# Department of Biochemistry & Biotechnology

## M.Sc. Biotechnology

Choice Based Credit System (CBCS) – 2 year program (2018-2019)

**Revised Scheme of Examinations and Syllabus**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Theory &amp; Practical</th>
<th>Credit</th>
<th>Internal Assessment Marks</th>
<th>End Semester Examination Marks</th>
<th>Total Marks</th>
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<tbody>
<tr>
<td>SEMESTER-I</td>
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<tr>
<td>BIT C 101</td>
<td>Basic Biochemistry</td>
<td>4</td>
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<tr>
<td>BIT C102</td>
<td>Cell Biology and Genetics</td>
<td>4</td>
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<td>BITP 103</td>
<td>Practical I</td>
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<td>75</td>
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<td>Optional-I</td>
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<td>4</td>
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<td>75</td>
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<tr>
<td>ENG C 116</td>
<td>Soft Skills</td>
<td>4</td>
<td>4</td>
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<td>Total Credits: 20</td>
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| SEMESTER-II  |                    |        |                            |                                |             |
| BIT C 201    | Enzyme Technology  | 4      | 4                          | 25                             | 75          | 100         |
| BIT C 202    | Immunology & Immuno- | 4      | 4                          | 25                             | 75          | 100         |
| BIT C 203    | Industrial and Environmental Biotechnology | 4      | 4                          | 25                             | 75          | 100         |
| BIT C 204    | Molecular Biology  | 4      | 4                          | 25                             | 75          | 100         |
| BIT P 205    | Practical II       | 9      | 3                          | 40                             | 60          | 100         |
| BIT P206     | Practical III      | 9      | 3                          |                                 |             |             |
| Optional-II  |                    | 4      | 4                          | 25                             | 75          | 100         |
| Total Credits: 26 |

| SEMESTER –III|                    |        |                            |                                |             |
| BIT C 301    | Analytical Techniques | 4      | 4                          | 25                             | 75          | 100         |
| BITC 302     | Genetic Engineering and Nanobiotechnology | 4      | 4                          | 25                             | 75          | 100         |
| BIT C 303    | Plant Biotechnology | 4      | 4                          | 25                             | 75          | 100         |
| BIT C 304    | Animal Biotechnology |        |                            |                                |             |             |
| BIT P 305    | Practical IV       | 4      | 4                          | 25                             | 75          | 100         |
| Optional-III | (Value Added Course) | 4      | 4                          | 25                             | 75          | 100         |
| Total Credits: 24 |

| SEMESTER IV  |                    |        |                            |                                |             |
| BIT C 401    | Genomics, Proteomics and Bioinformatics | 4      | 4                          | 25                             | 75          | 100         |
| BIT C 402    | Food and Medical Biotechnology |        |                            |                                |             |             |
| BIT P 403    | Practical V        | 4      | 4                          | 25                             | 75          | 100         |
| Optional –IV | (Value Added Course) | 4      | 4                          | 25                             | 75          | 100         |
| BIT PJ 404   | Project            | -      | 5                          | 25                             | 75          | 100         |
| Total Credits: 20 |

**Distribution of Credits**

- Core Courses and Project: 70 credits
- Soft Skills and Optional: 20 credits
- Total: 90 credits
Optionals: Any 4 from the following:
1. Chemistry
2. Microbiology
3. Statistical Methods
4. Drug Design and Drug Action
5. Genetic Engineering
6. Yoga
7. Vermiculture & Sericulture
8. Marine Biotechnology
9. Biotechnology Management
10. Clinical Biochemistry
11. Any other course offered by other departments from time to time.

AIDS, Antisense and siRNA therapy, Nanotherapy, Stem cell therapy, Bioethics- Food and drug safety. Ethical issues in human gene therapy, human genome analysis and human cloning.

