



**ASSAM UNIVERSITY, SILCHAR  
SYLLABUS UNDER**

**CHOICE BASED CREDIT  
SYSTEM**

**BIOTECHNOLOGY  
(HONOURS & GENERAL)**

**Course Structure (Biotechnology-Major)**  
**Details of courses under B.Sc. (Honours) Course**  
**Credits**

| Papers details  |   | Theory Credits     | + | Practical Credits  | Total Credits |
|---|---|--------------------|---|--------------------|---------------|
| <b>CORE COURSE (C)</b>                                    |   |                    |   |                    |               |
| <b>CORE</b>   | 14 Theory + 14 Practical<br>Theory 4 credits each paper<br>Practical 2 credits each paper           | <b>14 x 4 = 56</b> | + | <b>14 x 2 = 28</b> | <b>84</b>     |
| <b>ELECTIVE COURSE (DSE + GE)</b>                         |   |                    |   |                    |               |
| <b>DSE</b>  | 4 Theory + 4 Practical<br>Theory 4 credits each paper<br>Practical 2 credits each paper             | <b>4 x 4 = 16</b>  | + | <b>4 x 2 = 8</b>   | <b>24</b>     |
| <b>GE</b>   | 4 Theory + 4 Practical<br>Theory 4 credits each paper<br>Practical 2 credits each paper             | <b>4 x 4 = 16</b>  | + | <b>4 x 2 = 8</b>   | <b>24</b>     |
| <b>ABILITY ENHANCEMENT COMPULSORY COURSES (AECC)</b>      |   |                    |   |                    |               |
| <b>AECC</b>   | 1. English/MIL Communication<br>2. Environmental Science<br>2 Theory<br>Theory 4 credits each paper | <b>2 x 4 = 8</b>   | + | -                  | <b>08</b>     |
| <b>ABILITY ENHANCEMENT ELECTIVE COURSES (SKILL BASED)</b> |   |                    |   |                    |               |
| <b>SEC</b>  | 2 Theory<br>Theory 4 credits each paper   | <b>2 x 4 = 8</b>   | + | -                  | <b>08</b>     |
| <b>TOTAL CREDITS</b>                                      |   |                    |   |                    | <b>148</b>    |

**Each credit is equivalent to 1 hour of activity per week**

**SCHEME FOR CHOICE BASED CREDIT SYSTEM IN  
B. Sc. Honours (Biotechnology)**

| Sem | CORE COURSE (14) | Ability Enhancement Compulsory Course (AECC) (2)   | Ability Enhancement Elective Course (SEC) (2) | Elective: Discipline Specific (DSE) (2) | Elective: Generic (GE) (4) |
|-----|------------------|--|---|---|----------------------------|
| I   | BIOTECH-C-101    | English/MIL/Communication<br>Environmental Science |   |   | GE-1                       |
|     | BIOTECH-C-102    |  |   |   |                            |
| II  | BIOTECH-C-201    | English/MIL/Communication<br>Environmental Science |   |   | GE-2                       |
|     | BIOTECH-C-202    |  |   |   |                            |
| III | BIOTECH-C-301    |  | BIOTECH-SEC-301                               |   | GE-3                       |
|     | BIOTECH-C-302    |  |   |   |                            |
|     | BIOTECH-C-303    |  |   |   |                            |
| IV  | BIOTECH-C-401    |  | BIOTECH-SEC-401                               |   | GE-4                       |
|     | BIOTECH-C-402    |  |   |   |                            |
|     | BIOTECH-C-403    |  |   |   |                            |
| V   | BIOTECH-C-501    |  |   | BIOTECH-DSE-501                         |                            |
|     | BIOTECH-C-502    |  |   | BIOTECH-DSE-502                         |                            |
| VI  | BIOTECH-C-601    |  |   | BIOTECH-DSE-601                         |                            |
|     | BIOTECH-C-602    |  |   | BIOTECH-DSE-602                         |                            |

