2017

# Multani Mal Modi College, Patiala

## Unit Planning M.Sc Biotechnology

Department of Biotechnology

## Class – MSc I (Semester I) Biotechnology

## Subject: Principles of Biochemistry (Paper-I)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I |
|---|
| 1. **Introduction to biomolecules***:*Biological properties of water, pH, ionization, biological buffers, titration of amino acids, amino acids, proteins and their three dimensional structure, weak and strong interactions, hydrophobic interactions.<br>2. **Structure and function of carbohydrates***:*Monosaccharides, disaccharides, polysaccharides, homopolysaccharides (starch, cellulose, chitin), heteropolysaccharides, mucopolysaccharides; Structure and function of nucleic acids (purines, pyrimindines, nucleosides, nucleotides, inter nucleotide bonding, tautomerism).<br>3. **Structure and function of lipids***:*Neutral lipids, phospholipids, isoprenoids, phosphatidyl inositol (intracellular messenger), biological effectors.<br>4. **Vitamins***:*Water soluble and fat soluble; Hormones, their structure and functions.<br>5. **Enzymes:**General properties of enzymes and coenzymes, their nature, classification and nomenclature of enzymes, fundamentals of steady state kinetics, enzyme inhibition, isozymes.<br>6. **Biological membrane and cell wall:**Properties of lipid aggregates, micelles, liposomes, structure and properties, membrane proteins and their function, fluid mosaic model, membrane mediated transport, membrane equilibrium and permeability, chemical, physical composition and biosynthesis of cell wall components. |
| **TILL MST – II** |
| 7. **Carbohydrate metabolism***:*Glycolysis, biochemistry of alcohol and lactic acid fermentation, citric acid cycle, pentose phosphate pathway, EDP pathway, disaccharide and polysaccharide metabolism, gluconeogenesis, regulation of carbohydrate metabolism.<br>8. **Oxidative phosphorylation/respiration:**Electron transport chain, photorespiration, microsomal electron transport.<br>9. **Biochemistry of lipid metabolism:Biosynthesis** and catabolism of fatty acids, neutral |

lipids, phospholipids and cholesterol, glycolate cycle, regulation of fatty acid metabolism.

10. **Amino acid metabolism:** Biosynthetic families of amino acids, ammonia ion assimilation into amino acid by Glu and Gln, regulation of amino acid synthesis; Degradation of amino acids-oxidative deamination of glutamate, carbon atom degradation, amino acid as major metabolic intermediates, $C_3$, $C_4$ and $C_5$ families, amino acid degradation to succinyl CoA, leucine, phenyl alanine and tyrosine degradation; Urea cycle; Nitrogen fixation and nitrogenase complex.

**TILL FINAL EXAM**

11. **Nucleotide metabolism:** Purine and pyrimidine nucleotide biosynthesis, synthesis of deoxyribonucleotides, degradation of purines, regulation of nucleotide metabolism.
12. **Photosynthesis:** Photosynthetic pigments, cyclic and noncyclic electron flow;Oxygen evolution system; Calvin cycle; C3 and C4 mode of photosynthesis.

**Mode of Assessment**

| Sr. No. | Component | Weightage |
|---|---|---|
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

## Class – MSc I (Semester I) Biotechnology

## Subject: Molecular Genetics (Paper-II)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I | |
|---|---|
| 1. | **Genetic material and genomes:**Genome size, gene density and ultrastructure of chromosome in prokaryotes and eukaryotes; DNA supercoiling and topoisomerases, repetitive DNA, transposons. |
| 2. | **Molecular tools and techniques:**Electrophoresis, IEF, PFGE, DNA sequencing, PCR, Southern, Northern, Western and Dot blotting; DNA probes, DNA fingerprinting, DNA foot printing, RFLP, ribozymes, antisense RNA/DNA: DNA denaturation/hybridization: cot/rot curves. |
| 3. | **DNA replication:** Unit of replication, enzymes involved, replication origin, initiation, elongation and termination, extrachromosomal replicons, reverse transcription; DNA repair mechanisms; Recombination-homologous and site specific recombination. |
| 4. | **Transcription:** Process in prokaryotes and eukaryotes, post transcriptional modifications,transcription inhibitors. |
| 5. | **Translation:** Genetic code, protein biosynthesis in prokaryotes and eukaryotes-initiation, elongation and termination, inhibitors of translation; Co-translational and post-translational modifications, protein localization, protein secretion. |
| 6. | **Gene Regulations in prokaryotes:**Operon hypothesis e.g., Lac, Ara, Trp, Hut operons, negative, positive and compound control; Stringent response, quorum sensing,gene regulation in eukaryotes-cell cycle and growth regulation,signal transduction;growth factors, growth factor receptors, apoptosis-genomic imprinting and its consequences, gradient and cascade in development of plants and animals; Role of chromatin in regulating gene expression and gene silencing; Cancer genetics-oncogenes, suppressor genes. |
| **TILL MST – II** | |
| 7. | **Genome organization:**Bacteriophage genomes-øX174, M13, Mu, T4, HIV and lambda; Extra nuclear DNA-plasmids, mitochondrial and chloroplast genomes. |

