### B. Sc. Biotechnology Second Year (Third Semester)

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Paper Title</th>
<th>Teaching Periods/Week</th>
<th>Maximum Marks T/P (A)</th>
<th>Internal Test Marks (B)</th>
<th>Total Marks (A+B)</th>
<th>Duration of Exam (in Hrs)</th>
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<tr>
<td>BTT-3.1</td>
<td>Metabolism-I</td>
<td>04</td>
<td>80</td>
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<td>BTT-3.2</td>
<td>Cytology</td>
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<td>BTT-3.3</td>
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<td>BTT-3.4</td>
<td>Mathematics, Biostatistics and Computers</td>
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### B. Sc. Biotechnology Second Year (Fourth Semester)

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<th>Code No.</th>
<th>Paper Title</th>
<th>Teaching Periods/Week</th>
<th>Maximum Marks T/P (A)</th>
<th>Internal Test Marks (B)</th>
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<th>Duration of Exam (in Hrs)</th>
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<tr>
<td>BTT-4.1</td>
<td>Metabolism-II</td>
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<tr>
<td>BTT-4.2</td>
<td>Applied &amp; Medical Microbiology</td>
<td>04</td>
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<td>BTT-4.3</td>
<td>Immunology and Virology</td>
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<td>BTT-4.4</td>
<td>Plant and Animal Cell Culture</td>
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**B.Sc. Biotechnology Second Year -III Semester**

**BTT.3.1 : Metabolism-I**

<table>
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<tr>
<th>Marks</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>50</td>
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</table>

**Objective:** To provide an understanding of basic thermodynamics and metabolic activities.

**UNIT I :** Thermodynamics: Fundamentals of thermodynamics- Law of thermodynamics, endergonic and exergonic processes, enthalpy, entropy, activation energy, free energy change, phosphoryl transfer reaction, oxidation reduction reaction, redox potential, equilibrium and non equilibrium thermodynamics, high energy compounds, causes of energy richness in ATP.

**UNIT II :** Carbohydrate Metabolism :EMP Pathway, HMP And ED Pathway, TCA Cycle.

**UNIT III :** Concept of respiration, Types of phosphorylation (substrate, photo and oxidative), mitochondrial electron transport chain, Electron Transport Chain: Components of the chain, sites of ATP synthesis, chemiosmotic theory of oxidative phosphorylation Regulation of ATP synthesis.


**Text and Reference:**
1. Hayne - Biological thermodynamics - Oxford
2. G Gottschalk - Bacterial Metabolism (2nd Ed) - Springer
4. Lehninger Principles of Biochemistry - Kalyani Publication
5. Stryer - Biochemistry – W.H. Freeman
7. Cohn and stump- Outlines of Biochemistry – Wiley India
9. B.P. Pandy - Plant Physiology –Vikas
11. S.K. Verma - Plant Physiology & Biochemistry- S.Chand
12. Bioenergetics by Lehninger- W. A. Benjamin

**Practicals :**
1. Problems based on Entropy, Enthalpy, Free energy and Gibbs Equation (Two of each)
2. Detection of sugars by Paper chromatography / TLC
3. Separation of Photosynthetic pigments by TLC
4. Demonstation of Hill Reaction
5. Study of Enzymatic hydrolysis of Lipids
6. Demonstration of aerobic and anaerobic respiration in microorganisms
7. Estimation of fatty acids by suitable method.
Objective: To provide an understanding of structure and function of Cell and its organelles

Unit I: Introduction to the Cell:
Diversity of cell size and shape, History & Evolution, Cell as the basic unit of life, cell theory, Structural organization of prokaryotes and eukaryotes. Biogenesis of Mitochondria, Chloroplast.


Unit III: Cellular transport: Transport across cell membrane, Passive transport: Simple diffusion & osmosis, Active Transport: Endo & Exocytosis, (Phagocytosis, Pinocytosis, receptor mediated, Clathrin mediated). Na / K ion Channel, Vesicular transport,

Unit IV: Cellular regulation: Cell division and cell cycle – General events of Mitosis and Meiosis, Cell-cell interaction (Plasmodesmata, GAP junction, Tight junction, Desmosome), Cell signaling: G protein coupled receptor, Autocrine Signaling, Brief introduction of concept of Cancer.

