIVE 5: Environmental Microbiology & Biotechnology
	ELECTIVE 6: Agriculture Biotechnology & Bioinformatics
	ELECTIVE 7: Plant Molecular Biology, Biotechnology & Tissue Culture

M.Sc. Syllabus Biotechnology 2nd Year 4th Semester					
Course code	**Course Title**	**L**	**P**	**T**	**Total Credits**
TIU-PBT-S296	**Career Advancement Skill Development (Grand Viva)**	0	3	0	3
TIU-PBT-P298	**Project - II**	0	20	0	20
TIU-PES-S298	**Entrepreneurship Skill Development**	0	2	0	2
	Total Credit	0	25	0	25

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M.Sc. Syllabus Biotechnology 1st Year 1st Semester					
Course code	**Course Title**	**L**	**P**	**T**	**Total Credits**
TIU-PBT-T103	**Biochemistry**	3	0	0	3
TIU-PBT-T105	**Molecular Biology**	3	0	0	3
TIU-PBT-T117	**Environmental Science**	3	0	0	3
TIU-PBT-T115	**Cell Biology and Signaling**	3	0	0	3
TIU-PBT-L103	**Biochemistry Lab**	0	2	0	2
TIU-PBT-L111	**Molecular Biology Lab**	0	2	0	2

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Detailed M.Sc. Syllabus Biotechnology 1st Year 1st Semester

TIU-PBT-L109	**Bioinformatics Lab**	0	2	0	2
TIU-PBT-S199	**Industrial Visit**	0	1	0	1
TIU-PES-S199	**Entrepreneurship Skill Development**	0	2	0	2
TIU-PEN-T101	**Career Advancement Skill Development**	3	0	0	3
	Total Credit	18	8	0	27

TIU-PBT-T103: Biochemistry

Unit-I: Water as universal solvent, pH, Buffer, Blood Buffer, colloidal solution, osmosis and its Maintenance, Solution (Normality, Molarity etc.).

Unit-II: Cell membrane (Fluid Mosaic Model, Membrane Fluidity), Membrane Transport.

Unit-III: Structural and Functional details of: Carbohydrate, Protein, Fat, Nucleic Acid, Vitamins and Hormones. Structure and function: Hemoglobin, Myoglobin, Chlorophyll.

Unit-IV: Antioxidant and Redox Signaling, Oxidative stress related disease, Medicinal foods.

TIU-PBT-T105: Molecular Biology

Unit I: DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, and DNA damage and repair mechanisms.
RNA synthesis a**nd processing:** Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.
Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyltRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins.

Unit II: Control of gene expression at transcription and translation level: Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing.

Unit III: Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

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Unit IV: Organization of genes and chromosomes: Operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.

TIU-PBT-T115: Cell Biology and Signaling

Unit I: Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Unit II: Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

Unit III: Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.

Unit IV: Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.

Unit V: Cellular communication: General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

Unit VI: Cancer: Oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

TIU-PBT-T117: ENVIRONMENTAL SCIENCE

UNIT I: Environment- Basic concepts and issues; Environmental pollution: types of pollution, measurement of pollution; Methodology of environmental management - the problem solving approach, its limitations. Biodegradation: Biodegradation of pollutants by microorganisms: Persistent organic pollutants; non biological degradation of pollutants: Decay behaviour& degradative plasmids; Hydrocarbons, Substituted hydrocarbons, Oil pollution, Surfactant. Bioremediation: definition; types; notable examples; Xenobiotics in environment: Biodegradation of Hydrocarbons; Substituted hydrocarbons; Surfactant; Pesticides; Lignin; Tannin; Synthetic dyes; Biotransformation: Oxidation reactions: Cytochrome P450 monooxygenase system; Alcohol and aldehyde dehydrogenases; Peroxidases. Reduction reactions: Cytochrome P450 and flavin dependent reactions. Hydrolysis reactions: Carboxyl esterases. Conjugation reactions: Gluthione S transferases. Regulation of biotransformation

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Unit II: Water pollution and its Control : Water as a scarce natural resource; Need for water management; Measurement of water pollution; Sources of water pollution; Wastewater collection; Wastewater treatment-physical, chemical and biological treatment processes, Microbiology of waster water treatments; Aerobic processes: Activated sludge, Oxidation ditches, Trickling filter, Towers, Rotating discs, Rotating drums, Oxidation ponds; Anaerobic processes: Anaerobic processes; Anaerobic digestion, Anaerobic filters, Upflow anaerobic sludge blanket reactors; Treatment schemes for wastewaters of dairy, distillary, sugar, antibiotic industries. Solid wastes; Sources and management: composting, wormiculture and methane production, Food, feed and energy from solid waste (biomass and agrowastes)

Unit III: Global Environmental Problems: Ozone depletion, UV-B and greenhouse effect, Acid rain, its impact and biotechnological approaches for management. Biodiversity and biotechnology: Classification and quantification of biodiversity; Value; loss and conservation of Biodiversity. Biotechnological methods of conservation: Crypreservation and micropropogation. Environmental Monitoring and Impact Assessment: Biological monitoring program; bioindicators, Environmental Audit: Introduction; Types; General Methodology; Environmental Laws: Problems in making and implementing environmental laws; Indian environmental laws; national environmental policy (draft) 2004; GIS and remote sensing