Text Books

Reference Books

BITP 403: PRACTICAL V
Bioinformatics, Food and Medical Biotechnology
1. Sequence alignment and searching
2. Gene prediction
3. Multiple sequence alignment
4. Phylogenetic analysis
5. Protein sequence analysis, structure prediction
6. Primer design
7. SNP and ORF finding in DNA sequence
8. Visualization tools.
10. Dehydration of fruits and vegetables. Preparation of fruit juice powders.
11. Isolation of microbes from spoiled vegetables.
12. Preparation of fruit juice concentrates and use of enzymes for clarity.
13. Identification & characterization of proteins resolved on 2D PAGE Demo.
14. HPTLC and GC-MS- Demonstration.
15. Structure determination of proteins and nucleic acids by NMR & XRD- Demo.
16. Aseptic packaging, freeze preservation, drying and dehydration, food fermentation, pickling and curing.
17. Preservation of food products using chemical preservatives.
18. Tissue collection, formalin fixation, sectioning, and staining.
19. Analysis of biochemical analytes by autoanalysers.
20. Biochemical analyses for diabetes (blood glucose) and cardiovascular disease (serum cholesterol).
BITC 402: FOOD AND MEDICAL BIOTECHNOLOGY

Objective: To acquire knowledge in food biotechnology, molecular basis of diseases, molecular diagnostics & therapeutics.

Unit–I Food spoilage and preservation
Types and sources of microorganisms associated with food. Conditions influencing microbial growth in food. Composition and spoilage of food, meat, fish, cereals, pulses, nuts and oil seeds, fruits and fruit products, vegetable and vegetable products. Methods of food preservation. Control of microorganisms by retarding growth- low temperature, drying, intermediate moisture, chemicals. Control of microorganisms by destruction- gas treatments, heat, ionization radiation, ultraviolet radiation. canning and packing (Elementary idea).

Unit–II Fermented foods and enzymes in food industry
Basic principles of food fermentation. Fermented foods:fermented milk- yoghurt, cheese, bread; fermented vegetables- sauerkraut, olives. Fermented meats and fish. Production of beer, wine, and vinegar. Mushroom farming. Use of enzymes in food industry- proteases in food processing, enzymes in baking and dairy industry, enzymes in fruit juice and brewing industry. Pickling and curing.

Unit–III Molecular Basis of diabetes, atherosclerosis & cancer

Unit–IV Molecular Diagnostics

Unit–V Molecular Therapeutics

BITC 101: BASIC BIOCHEMISTRY

Objective: To comprehend the structure-function relationships of various biomolecules and concepts of metabolism.

Unit–I Bioenergetics and Biological Oxidation

Unit–II Carbohydrates and Lipids
Classification of carbohydrates. Biologically important monosaccharides and disaccharides. Structure and biological functions of homopolysaccharides and heteropolysaccharides. Carbohydrate metabolism (structures not required)- brief outline of glycolysis, citric acid cycle, gluconeogenesis, pentose phosphate pathway, glycogen metabolism.

Classification of lipids. Fatty acids. Biological functions of eicosanoids, phospholipids, sphingolipids, and cholesterol. Lipid metabolism (structures not required): brief outline of fatty acid oxidation and lipogenesis.

Unit–III Proteins-I

Unit–IV Proteins-II

Protein metabolism (structures not required): Catabolism of amino acid nitrogen- transamination, deamination, ammonia
formation, urea cycle, catabolism of carbon skeletons (overview only). Conversion of amino acids to specialized products.

Unit–V Nucleic acids and Nucleic acid-binding proteins
Nitrogenous bases, nucleosides and nucleotides. Biologically important nucleotides.
DNA double helical structure- Watson and Crick model. A, B, and Z forms of DNA. Triple and quadruple structures. DNA supercoiling and linking number. Properties of DNA: buoyant density, viscosity, denaturation, cot curve. Differences between DNA and RNA. Major classes of RNA- structure and biological functions. Minor classes of RNA.

DNA binding proteins- the helix-turn-helix motif, zinc finger, leucine zipper, and helix-loop-helix.

Text Books

Reference Books

BITC 102: CELL BIOLOGY AND GENETICS

Objective: To learn in detail about the molecular organization of cells and cellular processes and the principles of genetics.

Unit–I Cell and tissue organization

Major classes of cell junctions- anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs)- cadherins, integrins. Brief account of the extracellular matrix.

Unit–IV Structural & functional proteomics & applications
Structural proteomics: X-ray and NMR for protein structure analysis. Comparative and homology modeling, secondary structure prediction, fold recognition and \textit{ab initio} prediction. SCOP. Protein sequence analysis: substitution score matrices, pairwise similarity search, pattern recognition. Protein function determination: database search for homology, phylogenetic profile method, domain fusion. Protein-protein interactions: yeast 2-hybrid system. Protein arrays and chips (concept and applications). Applications of proteomics.