Text and Reference:
1. Verma Agrawal; Cell biology - S. Chand.
2. Gerld Carp- Cell and Molecular biology -Wiley
3. David Sadava; Cell and Molecular biology. Jones & Bartlett Publishers
4. P.S. Verma, V.K. Agarwal- Cytology- S. Chand
6. Lodish- Cell and Molecular biology- W.H. Freeman
7. Albert Bruce- Molecular Biology of The Cell- Garland
8. De Robertis; Cell and Molecular biology- Lippincott Williams & Wilkins

Practicals:
1. Study of different Cell types
2. Sub cellular fractionation and isolation of Mitochondria, Chloroplast.
3. Study of Meiosis by maceration technique
4. Study of Mitosis. by maceration technique
5. Study of Karyotyping to find chromosomal position
6. Study of Osmosis, and membrane selective permeability
7. Study of Polytene Chromosome.
8. Study of Tissue/ cells by Microtomy
9. Study of Microscopy; Bright field Microscope/ Light microscope
10. Determination of cell density by turbidometry
11. Demonstration of dialysis.
B. Sc. Biotechnology Second Year -III Semester

BTT-3.3: Molecular Biology  
Marks: 80  
Hours: 50

Objective: To extend understanding of the molecular mechanisms of gene expression via which genetic information are stored, expressed and transmitted among generations

UNIT I: DNA structure, replication & repair:  
DNA structure: Structure of DNA, Properties of DNA, Cot curve  
DNA replication: Replication in prokaryotic and eukaryotic cells, models & mechanism of DNA replication, Enzymes involved in DNA replication –Primosome, Replisome, Topoisomerase, DNA polymerase, SSBP & Ligase. DNA Repair- Direct repair – Photo Reactivation, Excision, mismatch, Recombination repair, SOS repair

UNIT II: Transcription and RNA processing  
Transcription in Prokaryotes: Initiation, Elongation & Termination. Structure of RNA polymerase, Role of sigma factor, Promoter.  

UNIT III: Translation  

UNIT IV: Regulation of gene expression  
Regulation of transcription in prokaryotes , Operon concept, trp-operon, lac- operon, ara- operon.

Text and Reference :  
1. Kakoli and Upadhya- Molecular Biology- Himalaya  
2. Watson – Molecular biology of gene- Pearson  
3. David Freifelder - Microbial Genetics – Narosa  
4. David Freifelder – Molecular Biology – Jones and Bartlett /Narosa  
7. T.A. Brown – Genomes – Garland Science  
10. B. Lewin – Genes- IX- Oxford

Practicals:  
1. Study of Ames test  
2. Study of fluctuation test  
3. Isolation and quantization of DNA from Bacteria, Yeast,  
4. Effect of UV radiation on yeast / bacteria  
5. Study of DNA repair mechanism by photo reactivation.  
6. Agarose gel electrophoresis of genomic DNA & plasmid DNA  
7. Isolation of Lac mutants by using Replica plate method.  
8. Determination of Tm value of DNA/ Cot curve.
B.Sc. Biotechnology Second Year –III Semester

BTT-3.4: Mathematics, Biostatistics and Computers Marks: 80 Hours: 50

Objective: To develop skills of Mathematics, Statistics and Computers in the field of biology

Unit I:
Set Theory: Set, types of set, subset, universal set Venn diagram, set operation. Examples.
Relation & function: Cartesian product, relation, function types of function, introduction to limit, introduction to derivative examples.

Unit II:
Preliminary concept Definition of statistics, Data & types, Frequency distribution.
Graphical representation (Histogram, frequency polygon, frequency curve). Diagrammatic representation (simple Bar, Subdivided bar, pie chart)
Central Tendency: Concepts, definition, formulas of ungrouped and grouped data examples of Mean, Median, Mode and Quartiles.

Unit III
Measures of Variation: Concept, Definition, formula, examples of Range, Standard Deviation. Definition, examples of Variance and Coefficient of Variation

Test of significance: Z test, t-test, Chi-Square test, Correlation & linear regression

Unit IV
Basics of Computer:
Introduction to computer system low level high level language flow chart & programming techniques, Introduction to OS. Windows & Linux. MS Office covering word processing spread sheets & presenting software.
Internet concept, WWW, URL, http, Browsers, Search engines etc

Text Reference
1. Introduction of Mathematics for Life science- E. Batschelet - Springer
2. Discrete Mathematics- Semyour Lipschutz & Marc Lipson-McGr aw Hill
3. Statistical Methods - Gupta-Himalaya
4. Fundamental of Biostatistics – P. Hanamantrao
5. Introduction to Biostatistics Dr. Pranabkumar Banerjee
7. Computer fundamentals - PK Sinha- BPB New Delhi
8. Microsoft Office-2000 Complete- BPB

Practicals
1. Calculation oriented statistical techniques
2. Problem based on test of significance
3. Introduction to computer Hardware and Networking
4. Study of word processing MS- word,
5. Preparation of chart & graphs by MS- Excel and MS word
6. Making presentation in MS power point
7. Internet- E-mail, Search Engines
B.Sc. Biotechnology (Semester Pattern) IV Semester

BTT-4.1 : Metabolism-II  
Marks 80  
Hours 50

Objective: To understand principles of biosynthesis of building blocks of living system.