Unit IV: Biosafety: Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena . **Environmental Problems:** Ozone depletion, UV-B and greenhouse effect, Acid rain, its impact and biotechnological, andapproaches for management. **Biodiversity and biotechnology:** Classification and quantification of biodiversity; Value; lossand conservation of Biodiversity. Biotechnological methods of conservation: Cryopreservationand micropropogation. **Environmental Monitoring and Impact Assessment:** Biological monitoring program;bioindicators, Environmental Audit: Introduction; Types; General Methodology;Environmental Laws: Problems in making and implementing environmental laws; Indianenvironmental laws; national environmental policy (draft) 2004; GIS and remote sensing

TIU-PBT-L103: Biolochemistry Lab

- Concept of Normality, Molarity, Molality, Percentage solutions and their inter-conversion
- Operation of pH meter and pHing buffers
- Isoelectric point determination of amino acids
- Introduction to spectrophotometer, absorption maxima
- Estimation of nucleic acids, amino acids, proteins, carbohydrates and fats
- Separation of amino acids by Paper chromatography and TLC

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TIU-PBT-L111: Molecular Biology Lab

- Isolation of genomic DNA from bacteria
- Isolation of genomic DNA from plant
- Isolation of genomic DNA from animal cells
- Isolation of plasmid DNA from bacteria
- Agarose gel electrophoresis of genomic and plasmid DNA
- Karyotyping of mammalian cells
- Cell Fractionation (Demonstration)

TIU-PBT-L109: Bioinformatics Lab

- Sequence Retrieval from BLAST and its Annotation
- Phylogenetic Analysis
- Prediction of the structural components of a gene
- Designing PCR primers for expression vectors
- Protein secondary and tertiary structure prediction
- Protein Localization

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Book list

Advanced Biological Chemistry

1. Principles of Biochemistry (2008). Lehninger A.L. (ed.)
2. Biochemistry. (2002). Stryer, L.
3. Principles of Biochemistry. (1995). Zubay, G.L., Parson, W.W. & Vance, D.E.
4. Harper's Biochemistry.(1990). Murray, R.K. et al
5. Biochemistry. (2004). Voet, D. &Voet J.G.
6. Biochemistry and Molecular Biology.(2005). Elliott, W.H. & Elliott, D.C.
7. Fundamentals of Biochemistry. (1999). Voet, D., Voet, J. &Pratt,C.W.
8. Introduction to Protein Structure (1999). Branden C. &Tooze J.

Molecular Biology

1.Genes X (2010). Lewin, B.
2. Essential Genes (2006) Lewin.
3. Essential Genetics: A genome perspective. Hartl and Jones. (4th Edition)
4. Principle of Genetics. Gardner, E.J., Simmons, M.J. &Snustad, D.P. (8th Edition)
5. Genetics (2002). Strickberger, M
6. Molecular Biology of the Cell (2002) Alberts. et al.
7. Molecular Biology of the Gene (2008) Watson et al.
8. Cell and Molecular Genetics (1987) Schlesf, R.
9. Microbial Genetics (2006). S.Maloy, J.Cronan Jr and Friefelder, D
10. Concept of Genetics (2002). Klug, W.S. & Michael, R & Cummins, M.R.

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CELL BIOLOGY AND CELL SIGNALLING

1. Molecular Biology of the Cell (2002) Alberts. et al.
2. Molecular Biology of the Gene (2008) Watson et al.
3. Cell and Molecular Genetics (1987) Schlesf, R

Detailed M.Sc. Syllabus Biotechnology 1st Year 2nd Semester

M.Sc. Syllabus Biotechnology 1st Year 2nd Semester

Course code	Course Title	L	P	T	Total Credits
TIU-PBT-T102	**Immunology**	3	0	0	3
TIU-PBT-T114	**Bacteriology and Virology**	3	0	0	3
TIU-PBT-T116	**Plant and Agriculture Biotechnology**	3	0	0	3
TIU-PBT-T124	**Bioenergetics**	3	0	0	3
TIU-PBT-T202	**Recombinant DNA Technology**	3	0	0	3
TIU-PBT-L102	**Cell Biology and Immunology Lab**	0	2	0	2
TIU-PBT-L202	**Genetic Engineering Lab**	0	2	0	2
TIU-PBT-L114	**Microbiology Lab**	0	2	0	2
TIU-PES-S198	**Entrepreneurship Skill Development**	0	2	0	2
TIU-PEN-T100	**Career Advancement Skill Development**	3	0	0	3
	Total Credit	18	8	0	26

TIU-PBT-T102: Immunology

Unit 1: Basic concept of immunology: Introduction; overview of the immune system; Cells and organs of Immune system: Hematopoietic stem cells; Stromal cells; Hematopoietic growth factors; Lymphoid organs (primary and secondary) and cells; Mononuclear cells; Granulocytic cells; Mast cells; Dendritic cells- characteristics and functions; Types of Immunity: Innate immunity - mechanism of immune response (anatomic; physiological; phagocytic and inflammatory barriers); Adaptive immunity: Humoral and Cell-mediated immunity; Mechanism of immune response---antigen processing and presentation; types and structures of Major Histocompatibility Complex molecules (MHC) and their role in antigen presentation; clonal selection of lymphocytes; definition of cytokine; generation of humoral and cell mediated response by cellular interactions (general concept only).