Unit–V Bioinformatics

Text Books

Reference Books
4. Separation of plant pigments by adsorption chromatography.
5. Separation of proteins by SDS-PAGE.
6. HPLC-Demonstration.
7. Subcellular fractionation.
9. Restriction enzyme digestion of DNA.
10. PCR and analysis of PCR products
11. Blotting techniques - Western.
12. GFP cloning. Demonstration
13. Protoplast isolation and culture.
14. Preparation of tissue culture medium and membrane filtration.
15. Preparation of single cell suspension, cell counting, viability of cells.
16. Trypsinization of monolayer and subculturing.
17. MTT assay for cytotoxicity testing.

BITC 401: GENOMICS, PROTEOMICS, AND BIOINFORMATICS

Objective: To understand the principles of genome mapping, sequencing, and genome analysis, and the tools and applications of proteomics and bioinformatics.

Unit–I Genome mapping and sequencing
Genome mapping-rationale. Types of gene map-genetic, cytogenetic and physical. Molecular markers for mapping-RFLPs, microsatellites and SNPs. Assembling a physical map of the genome - chromosome walking and jumping. Genome sequencing approaches: whole-genome shotgun, hierarchical shotgun. Identifying genes- sequence inspection, EST comparison, similarity searches.

Unit–II Genome projects, post-genome analysis
Genome projects: genome sequence data of model organisms- E.coli, D.melanogaster, and mouse. The Human Genome Project: goals, mapping strategies, markers, sequencing technologies, results of final sequence, potential benefits and risks, ELSI. Post-genome analysis- differential display, DNA microarray, ChIPs, knock-out analysis.

Unit–III Protein separation, identification and quantitation
Proteomics-introduction. Protein separation- general principles. 2D-gel electrophoresis, liquid-liquid chromatography. Protein identification by antibodies, Edman degradation, mass spectrometry-based principle and instrumentation, ESI, MALDI-TOF, SELDI-TOF, tandem MS. Peptide mass fingerprinting (elementary details).

Unit – II Membrane composition and transport
Composition of membranes- the lipid bilayer, peripheral and integral proteins. The fluid mosaic model. Brief account of membrane rafts. Endocytosis and exocytosis.

Membrane transport types. Diffusion- passive and facilitated. General classes of transport systems- uniport, symport, antiport. Active transport- primary and secondary. The P-type ATPases (Na⁺⁻K⁺-ATPase), F-type ATPases (ATP synthases), ABC transporters, ionophores, aquaporins, ion channels (ligand-gated and voltage-gated).

Unit–III Cell division, differentiation, cell cycle and cell death
Molecular events in mitosis and meiosis. Brief account of cell differentiation.

The cell cycle: phases, regulation by cyclins and cyclin-dependent kinases. Checkpoints.


Unit–IV Cell signaling
Fundamental concepts and general features of cell signalling. Endocrine, paracrine, autocrine signaling and juxtacrine signalling.


Unit–V Genetics
Definitions of some common terms in genetics- phenotype, genotype, heterozygous, homozygous, allele (dominant, recessive, wild-type, mutant), character, gene, gene locus, pure line, hybrid. Mendel’s laws. Monohybrid cross, multiple alleles, dihybrid cross, test cross, backcross, epistasis.


Text Books
BITP 103: PRACTICAL-I
Biochemistry, Cell Biology & Genetics
1. Quantitative estimation of amino acids by ninhydrin method.
2. Estimation of proteins by Lowry et al method.
3. Thermal denaturation of DNA
4. Estimation of DNA by diphenylamine method.
5. Estimation of RNA by orcinol method.
6. Microscopic examination of epithelial cells, plant cells.
7. Isolation of lymphocytes.
8. Microscopic examination of blood cells, epithelial cells, plant cells, tissue types.
10. Buccal smear- Barr bodies.

Unit–III Manipulation of animal reproduction &characterization of animal genes
Production of recombinant vaccine for foot and mouth disease. Probiotics for disease control.

Unit–IV Gene transfer methods

Unit–V Transgenic animal technology

Text Books

Reference Books

BITP 305: PRACTICAL–IV
(Analytical Techniques, Genetic Engineering, Plant and Animal Biotechnology)
1. Spectrophotometry: Analysis of standard curve, absorption spectrum of oxidized and reduced forms (NAD,NADH).
2. Separation of lipids by thin layer chromatography.

**Unit–V Transgenic plant technology-II**

**Text Books**

**Reference Books**

**BITC 304: ANIMAL BIOTECHNOLOGY**

**Objective:** To gain an insight into animal tissue culture techniques, gene transfer and gene manipulation methods, and transgenic animal technology.