UNIT I: Enzymes: Definition, Nomenclature, Classification of enzymes, Specificity of active sites, E units Enzymes Kinetics: - Michaelis-Menton Equation, significance of Km and Vmax, factors affecting enzyme activity.

UNIT II: Biosynthesis of Carbohydrate: Trapping of solar energy into chemical energy (PS-I & PS-II) in green plants, utilization of this energy to synthesize carbohydrate (Calvin cycle, cycle in C-4 and CAM plants), photorespiration (C-2 cycle). Gluconeogenesis, glycogenesis, and glycogenolysis, glucosides, peptidoglycan

UNIT III: Nucleotide and Amino acid Biosynthesis: Purines, Pyrimidines, deoxynucleotides, Salvage and de novo pathway. Synthesis of amino acids (Lysine, Arginine & Tryptophan)

UNIT IV: Biosynthesis of Fatty acids: fatty acid synthase complex, regulation, Microsomal & Mitochondrial system of chain elongation and synthesis of unsaturated fatty acids. Cholesterol and phospholipids

Biosynthesis of Secondary metabolites: Plants :- Synthesis of Alkaloids, Flavonoids Hormone IAA, Cytokine, Gibberlic acid. Microorganisms :- Antibiotics Beta lactum, tetracycline and macrolides

Text and Reference:
1. G Gottschalk-Bacterial Metabolism (2nd Ed ) - Springer
3. Lehninger Principles of Biochemistry- Kalyani Publication
5. Voet & Voet- Biochemistry – Wiley
6. Cohn and stump- Outlines of Biochemistry – Wiley
7. G Carp- Cell and Molecular Biology –Wiley
9. B.P. Pandey- Plant Physiology – Vikas
11. S.K. Verma- Plant Physiology & Biochemistry- S.Chand

Practical s:
1. Study of Enzyme activity: Amylase/ Cellulase
2. Effect of pH /temperature/ Substrate concentration on Enzyme activity
3. Study of Michaelis-Menten equation
4. Production of Plant hormones from biological sources
5. Extraction and Purification of Flavonoids, Alkaloids
6. Estimation of Cholesterol, bilirubin
7. Extraction and Purification of lipids; Thin layer Chromatography
8. Extraction and Purification of amino acids ; Thin layer Chromatography
9. Identification of production of antibiotics by bioassay
B.Sc. Biotechnology Second Year IV Semester

BTT-4.2: Applied and Medical Microbiology                     Marks 80  Hours 50

Objective: To understand applications of microorganisms in different areas.


Air Microbiology: Significance of microorganisms in air, enumeration of microorganisms and control of airborne microorganisms.

UNIT II: Water Microbiology: Types of water, bacteriological examination of water (presumptive confirmative, complete test) MPN, SPC, membrane filter technique, indicator of fecal pollution, significance of index organism (E. coli), fecal/ non fecal coli forms (IMViC).

Food Microbiology: Scope of food microbiology, microbial spoilage of food, microbial examination of food, preservation of food by high temperature, chemicals, irradiation, physical techniques. Major food born infections and toxins.

UNIT III: Medical Microbiology: Etiological Agent, Virulence, Pathogenesis epidemiology (Sporadic, endemic, pandemic) Reservoirs of infection, Normal flora, commansals, opportunistic pathogens, carriers, septic shock, septicaemia, pathogenicity, virulence factors, toxins, bio safety levels. Concept of waterborne, airborne, nosocomial infections.

UNIT IV: Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive, Measures and chemotherapy for Typhoid, Tuberculosis, Malaria and AIDS.

Plant Pathology: Concept, Host-Pathogen Relationships in plants.