Unit II: Antigen and antibody: Concept of antigen; Chemical nature; antigenicity;immunogenicity; hapten; epitopes; mitogens (definition; properties; examples); Adjuvant;Immunoglobulins: Isotypes- definition; basic and fine structures; generalcharacteristics and functions. Monoclonal and polyclonal antibody (definition and characteristics); Antigen - Antibody interactions: Precipitation reactions-Radial

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immunodiffusion; double immunodiffusion; immunoelectrophoresis; Agglutination reactions-Hemagglutination; passive agglutination; bacterial agglutination; agglutination inhibition; Important features of both categories of antibodies; Complement: The complement components; function; complement activation.

Unit III: Immunity to Infection: Bacteria, viral, fungal and parasitic infections (withexamples 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 immunodeficiencies, Acquired or secondary immunodeficiency.
Vaccines: Active and passive immunization (definition; characteristics; examples and functions); Attenuated and inactivated viral or bacterial vaccines (definition; characteristic; functions; examples); Vaccine technology- Role and properties of adjuvants, recombinantDNA and protein based vaccines, plant-based vaccines, Peptide vaccines, conjugate vaccines.

Unit IV: Immunological techniques: One and two dimensional single radial immunodiffusion; Ouchterlony immunodiffusion; Rocket immunoelectrophoresis; ELISA; Direct, indirect and Sandwich immunofluorescence; hybridoma technology and monoclonal antibody production.

TIU-PBT-T114: BACTERIOLOGY AND VIROLOGY

Unit I: History and notable contributions in the development of Microbiology: i) Spontaneous generation (abiogenesis) ii) Biogenesis iii) Germ Theory of Disease iv) Koch's Postulates v) Scope of Microbiology Isolation, pure culture techniques, Methods of sterilization and Enrichment culture techniques; Position of microorganisms in biological world: Whittaker's Five-kingdom and three-kingdom concept of living organisms (General characteristics of those groups); General features of Eubacteria and Archaebacteria (major difference within Eubacteria). Brief account of all group of bacteria and cyanobacteria, Rickettsia, Chlamydia and Mycoplasma; Archaea :Archaebacteria and extremophilic microbes – their biotechnological potentials.

Unit II: Bacterial identification, nomenclature and classification, New approaches to bacterial taxonomy / classification including ribotyping and ribosomal RNA sequencing, Study of bacterial morphology: Classification of bacteria according to morphology and staining; Exospores & Cysts: types & structure; Endospore; Flagella; Pilus; Fimbriae (structure; composition and functions); Plasmids and episomes, Nuclear material; Bacterial Chromosome

Unit III: Nutrition, growth and control of microorganisms: Microbial Nutrition: Nutritional types (definition and example) - Photoautotrophs; Photoorganotrophs; Chemolithotrophs (ammonia; nitrite; sulfur; hydrogen; iron oxidizing bacteria); Chemoorganotrophs; Effect of oxygen on growth - classification on the basis of oxygen requirement and tolerance. Bacterial Growth: Growth phases - Generation time; Kinetics of growth: Batch culture, Continuous

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culture, Synchronous culture (definition and brief description); Physical factors influencing growth – Temperature, pH, osmotic pressure, salt concentration. Control of growth of Microbes: Sterilization; disinfection; antiseptic; sanitizer; germicide; antimicrobial agent (definition; application & examples); physical method of disinfection and sterilization - dry heat; moist heat; filtration; radiation (mode of action; applications); Chemical control – dye solutions; alcohol; acid; alkali; halogen; heavy metal; phenol; phenol derivatives; formaldehyde; ethylene oxide; detergents (mode of action; applications). Assessment of chemical disinfectant; phenol coefficient-definition and method of determination; Chemotherapeutic agents - sulphonamides; antibiotics; (definition types); mechanism of action and antimicrobial spectrum of penicillin, streptomycin, tetracycline, chloramphenicol, Nalidixic acid and metronidazole; drug resistance - phenomena and mechanism**.**

Unit IV: Virology: General characteristics of viruses: What are viruses? Difference between bacteria and viruses; Components of viruses; sizes and shapes of different viruses (describe with at least one example); host range and specificity; Classification of viruses based on the nucleic acid content: DNA (dsDNA; ssDNA) and RNA (ssRNA; dsRNA) viruses with examples: Human cancer viruses (SV40; HTLV - 1 & 2; Epstein-Barr virus only) Virus like agents: viroids and prions (concept and significance); Viral replication: General characteristics of replication; Replication of T4 phage; Phage growth and the estimation of phage numbers; Lytic and lysogenic life cycle of bacteriophage lambda; mechanism(s) that determines lytic and lysogenic life cycle**.**