**PROPOSED SCHEME FOR CHOICE BASED CREDIT  
SYSTEM IN  
B. Sc. (General)**

| Papers details  |   | Theory Credits     | + | Practical Credits  | Total Credits |
|---|---|--------------------|---|--------------------|---------------|
| <b>CORE COURSE</b>  |   |                    |   |                    |               |
| <b>CORE</b>   | 12 Theory + 12 Practical<br>04 Courses from each of the<br>03 disciplines of choice | <b>12 x 4 = 48</b> | + | <b>12 x 2 = 24</b> | <b>72</b>     |
| <b>ELECTIVE COURSE</b>                                    |   |                    |   |                    |               |
| <b>EL</b>   | 6 Theory + 6 Practical<br>Two papers from each<br>discipline of choice              | <b>6 x 4 = 24</b>  | + | <b>6 x 2 = 12</b>  | <b>36</b>     |
| <b>ABILITY ENHANCEMENT COURSES</b>                        |   |                    |   |                    |               |
| <b>AECC</b>   | English/MIL Communication<br>Environmental Science<br>2 papers                      | <b>2 x 4 = 8</b>   | + | -                  | <b>08</b>     |
| <b>ABILITY ENHANCEMENT ELECTIVE COURSES (SKILL BASED)</b> |   |                    |   |                    |               |
| <b>SEC</b>  | 4 Theory  | <b>4 x 4 = 16</b>  | + | -                  | <b>16</b>     |
| <b>TOTAL CREDITS</b>                                      |   |                    |   |                    | <b>132</b>    |

**Each credit is equivalent to 1 hour of activity per week**

**SCHEME FOR CHOICE BASED CREDIT SYSTEM IN  
B. Sc. With Biotechnology**

| Sem | CORE COURSE (12) | Ability Enhancement Compulsory Course (AECC) (2)   | Skill Enhancement Course (SEC) (4) | Discipline Specific Elective (DSE) (6) |
|-----|------------------|--|------------------------------------|--|
| I   | BIOTECH-DSC-101  | English/MIL/Communication<br>Environmental Science |                                    |  |
|     | DSC-2 A          |  |                                    |  |
|     | DSC-3 A          |  |                                    |  |
| II  | BIOTECH-DSC-201  | English/MIL/Communication<br>Environmental Science |                                    |  |
|     | DSC-2 B          |  |                                    |  |
|     | DSC-3 B          |  |                                    |  |
| III | BIOTECH-DSC-301  |  | BIOTECH-SEC-301                    |  |
|     | DSC-2 C          |  |                                    |  |
|     | DSC-3 C          |  |                                    |  |
| IV  | BIOTECH-DSC-401  |  | BIOTECH-SEC-401                    |  |
|     | DSC-2 D          |  |                                    |  |
|     | DSC-3 D          |  |                                    |  |
| V   |                  |  | BIOTECH-SEC-501                    | BIOTECH-DSE-501                        |
|     |                  |  |                                    | DSE-2 A                                |
|     |                  |  |                                    | DSE-3 A                                |
| VI  |                  |  | BIOTECH-SEC-601                    | BIOTECH-DSE-601                        |
|     |                  |  |                                    | DSE-2 B                                |
|     |                  |  |                                    | DSE-3 B                                |