8. **Genome mapping technologies:** Genetic mapping,linkage analysis; Physical mapping-restriction mapping, FISH, STS mapping; DNA sequencing-chain termination, chemical degradation, pyrosequencing; Sequence assembly-shotgun approach, contig approach, chromosome walking, EST sequencing, RAPD, ribotyping.
9. **Proteome analysis:** 2DGE, DGGE, flow cytometry, MS, MALDI-TOF.
10. **Genomic techniques:**Flow cytometry, SAGE, SADE, Microarrays-DNA, protein; Gene function analysis-gene homology analysis; Comparative genomics-gene evolution, exon shuffling; Genome annotation-functional domain, gene ontology; Molecular phylogenetics; Gene knockout-insertional mutagenesis, iRNA.

**TILL FINAL EXAM**

11. **Genome environment interaction:** Heat stock and oxidative stress response; Pharmacogenomics-pharmacodynamics, pharmacokinetics and phamacotoxicology;Pharmacogenetic polymorphisms e.g., MDR.
12. Application of genomics and proteomics in biotechnology.

**Mode of Assessment**

| Sr. No. | Component | Weightage |
|---|---|---|
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

## Class – MSc I (Semester I) Biotechnology

## Subject: Introductory Microbiology (Paper-III)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I |
|---|
| 1. **Introduction:** Beginnings of Microbiology; Contributions of Lister, Koch and Pasteur; Microscopy-brief account of various types and their applications.<br>2. **Microbial systematics and taxonomy:** Morphological, physiological, biochemical & ecological characteristics and molecular techniques used in taxonomy; A brief account of Bergey's system of bacterial classification.<br>3. **Prokaryotes and eukaryotes:** Generalized account of bacteria, archaebacteria, cyanobacteria, actinomycetes, molds, slime molds, yeast, algae, protozoa, etc.<br>4. **Viruses:** Structure, classification and replication of important bacterial, plant and animal viruses.<br>5. **Microbial growth:** Requirements of various nutrients for microbial growth, mathematical expression of growth, measurement of growth, factors affecting growth; Synchronous and diauxic growth.<br>6. **Methods of microbiology:** Basic techniques of isolation, sterilization, maintenance and preservation of cultures; Types of media. |
| **TILL MST – II** |
| 7. **Cultural characteristics and anaerobic cultivation:** Cultural characteristics on solid and liquid media; Methods for culturing anaerobes.<br>8. **Microbial metabolism:** Utilization of energy and biosynthesis.<br>9. **Microbial genetics:** Generalized account of gene function and mutation.<br>10. **Microbial interactions:** Symbiotic interactions, parasitism, ammensalism and competition; A brief account of cycles of matter and microbial interactions. |
| **TILL FINAL EXAM** |
| 11. **Microbial flora of healthy human host:** Distribution and occurrence of normal flora in humans. |

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| *12.* **Microbial pathogenesis:** Host-microbe interactions; Bacterial, fungal and protozoal pathogenesis |

| **Mode of Assessment** | | |
|---|---|---|
| **Sr. No.** | **Component** | **Weightage** |
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

# Class – MSc I (Semester I) Biotechnology

## Subject: Immunology (Paper-IV)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I |
|---|
| 1. **Introduction and scope of immunology:**History, types of immunity, innate immunity, acquired immunity, active and passive immunity.<br>2. Antigens and antigenicity, haptens, epitopes.<br>3. **Immunoglobulins:** Types, structure, distribution, function, molecular biology of immunoglobulin synthesis, organization of immunoglobulion genes; Complement system.<br>4. **Cellular immunity:** Cells involved in immune system, organs of immune system, lymphocyte, macrophages.<br>5. **Humoral immune response:** T-dependent and T-independent immune response; Type I hypersensitivity, type II, III and IV immune reactions, autoimmunity.<br>6. **Immunomodulation:** Immunosuppression and immunopotentiation. |
| **TILL MST – II** |
| 7. **Immunization and vaccines:** Active and passive immunization-traditional and modern vaccines.<br>8. Interferons, Interleukines and other cytokines.<br>9. Major histocompatible complex and transplantation immunity.<br>10. **Antigen-antibody assays:**Methods to assay humoral immune response (Agglutination, immunodiffusion, immunoelectrophoresis, RIA, fluorescent assays, ELISA);Physical methods for isolation of antibodies; Methods for enumeration of various types of cells in immune system, immunoblot.<br>11. Methods of assay cell mediated immune response. |
| **TILL FINAL EXAM** |
| 12. **Hydridoma technology:** Myeloma cell lines, fusion, selection and screening of positive hybrid cells, cloning methods, purification, characterization and applications of monoclonal antibodies in diagnosis and therapy and in biomedical research;Antibody engineering; |