TIU-PBT-T120: Plant Biotechnology

Unit I: DNA molecular markers; Principles, type and applications; RFLP, AFLP, RAPD, SSR, SNP, Structural and functional genomics, gene mapping, genome mapping, gene tagging and comparative genomics and applications, Restriction enzymes and their uses, Salient features of most commonly used vectors i.e. plasmids, bactetiophages, phagmids, cosmids, BACs and PACs, YACs, binary vectors, expression vectors, Gene cloning and sub-cloning strategies, chromosome walking, genetic transformation, Risk assessment and IPR

Unit II: Isolation of genes of economic importance, Gene construction for tissue-specific expression, Different methods of gene transfer to plants, *viz.* direct and vector-mediated, Molecular analysis of transformants, Molecular biology of various stresses like drought, salt, heavy metals and temperature, and biotic stresses like bacterial, fungal and viral diseases, Signal transduction and its molecular basis, Potential applications of plant genetic engineering for crop improvement, i.e. insect-pest resistance, abiotic stress resistance, herbicide resistance, storage protein quality, increasing shelf-life, oil quality, Current status of transgenics, biosafety norms and controlled field trials and release of transgenics (GMOs)

Unit III: Basic techniques in cell culture and somatic cell genesis, Clonal propagation, Concept of cellular totipotency, Anther culture, Somaclonal and gametoclonal variations, Hybrid embryo culture and embryo rescue, Somatic hybridization and cybridization, Application of tissue

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culture in crop improvement, Secondary metabolite production, Bioprospecting, Biofortification, Gene pyramiding and gene fusion, RNAi technology, *In vitro* mutagenesis, cryopreservation and plant culture repository

TIU-PBT-T202: Recombinant DNA Technology

Unit I: Basics Concepts of rDNA technology; Restriction Enzymes; DNA ligase;Modificationmethylases and other enzymes needed in genetic engineering; Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; DNA-Protein Interactions-Electromobility shift assay; DNaseIfootprinting.

Unit II: Cloning vectors: Plasmids; Bacteriophages; M13 vectors; PUC19 and Bluescriptvectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Expression vectors; Protein purification; His-tag; Plant based vectors: Ti and Ri as vectors, Yeast vectors, Shuttle vectors.

Unit III: Molecular cloning: Recombinant DNA techniques; construction of genomic DNAand cDNA libraries; screening of recombinants, Reporter assays; Sequencing of DNA: Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; Site-directed mutagenesis; gene replacement and gene targeting, Gene silencing techniques: Introduction to siRNA; siRNA technology. Polymerase chain reaction and its applications: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T/Avectors; Proof reading enzymes; PCR in gene recombination; deletion; addition; Overlap extension; Site specific mutagenesis, RFLP, RAPD and AFLP

Unit IV: Applications of genetic engineering: Transgenic animals; production ofrecombinant pharmaceuticals; gene therapy; disease diagnosis, CRISPR, Cas9

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TIU-PBT-L102: Cell Biology and Immunology Lab

- Assessment of antigen similarity using Ouchterlony double diffusion test.
- DOT ELISA test
- Quantitative ELISA
- Immunoelectrophoresis
- Western Blotting
- Lymphocyte Isolation & Culture
- Animal Cell Culture

TIU-PBT-L202: Genetic Engineering Lab

- Isolation of genomic DNA from bacteria
- PCR amplification of Gene of Interest
- Miniprep isolation of plasmid DNA
- Restriction digestion of plasmid DNA and Agarose gel electrophoresis of restriction digests and PCR products
- Cloning of PCR product into the isolated plasmid and transformation
- Identification and characterization of transformed colonies

TIU-PBT-L114: Microbiology Lab

- Preparation of media and slants for bacterial culture
- Isolation of pure culture in slant techniques and by streak plate techniques
- Dilution plating for viable count
- Simple staining and gram staining of bacteria
- Endospore staining,
- Determination of cell number, growth curve preparation
- Biochemical Characterization of Bacteria: Oxidation/Fermentation Test, Catalase, Oxidase and Urease Tests, IMViC test, Hydrogen Sulfide Test and Nitrate Reduction Test, Casein and Starch Hydrolysis
- Antibiotic Assay (Disc Diffusion Method)

BOOK LIST

PLANT and AGRICULTURE BIOTECHNOLOGY

1. **Plant Tissue culture: Basic and applied (2006) T. Jha and B. Ghosh.**
2. **Plant Biotechnology: Methods in tissue culture and gene transfer (2006). R. Keshavachandra and K.V. Peter.**
3. **Plant, cell, tissue and organ culture (2005) Gamborg and Phillips.**
4. **Plant cell and Tissue culture.(2005). I Vasil and T. Thorpe.**
5. **Plant tissue culture: Theory and practice- revised editions. Bhojwani and M. Rajdan**
6. **Plant cell & tissue culture. (1994). Vasil, I.K. & Thorpe, T.A.**
7. **Plant tissue culture: Applications and limits. (1990). Bhojwani, S.S.**

IMMUNOLOGY

1. **Essential Immunology (2005) Roitt I.M. and Delves P.J.**
2. **Immunology – Roitt I, Bostoff J. & Male D.**

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3. Immunology (2006) Luttmann M, Bratke K, Kupper M &Myrtek D.
4. Immunology (2007) Goldsby R.A., Kindt T.J., Osbrne B.A. and Kuby J.