Text and Reference:
1. Alexander – Soil Microbiology-John Wiley
2. N.S. Subbarao – Soil Microbiology – Oxford
5. Adams & Moss- Food Microbiology Royal Society of Chemistry
6. Frazier- Food Microbiology- Tata Mc Graw Hill
8. General Microbiology- Powar and Daginawala- Himalaya

Practicals:
1. Enumeration of microorganisms from Soil.
2. Isolation of Symbiotic and Non Symbiotic N2 fixing microorganisms/ PSB from soil.
3. Enumeration and Study of air Micro flora
4. Microbial examination of water, enteric pathogen form water sample. (IMViC test)
5. Isolation & Enumeration of microorganisms from food sample.
6. Isolation of micro flora from human skin and throat etc
7. Analysis of contaminated food material and analysis of toxins
8. Visit to food and Dairy Industry.
B.Sc. Biotechnology (Semester Pattern) IV Semester

BTT-4.3 : Immunology and Virology                      Marks 80          Hours 50

Objective: To understand concepts of immune system and virology and basic techniques used

Unit I: Immunology


Unit III: Virology


Text and Reference:
1. Immunology – Kuby- W.H. Freeman
2. Essentials of Immunology- Roitt I. M.- Blackwell
3. Immunology- Nandini Shetty- New Age International
4. Textbook of Microbiology – Anantnarayan and Panikar-Orient Longman
5. Immunology- A.K. Abbas- Elsevier
6. An Introduction to Viruses- Amita Biswas- Vikas Publication
7. Bacterial and Bacteriophage Genetics– Edward Birge- Springer
8. Microbial Genetics-David Freifelder- Narosa
10. Introduction to Modern Virology IV 1 edition- Dimmock, Primrose

Practicals:
1. Immunodignostics (demonstration using Kits- Widal, VDRL, Blood Group etc)
2. Immunodiffusion, Immuno Electrophoresis, Western Blotting, Differential Leukocyte Count
3. Lymphoid organ, Cell and their microscopic observation
4. Immunization, collection of Serum
5. Purification of Ig G from Serum
6. Isolation of bacteriophage from sewage/Titration / one step growth curve of bacteriophage
7. Enumeration of Bacteriophage by PFU method
8. Cultivation of Virus in Embryonated egg, Heamagglutination test
9. ELISA study and demonstration
10. Isolation and study of plant virus
B.Sc. Biotechnology (Semester Pattern) IV Semester

BTT-4.4: Plant and Animal Cell Culture  
Marks 80  
Hours 50

Objective: To understand the basic techniques and applications of Plant and Animal cell culture

Unit I: Plant Tissue Culture: Introduction and Principles of plant tissue culture, history, Laboratory Organization, Sterilization Techniques, Cleanliness and care, Nutrition and physiology, Media components, Stock solutions, Totipotency, Callus culture, micro propagation, Types of cultures: Cell suspension culture, embryo culture, organ culture, Anther and Pollen Culture, Plant protoplast culture, De Differentiation, Redifferentiation.

Unit II: Applications of Plant Tissue Culture: Somatic Embryogenesis and artificial seed, Mass propagation, Protoplast fusion and somatic hybridization, Cybridisation, Improved crop varieties through somaclonal variation, Plant improvement for agriculture, horticulture and forestry, production of secondary metabolites, Preservation of plant genetic resources and germplasm conservation.


Unit IV: Applications of Animal Cell Culture: 
Commercial application of animal tissue culture, concepts of Stem cells and application, Diagnostics, cytotoxicity, monoclonal antibody production, Recombinant proteins and vaccine production, Tissue engineering, Cloning.

Text and Reference:
1. Elements of Biotechnology- Gupta P.K.-Rastogi publication
2. Introduction to plant tissue culture – M.K. Razdan-Oxford and IBH
3. Biotechnological innovations in crop improvement- Butterworth Heinemann, BIOTOL, Elsevier
5. Plant Tissue Culture-Bhojwani and Razdan-Elsevier
6. Methods in Plant Tissue culture- U Kumar- Agrobios India
9. Animal Biotechnology –R Sasidhara- MJP Publisher
10. In Vitro Cultivation of Animal cells- Butterworth- Heinemann, BIOTOL, Elsevier

Practicals:
1. Introduction, general operations, aseptic handling and precautions at cell culture laboratory
2. Stock solution and media preparation for animal cell culture / PTC
3. Callus culture technique, Suspension culture technique, Organ culture: Anther, Pollen culture.
4. Aseptic seed germination.
5. Somatic Embryogenesis and preparation of artificial seed
6. Micropropagation Stage I to IV- Initiation to acclimatization and hardening
7. Animal Cell separation-Trypsinization, Cell viability count by Neuber Chamber
8. Primary cell culture and secondary cell culture techniques
9. Visit to a Animal /Plant Tissue culture laboratory