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| Abzymes. |

| Mode of Assessment | | |
|---|---|---|
| **Sr. No.** | **Component** | **Weightage** |
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

# Class – MSc I (Semester II) Biotechnology

## Subject: Genetic Engineering (Paper-V)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I | |
|---|---|
| 1. | **Introduction, basic tools and techniques of genetic engineering:** DNA cutting and modifying enzymes-restriction endonucleases, alkaline phosphatase, polynucleotide kinase, DNA ligase, S1 nuclease, exonucleases; Real Time PCR, quantitative PCR, WGA; Ligation of DNA fragments-*in vitro* ligation strategies (Joining DNA with ligases, topoisomerases and site specific recombinases);Chemical synthesis of DNA-adaptors, linkers and homo-polymer tailing for *in vitro* ligation. |
| 2. | **DNA libraries:** Genomic libraries-construction, amplification and applications; cDNA libraries-construction and applications. |
| 3. | **Cloning vectors:**Types of vectors-plasmids, phages, cosmids, phasmids, transposons, etc., their salient features, genetic map and host-range;*In vitro* packaging. |
| 4. | **Transformation techniques:** Chemical, physical and biological strategies. |
| 5. | **Recombinant selection and identification:**Direct and indirect methods; Reporter genes, immunological methods; South-Western screening, North-Western screening, maxi and mini cells. |
| 6. | **Gene expression in recombinants:** Principles of maximizing gene expression; Expression vectors design for downstream processing and protein purification- His-tag, GST-tag and MBP-tag. |
| **TILL MST – II** | |
| 7. | **Cloning in bacteria and yeast:** Comparative features of Gram negative and Gram positive bacteria, yeast; Two hybrid system-vectors and applications. |
| 8. | Site directed mutagenesis, phage display and cell surface display; Protein engineering-directed evolution and gene shuffling. |
| 9. | **Cloning in plants:** Tissue culture, Ti, Ri and viral vectors; Transgenic plants; Pharming. |
| 10. | **Cloning in animal cells:** Cell lines, selectable markers, plasmid and viral vectors; Transgenic animals and cloning; Gene therapy-gene targeting, replacementand knockout strategies. |
| 11. | **Applications:**Recombinant products, new materials and devices-biosensors; Agricultural |

applications; Industrial applications; Medicinal applications-vaccines and nucleic acid therapeutics; Environmental applications;r-DNA regulation guidelines-DBT, NIH and FDA.

## TILL FINAL EXAM

12. **Introduction to metabolic engineering:** Metabolomics, metabolic flux analysis, strategies to increase/alter metabolite flow, metabolic control analysis; Importance of metabolic engineering-completion of partial pathways giving novel products (indigo and melanin in *E. coli*), transfer of entire biosynthetic pathway (Trp biosynthesis to *E. coli*, creating new products, redirecting metabolite flow (Increased Thr in bacteria),overproduction of Trp in *C. glutamicum*), increased CephC production; Metabolic engineering of PHAs in *E. coli* and carotenoids in *Erwinia herbicola*.

## Mode of Assessment

| Sr. No. | Component | Weightage |
|---|---|---|
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

# Class – MSc I (Semester I) Biotechnology

## Subject: Molecular Biophysics (Paper-VI)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I | |
|---|---|
| 1. | **Thermodynamics:**Laws of thermodynamics, concept of enthalpy, heat capacity at constant volume and pressure, isothermal expansion, differential scanningcalorimetry, concept of entropy, statistical and thermodynamic definitions of entropy, entropy change due to mixing of ideal gases, entropy change due to heating, Gibb's free energy, free energy spontaneity criteria, dependence of free energy on temperature (Gibb's Helmholtz equation), dependence of free energy on pressure, Vant Hoff equation, bioenergetics, physical chemist and biochemist standard states, coupled reactions, high energy bonds. |
| 2. | **Chemical kinetics:**Reaction rate, order of reaction, revaluation of DNA-case study, half life of a reaction; Determination of reaction order, molecularity of reaction; Complex reaction, consecutive kinetics, isotope effect, reactions in solution, fast reaction in solution (The flow method and the relaxation method). |
| 3. | **Quantum mechanics:**Wave theory of light, Planck's quantum theory, photoelectric effect, de Broglie's postulate, Bohr's theory of atomic spectra, Huckel theory; Schrodinger's wave equation, Heisenberg's uncertainty principles, particles in one dimensional box, quantum mechanical tunneling. |
| 4. | **Biological applications of spectroscopy:**Principles and applications of UV-visible spectrophotometry, spectrofluorimetry and IR spectroscopy. |
| 5. | **NMR and ESR:** Principles and applications of NMR, chemical shift, spin-spin coupling, Pascal triangle rule, ESR (electron spin spectroscopy), SECTION rules for allowed transitions, hyperfine splitting. |
| 6. | Optical activity, principles and applications of ORD and CD, mass spectrometry, X-ray diffraction. |
| **TILL MST – II** | |
| 7. | Useful general concepts in molecular modeling coordinate system, potential energy surface, |

molecular graphics, units of length and energy.