Bacteriology and Virology

1. Brock's Biology of microorganisms. (2007). Madigan, M., Martinko& Parker, J.Pearson Prentice Hal
2. Microbiology: Fundamentals and Applications. (1989). Atlas, R.M.
3. Microbiology (1996). M J Pelezar, Chan E C S and Krige
4. Industrial Microbiology. (1987). G Reed, Prescott & Dunn, CBS Publishers.
5. General Microbiology. (1987). Stanier, R.Y., Ingraham, Wheelis and Painter

Detailed M.Sc Syllabus Biotechnology 2nd Year 3rd Semester

M.Sc. Syllabus Biotechnology 2nd Year 3rd Semester					
Course code	**Course Title**	**L**	**P**	**T**	**Total Credits**
TIU-PBT-T205	**Animal Biotechnology**	3	0	0	3
TIU-PBT-T207	**Bioprocess Engineering and Downstream Processing**	3	0	0	3
TIU-PBT-T209	**Genetics and Statistics**	3	0	0	3
TIU-PBT-T211	**Microbial Ecology**	3	0	0	3
TIU-PBT-L203	**Environmental Chemistry Lab**	0	2	0	2
TIU-PBT-L215	**Bioprocess Engineering and Downstream Processing Lab**	0	2	0	2
TIU-PBT-L217	**Elective Lab**				
TIU-PES-S299	**Entrepreneurship Skill Development**	0	2	0	2
TIU-PBT-P299	**Departmental CASD (ElectiveTheory)**	3	0	0	3
	Total Credit	18	8	0	26

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TIU-PBT-T205: Animal Biotechnology

Unit I: Animal cell culture: Equipments and materials for animal cell culture technology. Various systems of cell culture; their distinguishing features; advantages and limitations; Culture medium: natural media; synthetic media; sera; Introduction to balanced salt solutions and simple growth medium; Brief discussion on the chemical; physical and metabolic functions of different constituents of culture medium; role of carbon dioxide; serum supplements. Characteristics of cells in culture: contact inhibition; anchorage dependence; cell-cell communication etc.; Cell senescence; cell and tissue response to trophic factors.

Unit II: Primary culture: behavior of cells, properties, utility; Explant culture; suspension culture; Established cell line cultures: definition of cell lines, maintenance and management, cell

adaptation; Measurement of viability and cytotoxicity; Cell cloning; cell synchronization and cell manipulation; Various methods of separation of cell types; advantages and limitations; flow cytometry.

Unit III: Basic techniques of mammalian cell cultures in vitro: Serum & protein free defined media and their applications; Measurement of viability and cytotoxicity; Cell synchronization; Cell transformation; Scaling up of animal cell culture; Stem cell cultures; embryonic stem cells and their applications; Somatic cell genetics; Apoptosis: Measurement of cell death

Unit IV: Commercial applications of cell culture: Stem cells and their applications, Hybridoma Technology and Monoclonal antibodies; Tissue culture as a screening system; cytotoxicity and diagnostic tests; Mass production of biologically important compounds (e.g. Vaccines); Harvesting of products; purification and assays; Organ cultures and tissue engineering

TIU-PBT-T207: Bioprocess Engineering and Downstream Processing

Unit I: Immobilized enzymes: methods, mass transfer considerations; Industrial enzymes.

Unit II: Microbial growth: Factors affecting microbial growth; Stoichiometry: mass balances; Stoichiometry: energy balances; Growth kinetics; Measurement of growth.

Unit III: Bioreactors: Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; Immobilized cells; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Culture-specific design aspects: plant/mammalian cell culture reactors. Bioseparations: Biomass removal; Biomass disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography Industrial Processes and Process economics: Description of industrial processes; Process flow sheeting; Process economics.

Unit IV: Downstream Processing: Biomass removal and disruption; Centrifugation; sedimentation; Flocculation; Microfiltration; Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis; Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Diafiltration ; Pervaporation; Perstraction; Adsorption and chromatography: size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (Ammonium Sulfate, solvent); Electrophoresis(capillary); Crystallization; Extraction (solvent, aqueous two phase, super critical), Drying; Case studies

TIU-PBT-T209: Genetics and Statistics

Unit I: Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance. **Concept of gene:** Allele, multiple alleles, pseudoallele, complementation tests. **Extensions of Mendelian principles:** Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

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Unit II: Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. **Extra chromosomal inheritance:** Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

Unit III: Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. **Human genetics:** Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. **Quantitative genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit IV: Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. **Structural and numerical alterations of chromosomes:** Deletion, duplication, inversion, translocation, ploidy and their genetic implications. **Recombination:** Homologous and non-homologous recombination, including transposition, site-specific recombination.

Unit V: Statistical Methods: Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test; analysis of variance; X^2 test;; basic introduction to Multivariate statistics, etc.