**Unit–I Animal cell culture-I**
Animal cell and tissue culture- merits and demerits. Laboratory facilities, substrate, culture media. Culture procedures- preparation, sterilization, disaggregation of tissue (mechanical and enzymatic), subculture, contamination. Primary culture, Secondary culture, cloning of cell lines, cancer cell lines. Measurement of cell viability and cytotoxicity. Large-scale culture of cell lines- monolayer, suspension and immobilized cultures.

**Unit–II Animal cell culture-II**
Organ and histotypic culture- technique, advantages, limitations, applications. 3D cultures. Whole embryo culture. Somatic cell hybridization. Stem cells: types (embryonic, adult), isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues. Commercial applications of animal tissue culture. Hazards and safety aspects of tissue culture.

**BITC 201: ENZYME TECHNOLOGY**

**Objective:** To understand the basic aspects of enzyme action, kinetics, inhibition, and the applications of enzymes in industry.

**Unit–I**

**Unit–II**

**Unit–III**

**Unit–IV**

**Unit–V**
Use of enzymes in detergents, textiles, and leather industry, production of glucose syrup and cheese. Syenzymes and solvent engineering. Soluble enzymes- applications in food, starch
processing and detergents. Elementary details of enzymes as diagnostic aids. Therapeutic uses of enzymes: enzymes as thrombolytic agents and digestive aids. Regulations and safety criteria for enzyme production and use.

Text Books

Reference Books

BITC 202: IMMUNOLOGY AND IMMUNOTECHNOLOGY
Objective: To acquire knowledge on immunological mechanisms and immunotechniques.

Unit–I
Types of immunity- innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs. Cells of the immune system- lymphocytes, mononuclear phagocytes-dendritic cells, granulocytes. NK cells, mast cells, interleukins.

Antigens-definition, antigenicity and immunogenicity, antigenic determinants, epitopes, haptns. Immunoglobulins- structure, classification and functions.

Unit–II

Unit–III

Reference Books

BITC 303: PLANT BIOTECHNOLOGY
Objective: To acquire theoretical knowledge about plant tissue culture techniques, gene transfer methods, and transgenic plant technology.

Unit–I Plant tissue culture-I

Unit–II Plant tissue culture-II

Unit–III Cloning in plants
A. tumefaciens mediated transformation-Ti plasmids (cointegrate and binary vectors), direct nuclear transformation (protoplast transformation, particle bombardment), viral vectors (CaMV, TMV), chloroplast transformation. Use of reporter genes in transformed plant cells. Selectable markers for plants drug resistance and herbicide resistance markers. RFLPs, RAPDs, DNA fingerprinting-general principles and applications in plant biotechnology.

Unit–IV Transgenic plant technology-I
Insect resistance plants- cry genes of B.t., their proteins and target insects, cry gene expression in plants, insect resistance to Cry proteins. Strategies to obtain virus resistant transgenic plants. Herbicide resistance and stress - and senescence-tolerant plants.
Unit–III Expression systems

Unit–IV Techniques in Gene Manipulation

Unit–V Nanobiotechnology
Techniques for visualization of biomolecules at nanoscale- atomic force microscopy, optical microscopy, magnetic resonance force microscopy, TEM, SEM, FRET. Nanoparticles- metal, and bimetallic nanoparticles, quantum dots, dendrimers, and fluorescent nanoparticles. Production of nanoparticles: Collision/Coalescence mechanism of primary particle formation, nanoparticles agglomerates and aerogels. Biological synthesis of nanoparticles (brief account only). Applications of nanotechnology in biology, medicine and environment.

Text Books

Unit–IV

Unit–V

Text Books

Reference Books

BITC 203: INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY
Objective: To learn the principles and techniques of bioprocess engineering and downstream processing as well as biotechnological approaches to environmental management.

Unit–I Bioprocessing and bioreactors

Unit–II Downstream processing
Downstream processing: Stages: solid-liquid separation, release of intracellular compartments, concentration of biological products, membrane filtration, precipitation, adsorption, dialysis, reverse osmosis, ultrafiltration, preservation and stabilization, purification.

Industrial production of ethanol, citric acid, penicillin, and lysine/aspartate. Whole cell immobilization and industrial applications.