8. Protein folding and design, conformational properties of the commonly occurring amino acids, properties of some conformationally constrained amino acids, design of medium sized peptides; Protein design (coiled coils, four helix bundles).

9. Some basic principles of protein structure, the hydrophobic effect, first principle methods for predicting protein structure, lattice method for investigation of protein structure, rule based approach using secondary structure prediction, introduction to complex modeling, sequence analysis, pharmacophores, drug designing.

10. Parameterization and simulation of the physical properties of phosphorothiodate nucleic acids in the design and characterization of antisense oligonucleotide for the treatment of various human diseases.

**TILL FINAL EXAM**

11. Computer simulations by a genetic algorithm, implementation of the principles of genetic algorithm for RNA folding, formation of stems, disruption of stems and selection of structure.

12. Molecular dynamics simulation, setting up and running a molecular dynamic simulation; How TATA box selects its protein partner

**Mode of Assessment**

| Sr. No. | Component | Weightage |
|---|---|---|
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

# Class – MSc I (Semester II) Biotechnology

## Subject: Fundamentals of Bioprocess Development (Paper-VII)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I |
|---|
| 1. **Introduction:** Bioprocess development-an interdisciplinary challenge; Basics of chemical and biochemical engineering; Applications of biochemical engineering in bioprocess development.<br>2. **Basic concepts in bioprocess development:** Physical and chemical variables; Material balance and energy balance; Unit operations in bioprocesses.<br>3. **Mode of operation of a bioprocess:** Basic concepts of batch, fed batch and continuous operation of a bioprocess.<br>4. **Fluid flow:** Classification of fluids; Fluid in motion; Newtonian and Non-Newtonian fluids; Bernoulli's equation; Viscosity.<br>5. **Heat transfer:** Fourier's law; Conduction; Convention; Individual and overall heat transfer coefficient; General equipments for heat transfer.<br>6. **Mass transfer:** Molecular diffusion; Analogy between heat, mass and momentum transfer; Role of diffusion in mass transfer; Convective mass transfer; Liquid-solid mass transfer; Liquid-liquid mass transfer; Liquid-gas mass transfer; Oxygen uptake in cell culture; Factors affecting cellular oxygen demand; Mass transfer coefficient. |
| **TILL MST – II** |
| 7. **Bioreactors:** Basic design and construction of various types of bioreactors used in bioprocesses.<br>8. **Monitoring and control of bioprocesses:** Basic instruments for controlling physical and chemical variables in a bioprocess; Computer control in bioprocesses.<br>9. **Sterilization:** Thermal death time; F-value; Z-value; TDT curve; D-value; Kinetics of batch and continuous sterilization of media; Kinetics of air sterilization in bioreactors.<br>10. **Scale-up of bioprocesses:** Steps in scale-up and basic considerations; Major challenges and alternate strategies to overcome the problems.<br>11. **Downstream processing:** Cell separation techniques; Cell disruption-physical, chemical and mechanical methods; chromatographic and electrophoretic techniques; Finishing techniques in bioprocesses. |

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| **TILL FINAL EXAM** |
| 12. **Bioprocess economics:** Capital investment for equipments, raw materials, consumables, manpower and other costs, etc. |

| **Mode of Assessment** | | |
|---|---|---|
| **Sr. No.** | **Component** | **Weightage** |
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

# Class – MSc I (Semester II) Biotechnology

## Subject: Fundamentals of Fermentation Technology (Paper-VIII)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I |
|---|
| 1. **Introduction:** Fermentation design and control; Fermentation products-primary metabolites, secondary metabolites and single cell proteins.<br>2. **Media for microbial fermentations:** Nutritional requirements-carbon, nitrogen, minerals, oxygen & specific nutrients; Chemically defined and complex media formulation; Statistical-mathematical approaches for medium optimization.<br>3. **Fermentation types:** Surface, submerged and solid state fermentation; Factors influencing liquid and solid state fermentations; Merits and demerits of different types of fermentations.<br>4. **Inoculum development:** Development of inoculum for bacterial, yeast and fungal fermentations at industrial level.<br>5. **Microbial growth kinetics:** Growth kinetics of batch, fed batch and continuous system of fermentation.<br>6. **Fermentation modeling:** General characteristics of fermentation modeling; Types of models; Criteria for selection of a suitable model. |
| **TILL MST – II** |
| 7. **Immobilized biocatalysts:** Immobilization of whole cells; Criteria for selection of a suitable matrix/support; Techniques of whole cell immobilization; Factors influencing the operational stability of immobilized biocatalyst.<br>8. **Biotransformations:**Perspectives and practical aspects; Industrial biotransformations; Future of biotransformations.<br>9. **Alcoholic beverages:** Production technology of different types of wines, beer and whisky.<br>10. **Microbial biomass:** Baker's yeast; Single cell proteins-production, composition, economic parameters and constraints; Mass cultivation of *Spirulina*; Safety aspects of SCP. |
| **TILL FINAL EXAM** |