TIU-PBT-T211: MICROBIAL ECOLOGY

Unit I: Introduction to microbial ecology: overview, History, applications Microbial functions in ecosystems and global cycles, Harmful microbes (biofouling and bio deterioration and pathogenic microbes), Microbial processes and climate change, Characterization of microbial communities by PCR, real-time PCR, molecular fingerprints, FISH, sequencing, pyrosequencing, biofilm formation

Unit II: Microbiology of air, water and soil: Different types of microorganisms in the air, aerosols, Microbiological analysis of water (total count, indicative organism), B.O.D. & C.O.D. - determination and implication, Physical and chemical characteristics of various microbial groups in soil; Rhizosphere, Phyllosphere; Brief account of microbial interactions - (symbiosis, neutralism, commensalism, competition, ammensalism, synergism, parasitism, and predation); Biological nitrogen fixation - symbiotic and asymbiotic; Root -nodule formation in legumes; Compost and Biofertilizers

Unit III: Marine microbiology: What is marine microbiology, Biological organization and the evolution of life, The world's oceans and seas, Chemical and physical factors in the marine environment, Marine microbial habitats - water column, Sediments, coastal ecosystems, mangroves salt marshes, Biofilms and Microbial mats, Microbial life at surfaces of living and non-living systems, Quorum sensing in marine microbes and significance, Carbon cycling in the oceans, Photosynthesis and primary productivity, Microbial processes in eutrophication of coastal waters.

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Unit IV: Microbial Diseases: Disease reservoirs; epidemiological terminologies; infectious disease transmission; respiratory infections caused by bacteria and viruses; tuberculosis; sexually transmitted diseases including AIDS; diseases transmitted by animals (rabies, plague), insects and ticks (rickettisias. lyme disease, malaria), food and water borne diseases; public health and water quality; pathogenic fungi; emerging and resurgent infectious diseases. Host-parasite relationships: Normal microflora if skin, oral cavity, gastrointestinal tract; entry of pathogens into the host; colonization and factors predicted to infections; types of toxins (Exo, Endo-, Entero) and their structure; mode of actions; virulence and pathogenesis.

TIU-PBT-L203: Environmental Chemistry Lab

- The pH and Buffer Capacity of Environmental Waters and Soil samples
- Alkalinity of Streams and Lakes
- Conductivity of Various Waters (TDS)
- Fluorimetric Determination of Polycyclic Aromatic Hydrocarbons
- Determination of Partition Coefficient for Organic Pollutants
- Bio-estimation of BOD and COD of waste water

TIU-PBT-L205: Elective Lab

- Calculation of eukaryotic (yeast) cell number by heamacytometer
- Study of cell viability by MTT assay
- Study of gene expression at the mRNA
- Study of gene expression at the protein level

TIU-PBT-L213: Bioprocess Engineering and Downstream Processing Lab

- Determination of enzyme kinetic parameters by spectrophotometric method
- Demonstration of effect of pH and temperature on enzyme activity
- Study of inhibitors on enzymatic activity (competitive, uncompetitive, noncompetitive)
- Isozyme Assays

TIU-PBT-P299: Departmental CASD (Elective Theory)

A: CELL SIGNALLING AND EUKARYOTIC GENE EXPRESSION

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Unit I: Cell signalling Basics: Receptors, Inducers, Agonists, Antagonists, Regulation of gene expression. Hormones and their receptors, cell surface receptor, signalling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signalling pathways, bacterial and plant two-component signalling systems, bacterial chemotaxis and quorum sensing.

Unit II: Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

Unit III: Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth, Signalling Immunology

B: CLINICAL AND PHARMACEUTICAL BIOTECHNOLOGY

A: Module I: Basic Pharmacology: General Pharmacological Principle; Definition, Routes of drug administration; Pharmacokinetics: Transport through biological membrane; Basic concept of ADME; Pharmacodynamics: Principle of drug action, Mechanism of drug action, Factors modifying drug action; Adverse drug effect.

Module II: Drug Designing: Fundamentals of drug designing, The Pharmacophore, The Drug Discovery: Combinatorial Chemistry, Structure based design, QSAR and drug design, Computational Drug design, Example of drug design, Limitation of De Novo design, Example of different Rational Drug Design Software, Future perspectives.

Chiral Technology: Introduction, Chiral compounds: synthesis of chiral compounds, Separation of Enantiomers, Importance of Enantiomer separation. Role of Chiral compounds Marketing, Role of Biotechnology in Chiral synthesis.

Module III: A. Molecular Pharming: Introduction, Creating transgenics, Biopharmaceuticals: Generation of Vaccine. **Pharmacogenomics:** Introduction, Identification of drug responsive genes, Microarray Gene Chips, Pharmacogenomics of multigenic diseases: Coronery Artery Disease, Schizophrenia, And Cancer. Benefits of Pharmacogenomics.

B. Herbal Drug Development: Introduction to natural products, definition and types of principle bioactive components, Antioxidant Redox Signalling and Cellular Longevity. Benefits of herbal drugs over other therapeutic approaches. Current Research on herbal drug development.