Unit–III Pollution and control

Unit–IV Soil and agricultural biotechnology

Unit–V Alternative energy sources and green technology

Text Books

Unit–V Centrifugation

Text Books

Reference Books

BITC 302: GENETIC ENGINEERING AND NANOBIOTECHNOLOGY

Objective: To master the basic principles of genetic engineering, cloning strategies, and techniques. To learn the basics and applications of nanobiotechnology

Unit–I Restriction endonucleases, cloning vectors, and ligation
Basic steps in gene cloning. Type II Restriction endonucleases-nomenclature and types of cleavage. Cloning vectors: plasmids (pBR322 and pUC), phage vectors (λ), cosmids, BACs and YACs. Methods of ligation of insert and vector DNA molecules: cohesive end method, homopolymeric tailing, blunt-end ligation, linkers and adapters.

Unit–II Gene transfer methods, cloning strategies & screening
BITC 301: ANALYTICAL TECHNIQUES

Objective: To learn the principle, operation, and applications of various techniques for analyzing biomolecules. This course will help students to understand the theoretical basis of separation and analysis of biomolecules which form the basic tools in research.

Unit–I Spectroscopy techniques

Unit–II Radioisotope Techniques and Microscopy

Microscopy- basic principles, and components of light, bright field, phase contrast, fluorescence and confocal microscopy. Electron microscopy- principle, preparation of specimens for TEM and SEM.

Unit–III Electrophoresis

Unit–IV Chromatography
General principles of partition and adsorption chromatography. Principle, instrumentation and applications of thin layer and gas chromatography. Principle, procedure, and applications of ion-exchange, molecular exclusion, and affinity chromatography. HPLC-principle, instrumentation and applications.

References

BITC 204: MOLECULAR BIOLOGY

Objective: To gain an insight into the molecular mechanisms of genetic information flow and regulation of gene expression.

Unit–I Chromatin and Genome complexity
The central dogma of molecular biology. The E. coli chromosome and DNA-binding proteins. Plasmids- classification and properties. Eukaryotic chromatin: nucleosomes, 30 nm fiber and higher order chromatin structure. Concept of the gene. Definitions of the following: gene, cistron, coding region (ORF), transcription unit, untranslated region (UTR), pseudogenes, euchromatin and heterochromatin. Typical structure of protein-coding genes in prokaryotes and eukaryotes. Split genes- exons and introns. DNA sequence elements: unique sequence DNA, repetitive DNA (SINEs, LINEs, satellite, minisatellites and microsatellites).

Unit–II Replication, Repair and Recombination


Unit–III Transcription and Post-transcriptional processing
Transcription in E. coli: RNA polymerase subunit structure, promoter sequence steps in transcription- template recognition, initiation, elongation and termination (intrinsic, rho-dependent). Transcription in

Classes of introns. Post-transcriptional processing of prokaryotic and eukaryotic rRNA, and tRNA, and eukaryotic mRNA. Brief account of ribozymes, RNA editing and Reverse transcription.

Unit IV Genetic code and Translation


Unit–V Regulation of Gene expression

Text Books

Reference Books

BITP 205: PRACTICALS IN ENZYME TECHNOLOGY, IMMUNOTECHNOLOGY AND MOLECULAR BIOLOGY
1. Determination of total and specific activity of α-amylase.
2. Effect of pH on enzyme activity (amylase).
3. Effect of temperature on enzyme activity (amylase).
4. Effect of substrate concentration on enzyme activity (amylase) and determination of Km value.
5. Identification of blood groups and Rh typing.
6. Radial immunodiffusion.
7. Double diffusion.
8. Immunoelectrophoresis.
10. Isolation of DNA, DNA electrophoresis in agarose gel, determination of molecular weight.
11. Isolation of RNA from yeast.
12. Bacterial conjugation, transformation (Demonstration).

BITP206: PRACTICAL-III (Microbiology, Industrial and Environmental Biotechnology)
1. Microscopic examination of bacteria, fungi, yeast.
2. Staining of microorganisms: Gram staining, acid fast staining.
3. Culture of microorganisms: media preparation, Serial dilution, inoculation, Culture of bacteria in culture tubes, agar plates.
5. Preparation of immobilized cell/enzyme beads using alginate.
6. Determination of growth curve of a microorganism and substrate degradation profile.
7. Comparative studies of ethanol production with different substrates.
8. Microbial production of citric acid using Aspergillus niger.
9. Determination of total dissolved solids in water.