11. **Agriculture related products:** Production and applications of bioinsecticides, biopesticides and biofertilizers.
12. **Biofuels:** Fermentative production of liquid fuels-ethanol, acetone and butanol, etc.; Factors affecting production of biofuels.

| Mode of Assessment | | |
|---|---|---|
| **Sr. No.** | **Component** | **Weightage** |
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

## Class – MSc II (Semester III) Biotechnology

## Subject: Enzymology (Paper-IX)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I |
|---|
| 1. Enzymes: Structure, evolution and its basis.<br>2. Enzyme action: Specificity, molecular aspects of enzyme action, and examples from different classes of enzyme.<br>3. Regulation of enzymic action: Activation of enzymes, covalent modification, allosteric interaction, multienzyme complexes.<br>4. Industrial production of enzymes: Sources of enzymes, criteria for the selection of source for enzyme production, methods of large scale production-solid substrate fermentation and submerged fermentation, factors affecting enzyme production, amylases, cellulases, pectinases, lactases, invertases, lipases, proteases.<br>5. Immobilization of biocatalysts: Definition, objectives and advantages of immobilization; techniques of immobilization, matrices - types, advantages and limitations.<br>6. Kinetic characterization: Immobilized enzymes - comparative account of immobilized biocatalysts, concept of co-immobilization. |
| **TILL MST – II** |
| 1. Biochemical applications: Role of soluble and immobilized enzymes in the synthesis and production of amino acids and chiral compounds; use of enzymes as detergents.<br>2. Pharmaceuticals: Role of soluble and immobilized enzymes in production of antibiotics, steroids, and other important intermediates of biotechnological industry; role of soluble and immobilized enzymes in diagnosis and treatment of diseases; enzyme therapy.<br>3. Applications in food industry: Soluble and immobilized enzymes - food production and processing, amylases, pectinases, proteases, lipases, glucoisomerases, naringinase.<br>4. Analytical applications: Theory and applications of various enzyme electrodes e.g. enzyme sensors, enzyme membranes, biochips/bio-semiconductors. |
| **TILL FINAL EXAM** |
| 1. Enzyme engineering: *In vitro* approaches to improve functional efficiency; Recombinant enzymes.<br>2. Enzymes in organic solvents: Modes of using enzymes, fundamentals and new properties. |

| Mode of Assessment |
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| Sr. No. | Component | Weightage |
|---|---|---|
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

# Class – MSc II (Semester III) Biotechnology

## Subject: Microbial and food technology (Paper-X)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I |
|---|
| 1. Microbial transformation: Types of transformation, applications in biotechnology and food technology, steroid transformations.<br>2. Pharmaceutical products: Fermentative production of antibiotics, penicillins, cephalosporins, erythromycins, vancomycins and streptomycin.<br>3. Vaccines: Fermentative production of vaccines & recombinant vaccines; edible vaccines.<br>4. Production of food additives and ingredients: Fermentative production of amino acids - L-glutamic acid and L-aspartic acid.<br>5. Production of vitamins: Thiamin (B-1), riboflavin (B-2), vitamin (B-12).<br>6. Microbial polysaccharides: Fermentative production of xanthan gums, dextrans, cyclodextrins and pullulan. |
| **TILL MST – II** |
| 1. Fermented foods: Production technology of cheese and bread; brief account of Indian fermented foods (*Idli, Vada, Dosa, Papad, Jalebi, Bhatura, Warries, Marchu, Gundruk*).<br>2. Fermented dairy products and sugar syrups: Production of cultured dairy milk, cultured cream, yoghurt; Sugar syrups - cane syrup, invert syrup, high fructose syrup, maltose syrup.<br>3. Immobilized whole cell technology in food industry: Brief account in wine, beer & dairy industry.<br>4. Food preservation: Physical (dehydration, freeze-drying, heat, irradiation) and chemical (antibiotics, organic acids, nitrates and nitrites, sulphites and sulphur dioxide) methods. |
| **TILL FINAL EXAM** |
| 1. Waste utilization: Technology for the utilization of waste from dairy, fruit and vegetable processing industries.<br>2. Food regulations: Brief account on FSSA 2006, FAO, FDA, AGMARK, HACCP, CODEX ALIMENTARIUS. |

| Mode of Assessment | | |
|---|---|---|
| **Sr. No.** | **Component** | **Weightage** |
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |

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|---|---|---|
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