Unit IV: Commercial applications of cell culture: Stem cells and their applications, Hybridoma Technology and Monoclonal antibodies; Tissue culture as a screening system; cytotoxicity and diagnostic

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tests; Mass production of biologically important compounds (e.g. Vaccines); Harvesting of products; purification and assays; Organ cultures and tissue engineering

C: AGRICULTURAL BIOTECHNOLOGY

Unit I: Applications of Plant Biotechnology in Crop Improvement: Biotechnology and its relevance in agriculture, Introduction to plant tissue culture, lab facilities and operations, tissue culture media: preparation and handling, establishing aseptic cultures; callus, suspension cultures, Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation. Micropropagation via axillary and adventitious shoot proliferation; Somatic embryogenesis; production of artificial seeds; Double haploid production by androgenesis and gynogenesis; triploid production by endosperm culture; production of virus free plants by meristem, shoot-tip culture; Cell Suspension cultures; protoplast isolation and regeneration, somatic hybridization and cybridization; protoclonal, somaclonal and gametoclonal variation for crop improvement; Cryopreservation.

Unit: II: Plant Genetic Engineering, Molecular Diversity and Production of Transgenic Plants:Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH).Genetic material of plant cells with an introduction to chloroplast and mitochondrial DNA; Restriction enzymes; Transformation of plant cells; different type of vectors including viral vectors and their benefits; Modes of gene delivery in plants: Particle bombardment, electroporation, microinjection; *Agrobacterium*mediated gene transfer, Ti and Ri plasmids; Screening and selection of transformants, PCR and hybridization methods; Transgene selection and silencing; Generation and maintenance of transgenic plants, Bt cotton, golden rice and some others as examples.

Unit: III: Biotechnology and Conservation of Botanical Resources: Plant genetic resources, Basics of conventional and molecular plant breeding, Biodiversity utilization and conservation, Analysis of transgenics, Enhancer trap, Promoter tagging, gene tapping gene tagging, Insertional mutagenesis, Developing herbicide resistance in crops: Target of herbicide action and Detoxification of herbicides, Biopolymer production through transgenic plants, Gene silencing, PTGS, RNai, Antisense technology, Applications, Plantibodies and plant vaccines, PPVR, Biosafety, Bioethics and plant biotechnology, Role of ethnobotany in relation to drug discovery, Herbal industry, WTO scenario, Indian system of medicine, Indigenous Traditional Knowledge, GAP in medicinal crop production, Production of secondary metabolites from cell and hairy root cultures, Biotransformations

D: MOLECULAR IMMUNOLOGY

Module I: Immune signal transduction, Immune endocytosis, Immune cell motility, Cell stress response
Module II: Communication between cells of immune systems, adhesion molecules, cytokines.
Module III: Immunity against tumors, host-parasite interactions
Module IV: Cell signaling in current diagnostics and treatment

E: RECOMBINANT DNA TECHNOLOGY AND PROTEIN ENGINEERING

Module I: Protein stability and folding: Overview of protein structure, Higher level structure, Protein stability, Mechanism of protein folding (types, level, thermodynamics), Folding Rate, Molten globule; Techniques for studying of protein folding;: NMR, CD spectroscopy, Proteolysis; Location and functions of Molecular chaperones, chaperonin and co-chaperons, HSP chaperone system in *Ecoli*& Human; Proteasomes and proteosome mediated protein degradation; Protein folding errors: Alzheimer's, prions and Mad Cow (BSE, CJD), Cystic Fibrosis and cancer. Polyketides and non-ribosomal peptides; Combinational manipulation of polyketides and non ribosomal peptides; application of protein folding to design new drug.Determination of secondary structure- UV, CD and fluorescence Determination of quaternary structure - X-ray, Cryo TEM; Functional proteins - Hemoglobin and some well characterized enzymes / lectins / peptide hormons;Chemical modifications

Module II: Protein engineering: Introduction to steps of Protein design and Engineering, protein splicing and its application; Solid phase peptide synthesis, Production of Novel Proteins; Random and site directed mutagenesis, Methods for Expressing Recombinant Proteins; Industrial applications of Protein Engineering (Engineering of Stability, affinity for substrate, Protease Specificity, Cofactor requirements of Protein). Structure-function correlations in the context of protein ligand interactions & protein protein/nucleic acid/carbohydrate interactions.

Module III: Proteomics: Introduction to proteomics; Two dimensional electrophoresis (2-D PAGE): Protein pre-fractionation and sample preparation, IEF, SDS-PAGE, visualization of protein spot. Protein identification by mass spectrometry: ESI-TOF, MALDI-TOF, MS/MS, PMF, protein sequencing; Post translational modification, Application of proteome analysis; Proteomics in Drug Development; Diagnosis of diseases by Proteomics; Protein array; Discovery of new biomarker; identification of protein-protein interactions and protein complexes; proteomics in drug delivery.

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F: MICROBIAL BIOTECHNOLOGY

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BOOK LIST

Environmental Biotechnology

1. Environmental Biotechnology Theory and applications – Evans et al., 2000.
2. Environmental Biotechnology – Gareth M.Evams et al., 2003
3. Biotechnology, Recombinant DNA Technology, Environmental Biotechnology – S.Mahesh et al., 2003