**Semester wise list of Biotechnology papers to be studied by a Biotechnology (H) students**

| <b>SEMESTER</b> | <b>COURSE NO.</b>          | <b>COURSE NAME</b>                       | <b>CREDITS</b> |
|-----------------|----------------------------|--|----------------|
| <b>I</b>        | <b>BIOTECH-C-101</b>       | <b>Biochemistry &amp; Metabolism</b>     | 4              |
|                 | <b>BIOTECH-C-101-LAB</b>   | <b>Biochemistry &amp; Metabolism LAB</b> | 2              |
|                 | <b>BIOTECH-C-102</b>       | <b>Cell Biology</b>                      | 4              |
|                 | <b>BIOTECH C 102-LAB</b>   | <b>Cell Biology LAB</b>                  | 2              |
| <b>II</b>       | <b>BIOTECH-C-201</b>       | <b>Mammalian Physiology</b>              | 4              |
|                 | <b>BIOTECH-C-201-LAB</b>   | <b>Mammalian Physiology LAB</b>          | 2              |
|                 | <b>BIOTECH-C-202</b>       | <b>Plant Physiology</b>                  | 4              |
|                 | <b>BIOTECH-C-202-LAB</b>   | <b>Plant Physiology LAB</b>              | 2              |
| <b>III</b>      | <b>BIOTECH-C-301</b>       | <b>Genetics</b>                          | 4              |
|                 | <b>BIOTECH-C-301-LAB</b>   | <b>Genetics LAB</b>                      | 2              |
|                 | <b>BIOTECH-C-302</b>       | <b>General Microbiology</b>              | 4              |
|                 | <b>BIOTECH-C-302-LAB</b>   | <b>General Microbiology LAB</b>          | 2              |
|                 | <b>BIOTECH-C-303</b>       | <b>Chemistry-1</b>                       | 4              |
|                 | <b>BIOTECH-C-303-LAB</b>   | <b>Chemistry-1 LAB</b>                   | 2              |
|                 | <b>BIOTECH-SEC-301</b>     | <b>Enzymology</b>                        | 4              |
| <b>IV</b>       | <b>BIOTECH-C-401</b>       | <b>Molecular Biology</b>                 | 4              |
|                 | <b>BIOTECH-C-401-LAB</b>   | <b>Molecular Biology LAB</b>             | 2              |
|                 | <b>BIOTECH-C-402</b>       | <b>Immunology</b>                        | 4              |
|                 | <b>BIOTECH-C-402-LAB</b>   | <b>Immunology LAB</b>                    | 2              |
|                 | <b>BIOTECH-C-403</b>       | <b>Chemistry-2</b>                       | 4              |
|                 | <b>BIOTECH-C-403-LAB</b>   | <b>Chemistry-2 LAB</b>                   | 2              |
|                 | <b>BIOTECH-SEC-401</b>     | <b>Molecular Diagnostics</b>             | 4              |
| <b>V</b>        | <b>BIOTECH-C-501</b>       | <b>Bioprocess Technology</b>             | 4              |
|                 | <b>BIOTECH-C-501-LAB</b>   | <b>Bioprocess Technology LAB</b>         | 2              |
|                 | <b>BIOTECH-C-502</b>       | <b>Recombinant DNA Technology</b>        | 4              |
|                 | <b>BIOTECH-C-502-LAB</b>   | <b>Recombinant DNA Technology LAB</b>    | 2              |
|                 | <b>BIOTECH-DSE-501</b>     | <b>Plant Diversity I</b>                 | 4              |
|                 | <b>BIOTECH-DSE-501-LAB</b> | <b>Plant Diversity I LAB</b>             | 2              |
|                 | <b>BIOTECH-DSE-502</b>     | <b>Animal Biotechnology</b>              | 4              |
|                 | <b>BIOTECH-DSE-502-LAB</b> | <b>Animal Biotechnology LAB</b>          | 2              |
| <b>VI</b>       | <b>BIOTECH-C-601</b>       | <b>Bio Analytical Tools</b>              | 4              |
|                 | <b>BIOTECH-C-601-LAB</b>   | <b>Bio Analytical Tools LAB</b>          | 2              |
|                 | <b>BIOTECH-C-602</b>       | <b>Genomics &amp; Proteomics</b>         | 4              |
|                 | <b>BIOTECH-C-602-LAB</b>   | <b>Genomics &amp; Proteomics LAB</b>     | 2              |
|                 | <b>BIOTECH-DSE-601</b>     | <b>Plant Biotechnology</b>               | 4              |
|                 | <b>BIOTECH-DSE-601-LAB</b> | <b>Plant Biotechnology LAB</b>           | 2              |
|                 | <b>BIOTECH-DSE-602</b>     | <b>Biostatistics/Bioinformatics</b>      | 4              |
|                 | <b>BIOTECH-DSE-602-LAB</b> | <b>Biostatistics/Bioinformatics LAB</b>  | 2              |