# Class – MSc II (Semester III) Biotechnology

## Subject: Environmental Biotechnology (Paper-XI)

**Max Marks: 75**

**Max Time: 3 Hrs**

### TILL MST – I

1. Introduction to environmental pollution: nature of pollutants, biochemical and physiological effects of pollutants on plants, animals and microbes; types of toxicity; toxicity assessment using biomarkers-enzymatic, microbial, algal, plant and animal systems
2. Environmental applications of biotechnology: bioremediation- *in situ* and *ex situ*, biological deodorization, municipal waste water treatment, biochemistry of degradation of low molecular weight organic compounds, pesticides, and hydrocarbons; microbial leaching, microbial enhanced oil recovery, treatment of industrial wastes- chemical and biological
3. Principles of Treatment: laboratory and equipment, design for containment of biohazards; bioaccumulation of hazardous wastes: kinetics of uptake, factors affecting uptake; stoichiometry and kinetics of waste treatment: Monod's equation for suspended and attached culture systems
4. Microbial transformations of heavy metal ions: metal microbe interactions, molecular mechanisms of heavy metal resistance in microbes, use of natural and engineered microorganisms; bioleaching, biomining and biohydrometallurgy -microbiology, biochemistry and applications, treatment of heavy metal laded industrial effluents
5. Aerobic treatment technologies: Biochemistry, microbiology and operation details of activated sludge (AS), completely mixed conventional activated sludge (CCAS), contact stabilizer (CSAS), step aeration (SAAS), completely mixed (CMAS), extended aeration (EAAS), pure oxygen or high purity oxygen (POAS), tapered aeration (TAAS) systems, aerated lagoons, aerobic and facultative tricking filters and rotating biological contactors
6. Anaerobic waste treatment technologies: Biochemistry, microbiology and operation details of anaerobic decomposition, anaerobic filter reactor, anaerobic contact reactor, fluidized bed reactor, up-flow anaerobic sludge blanket (UASB), anaerobic baffled reactor; factors affecting process operation.

### TILL MST – II

1. Solid waste treatment methods: sludge characterization and disposal; land based treatment systems, land farming and composting and vermicomposting- PUSA vermicomposting, requirements and preparation of vermicompost, nutrient comparison with ordinary and farmyard manure, Indian scenario of vermicomposting
2. Biogas technology: biogas technology raw materials, biochemistry, microbiology, biogas plant, factors affecting biogas production and its status in India.
3. Treatment of waste air: biological technologies of waste air treatment-bioscrubbers, biotowers and bioventing
4. Biosensors: Definition, advantages and disadvantages of biosensor, immobilization strategies for the construction of biosensors, types of transducers, Development of Biosensors for heavy metal ions, BOD biosensor.

### TILL FINAL EXAM

1. Construction of biosensors and kits: specific for pathogens, insecticides and pesticides, immune-biosensors.
2. Protein engineering and construction of generic biosensors: Modification at DNA level, modification of polypeptide chain, Zinc finger, carbonic anhydrate, CAM, CAMBP engineered antibodies and ion channels modifications that alter activity, surface properties, specificity, coenzyme attachment; New enzyme activities.

| **Mode of Assessment** | | |
|---|---|---|
| **Sr. No.** | **Component** | **Weightage** |
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

## Class – MSc II (Semester III) Biotechnology

## Subject: Commercial Biotechnology (Paper-XII)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST - I |
|---|
| 1. Scope and status of biotechnology in Punjab and India.<br>2. Institutions involved in biotechnology development: DBT, PSCST, International Organizations, University- Industry Relationship.<br>3. Biosafety: Introduction Biohazards, Department of Biotechnology Biosafety Guidelines 1990, IGMORIS, Cartagena Protocol.<br>4. Intellectual property rights: Intellectual property and its types, WIPO, UPOV, trade secret protection.<br>5. Patents: Patentability criteria; Prior art; Types of patent applications, patent specification; Patent claims.<br>6. Patenting system: Patent filing in India; Patent infringement; Patentability criteria for biological processes and products in India, patent cooperation treaty, Budapest treaty, International depository authorities. |
| **TILL MST - II** |
| 1. Total quality management: Introduction, concept, role and its importance; Contributions of management thinkers in quality management, introduction to six-sigma.<br>2. Core concepts of TQM: Quality of profit, cost and economics of quality, competitive bench marking.<br>3. Tools and techniques of TQM: Techniques for analyzing quality process, statistical process control, problem solving tools.<br>4. International Organization for Standardization (ISO) - About the organization and its functioning, members, relevance of certification. |
| **TILL FINAL EXAM** |
| 1. ISO 9000:2008- members and requirements; Introduction to GMP certification.<br>2. EMS in industry- ISO 14000:2004- members and requirements. |

| Mode of Assessment | | |
|---|---|---|
| **Sr.** | **Component** | **Weightage** |