BIOPROCESS TECHNOLOGY ANDDOWNSTREAM PROCESSING

1. Schuler &Kargi, Bio-process Engg. PHI
2. Bailey &Olis, Biochemical Engg. Fundamentals, McGraw-Hill, 1990
3. Mukhopadhyay, S.N. Process Biotechnology Fundamentals, Viva Books Pvt. Ltd. 2001.
4. Muni Cheryan, Handbook of Ultrafiltration
5. Perry, Chilton & Green, Chemical Engineers' Handbook, McGraw-Hill
6. Ho, W.S.W. & K. K. Sirkar, Membrane Handbook, Van Nostrand Reinhold, N.Y. (1992)
7. Encyclopedia of bioprocess technology. Vol 1-5. (1999). Flickinger, M.C. & Drew, S.W.(Ed).
8. Fermentation technology. (1994). Cassida.
9. Bioprocess engineering: Down stream processing & recovery of bioproducts, safety in biotechnology and regulations. (1990). Behrens, D. & Kramer, P.(Ed).
10. Enzymes. (1979). Dixon M. & Webb E.C.
11. Methods in Enzymology (relevant volumes of the series)
12. Fundamentals of Biochemistry. (1999). Voet, D., Voet, J.G &Pratt,C.W.
13. Genes VII. (2000). Lewin, B.
14. Biological Chemistry. (1986). Mahler, H.R. and Cordes E.
15. Bioseparations: Principles & Techniques (2005). Sivasankar B.
16. Enzymes- a practical introduction to structure mechanism and data analysis (2000).

Copeland, R.A. 8. Enzymes: Biochemistry, Biotechnology & clinical chemistry (2004). Palmer, T.

ANIMAL BIOTECHNOLOGY

1. In Vitro Cultivation of Animal Cells (1995) Butterworth – Heinemann \
2. Animal Cell Culture (2000) – A Practical Approach John R.W. Masters
3. Culture of Animal Cells – A manual of Basic technique (2005) R.I. Freshney

GENETICS AND BIOSTATICS

1.Genes X (2010). Lewin, B.
2. Essential Genes (2006) Lewin.
3. Essential Genetics: A genome perspective. Hartl and Jones. (4th Edition)
4. Principle of Genetics. Gardner, E.J., Simmons, M.J. &Snustad, D.P. (8th Edition)
5. Genetics (2002). Strickberger, M

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6. Microbial Genetics (2006). S.Maloy, J.Cronan Jr and Friefelder, D
7. Concept of Genetics (2002). Klug, W.S. & Michael, R & Cummins, M.R.

Microbial Ecology:

1. Microbiology: Michael Pelczar, E.C.S Chan, Noel R. Krieg; Tata McGraw - Hill Education (2001); 5th Edition.

2. General Microbiology: Author: Hans Gunter schlegel, Cambridge University Press (1993); 7th Revised Edition

PROTEOMICS AND GENOMICS

1. Principles of Genome Analysis and Genomics, Third Edition (2003) S.B. Primrose and R.M. Twyman, Blackwell Publishing Company, Oxford, UK.
2. Introduction to proteomics – Tools For The New Biology, First Edition (2002) D.C. Liebler, Humana Press Inc, New Jersey, USA.

Detailed M.Sc Syllabus Biotechnology 2nd Year 4th Semester

M.Sc. Syllabus Biotechnology 2nd Year 4th Semester					
Course code	**Course Title**	**L**	**P**	**T**	**Total Credits**
TIU-PBT-T210	**Methods in Biology**	3	0	0	3
TIU-PBT-S296	**Career Advancement Skill Development (Grand Viva))**	0	3	0	3
TIU-PBT-P298	**Project Work , Presentation**	0	16	0	16
TIU-PBT-L208	**Advanced Biological Techniques Lab**	0	2	0	2
TIU-PES-S298	**Entrepreneurship Skill Development**	0	2	0	2
	Total Credit	6	19	0	26

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TIU-PBT-T210: Methods in Biology

A. Molecular biology and recombinant DNA methods:

B. Histochemical and immunotechniques:

C. Biophysical methods:
D. Radiolabeling techniques:
E. Electrophysiological methods
F. Microscopic techniques:
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TIU-PBT-L208: Advanced Biological Techniques

- AFLP and RFLP Analysis
- Assay of cytokines and chemokines from cell supernatants

- Isolation of lymphocytes by density gradient centrifugation and their surface typing
- Nano-encapsulation and characterization of drug

TIU-PBT-P298: Project Work, Presentation and Grand Viva

Project Work Scheme / Guidelines for the Students; Supervisors and Examiners

Every student is required to carry out Experimental / Field Based Project Work on a related research topic of the subject /course. It must be an original work and will be evaluated by the examiner on the strength of experimental Project work. On the basis of this work; student must submit the Project Report (typed and properly bound) in two copies at least one month prior to commencement of the final Practical/lab Examination of Semester IV.

The project report shall comprise of Introduction; Material and Methods; Results; Discussion; Summary; Conclusions and; References along with the declaration by the candidate that the work is original and not submitted to any University or Organization for award of the degree and certificate by the supervisor and forwarded through Head/Course coordinator/ Director of the Department/Centre or the Principal of the College.

The topic for the project work will be assigned to the student by supervisor at the beginning of third semester. The topic will be forwarded to the controller of examination by the head of the department. The Project Work will carry total 300 marks and will be evaluated by both external and internal examiner in the respective Department / Center / Affiliated College.

TIU-PBT-S296: Career Advancement Skill Development (Grand Viva)

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TIU-PES-S298: Entrepreneurship Skill Development

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