| No. | | |
|---|---|---|
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

## Class – MSc II (Semester IV) Biotechnology

## Subject: Tissue and cell culture technology (Paper-XIII)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST - I |
|---|
| 1. Plant tissue culture: History of plant cell culture, culture media-composition, preparation and development, cellular totipotency, cryopreservation.<br>2. Callus and cell culture: Isolation of cells, growth of single isolated cells.<br>3. Suspension culture: Regeneration and maintenance of callus, organogenesis and embryogenesis.<br>4. Organ culture: Meristem culture, embryo culture and embryo rescue, anther culture, virus free plant production and haploid plant production, production of synthetic seed, micropropagation.<br>5. Protoplast culture and fusion: Isolation of protoplasts, culture and regeneration; fusion of protoplasts, selection of fusion products of protoplasts; Cybrids.<br>6. Somaclonal variation, instability and somaclonal variations, plant transformation-*Agrobacterium* mediated and particle gun mediated, secondary plant metabolites and application of plant biotechnology in crop improvement. |
| **TILL MST - II** |
| 1. Animal cell culture: History, biology of cultured cells, culture media-composition, preparation and development, cell isolation, establishment and evaluation of cell culture, sterilization techniques for ATC lab.<br>2. Animal cell lines: Establishment, properties and use of cell lines, cultures of tumor cells; Cryopreservation of animal cells.<br>3. Culture and scale up: Monolayer culture-surface requirements, gas phase requirements, capillary culture units, micro-carrier culture techniques for laboratory and scale up of cultures, suspension culture scale up. Somatic cell fusion: Methods of somatic cell fusion, selection, properties of cell hybrids and their applications. |
| **TILL FINAL EXAM** |
| 1. Animal cloning and embryo transfer: Superovulation, *in vitro* fertilization, embryo transfer technology in animals; Concepts and techniques of cloning.<br>2. Applications: Industrial applications of animal cell culture; Stem cell culture and its applications. |

| Mode of Assessment |
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| Sr. No. | Component | Weightage |
|---|---|---|
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

## Class – MSc II (Semester IV) Biotechnology

## Subject: Research Methodology (Paper-XIV)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST - I |
|---|
| 1. Objectives and types of research: Definition and types of research (Descriptive and analytical research, applied and fundamental research, qualitative and quantitative research, conceptual and empirical research).<br>2. Research formulation: Defining and formulating research problem and its necessity, selecting the problem, literature review and its importance; Primary and secondary data sources-library (books, journals, periodicals, reference sources, abstracting and indexing sources, reviews, monographs), patents, web (search engines, online libraries, online journals, e-books, e-encyclopedia, institutional websites); Journals and books-standards of research journals (impact factor, ISSN, ISBN, online and print journals, indexed journals, peer reviewed journals), citation index, H-index; Identifying gaps areas from literature review.<br>3. Research design and methods: Developing the research hypothesis; Research design – basic principles and need, important concepts; Observations and facts, laws and theories, prediction and explanation, induction, deduction; Development of models, developing a research plan, exploration, description, diagnosis, experimentation.<br>4. Data collection and analysis: Execution of research, observation and collection of data, methods of data collection, primary data, secondary data; Sampling methods, data processing and analysis, statistical tools, hypothesis testing, generalization and interpretation.<br>5. Documentation: Techniques and importance of documentation; Role of internet, information technology and computers in research and documentation.<br>6. Reporting and thesis writing: Structure and components of research report, types of report-monographs, review articles, research papers, thesis, books, technical reports and their significance; Different steps in preparation of a written scientific document-layout, structure and language of reports, illustrations and tables, bibliography, references, footnotes. |
| **TILL MST - II** |
| 1. Presentation of scientific papers: Poster presentations-layout and format; Oral presentation-planning, preparation, use of visual art, importance of effective communication.<br>2. Application of intellectual property rights: Commercialisation, copyright, royalty, intellectual property rights and patent law; Plagiarism-concept and authentication of originality of research; Citation and acknowledgement; Reproducibility and accountability.<br>3. Bioethics: Environmental impacts; Clinical and animal ethical issues and committees. |

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| 4. Cost analysis of project: Cost incurred on raw materials, different testing procedures, cost of instrumentation, downstream processing cost (wherever required); Cost of clinical trials |
| **TILL FINAL EXAM** |
| 1. Research grants: International funding agencies; Government and private bodies.<br>2. Industry-institute interactions: Industrial projects and their feasibility reports; Case studies. |

| **Mode of Assessment** | | |
|---|---|---|
| **Sr. No.** | **Component** | **Weightage** |
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

## Class – MSc II (Semester IV) Biotechnology

## Subject: Computer and Biostatistics (Paper-XV)

**Max Marks: 75**

**Max Time: 3 Hrs**

| TILL MST – I |
|---|
| 1. Fundamentals of computers: Definition, history and generation of computers, computer organization, memory, input and output devices; Data Representation - binary representation of integers and real numbers.<br>2. Types of computers and types of processing: Batch, real-time, online, offline, system handling, system commands and utilities.<br>3. File formats and directory structure; Data organization on a computer; Creating and editing graphic objects and charts, sorting data, filtering etc.; Operating systems - Linux, Windows.<br>4. Computer networking: Networking topologies, networking protocols - TCP/IP, ftp, http, internet and intranet, Networking gadgets (Router, Switch); Network security.<br>5. Web browser, e-mail, applications and utilities of windows, browsers, search engines.<br>6. Programming language C: Character set, identifiers and keywords data types, operator and expression control statements, switch break, continue statements, function arrays, pointers. |
| **TILL MST - II** |
| 1. Statistics: Definition, scope and applications of statistics in biological research and data analysis.<br>2. Measures of central tendency: Mean, median and mode; Measures of dispersion; Coefficient of variance; Skewness & kurtosis - concept and measures.<br>3. Correlation analysis: Simple, partial & multiple; Regression analysis - concept & measures, linear regression.<br>4. Elementary probability theory: Concepts, definitions and problems; Applications of probability and standard distribution.<br>5. Probability distributions: Binomial, poisson and normal distributions; Estimation, standard error and confidence interval, goodness of fit, etc. |
| **TILL FINAL EXAM** |
| 1. Testing of hypothesis: Concept, types of hypothesis, significance level, degrees of freedom, errors in hypothesis testing, procedure of testing hypothesis; Statistical tests - Chi-square test, t-test, F-test, ANOVA – 1 way and 2 way |

| Mode of Assessment | | |
|---|---|---|
| **Sr. No.** | **Component** | **Weightage** |
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |

## Class – MSc II (Semester IV) Biotechnology

## Subject: Introduction of Bioinformatics (Paper-XVI)

**Max Marks: 75**

**Max Time: 3 Hrs**

| **TILL MST - I** |
|---|
| 1. Bioinformatics: Definition, applications in scientific research, present bioinformatics scenario in India; Open access computational resources related to Life Sciences viz., NCBI, EBI, EXPASY.<br>2. Databases, datamining and datamining tools: Characteristics and categories of biological databases, primary, secondary and composite databases, navigating databases; Datamining and datamining tools, nucleic acid and protein sequence analysis.<br>3. Information retrieval systems and data submission tools: Entrez, SRS; BankIt, Sequin, WebIn.<br>4. Nucleotide sequence databases: Composition, organization and structure of data entries, INSDC, Genbank, EMBL, DDBL, REBASE, dedicated genome sequence databases (*E. coli*, Human).<br>5. Primary and secondary protein databases: Composition, organization and structure of data entries, IPSDC, Swiss-Prot, TrEMBL, PIR, UniProt, PDB, CATH, SCOP, PROSITE, Pfam.<br>6. Composite and specialized databases: composition and organization of OWL, BIOSILICO; Diseases database (OMIM), literature databases (PMC), metabolic pathways (KEGG), enzymes (BRENDA). |
| **TILL MST - II** |
| 1. Substitution matrices and alignment algorithms: Definition, dynamic programming, sequence comparison algorithms, dot plots; Substitution matrices algorithms - PAM and BLOSUM; Sequence alignment algorithms - pairwise comparison, global sequence alignment algorithm (Needleman Wunsch algorithm), local sequence alignment algorithm (Smith Waterman algorithm), Semiglobal algorithm.<br>2. Nucleic acid sequence comparison and analysis: Basic concepts of pairwise sequence alignment - types and applications of BLAST and FASTA; Statistical significance of scores; ORF and restriction analysis, sequence translation.<br>3. Protein sequence comparison and analysis: Pairwise and multiple alignment, peptide cleavage analysis, prediction of transmembrane proteins, *in silico* analysis of protein modifications, reverse translation, protein domains and family classification.<br>4. Overview of resources for genome analysis: Overview of web resources for genome information and analysis, functional genomics tools, overview of gene identification methods.<br>5. Protein classification and structure prediction: Protein classification, prediction of protein secondary structure - Chow-Fasman/GOR method; Prediction of protein 3D structure - structural profile method, contact potential method; Viewing protein structures, 2D modeling - RASMOL, MOLMOL; 3D modeling - DeepView |

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| (SwissPDB viewer). |
| **TILL FINAL EXAM** |
| 1. Phylogenetic analysis: Multiple sequence alignment tools - clustalW; Phylogentic analysis and methods - overview of Maximum Parsimony method, Distance methods - UPGMA, Neighbor-joining method; Maximum Likelihood approach, distance scores; Tree confidence; Analysis tools – Phylip. |

| **Mode of Assessment** | | |
|---|---|---|
| **Sr. No.** | **Component** | **Weightage** |
| 1 | Mid semester test (MST) | 40% (Average of 2 MST) |
| 2 | Written Assignments | 40% |
| 3 | Attendance | 20% |