**Semester wise list of Biotechnology Generic Elective papers for students taking honours in other subjects**

| <b>SEMESTER</b> | <b>COURSE NO.</b>         | <b>COURSE NAME</b>                           | <b>Credit</b> |
|-----------------|---------------------------|--|---------------|
| <b>I</b>        | <b>BIOTECH-GE-101</b>     | <b>Bioethics &amp; Biosafete</b>             | 4             |
|                 | <b>BIOTECH-GE-101-LAB</b> | <b>Bioethics &amp; Biosafety LAB</b>         | 2             |
| <b>II</b>       | <b>BIOTECH-GE-201</b>     | <b>Biotechnology &amp; Human Welfare</b>     | 4             |
|                 | <b>BIOTECH-GE-201-LAB</b> | <b>Biotechnology &amp; Human Welfare LAB</b> | 2             |
| <b>III</b>      | <b>BIOTECH-GE-301</b>     | <b>Developmental Biology</b>                 | 4             |
|                 | <b>BIOTECH-GE-301-LAB</b> | <b>Developmental Biology LAB</b>             | 2             |
| <b>IV</b>       | <b>BIOTECH-GE-401</b>     | <b>Entrepreneurship Development</b>          | 4             |
|                 | <b>BIOTECH-GE-401-LAB</b> | <i>Project Work LAB</i>                      | 2             |

**Semester wise list of Biotechnology papers to be studied by a B.Sc. student with Biotechnology**

| <b>SEMESTER</b> | <b>COURSE NO.</b>          | <b>COURSE NAME</b>                           | <b>Credit</b> |
|-----------------|----------------------------|--|---------------|
| <b>I</b>        | <b>BIOTECH-DSC-101</b>     | <b>Bioethics &amp; Biosafete</b>             | 4             |
|                 | <b>BIOTECH-DSC-101-LAB</b> | <b>Bioethics &amp; Biosafety LAB</b>         | 2             |
| <b>II</b>       | <b>BIOTECH-DSC-201</b>     | <b>Biotechnology &amp; Human Welfare</b>     | 4             |
|                 | <b>BIOTECH-DSC-201-LAB</b> | <b>Biotechnology &amp; Human Welfare LAB</b> | 2             |
| <b>III</b>      | <b>BIOTECH-DSC-301</b>     | <b>Developmental Biology</b>                 | 4             |
|                 | <b>BIOTECH-DSC-301-LAB</b> | <b>Developmental Biology LAB</b>             | 2             |
|                 | <b>BIOTECH-SEC-301</b>     | <b>Enzymology</b>                            | 4             |
| <b>IV</b>       | <b>BIOTECH-DSC-401</b>     | <b>Entrepreneurship Development</b>          | 4             |
|                 | <b>BIOTECH-DSC-401-LAB</b> | <i>Project Work LAB</i>                      | 2             |
|                 | <b>BIOTECH-SEC-401</b>     | <b>Molecular Diagnostics</b>                 | 4             |
| <b>V</b>        | <b>BIOTECH-SEC-501</b>     | <b>Basics of Forensic Science</b>            | 4             |
|                 | <b>BIOTECH-DSE-501</b>     | <b>Plant Diversity I</b>                     | 4             |
|                 | <b>BIOTECH-DSE-501-LAB</b> | <b>Plant Diversity I LAB</b>                 | 2             |
| <b>VI</b>       | <b>BIOTECH-SEC-601</b>     | <b>Industrial Fermentations</b>              | 4             |
|                 | <b>BIOTECH-DSE-601</b>     | <b>Plant Biotechnology</b>                   | 4             |
|                 | <b>BIOTECH-DSE-601-LAB</b> | <b>Plant Biotechnology LAB</b>               | 2             |

## **CORE COURSE IN BIOTECHNOLOGY**

### **BIOTECHNOLOGY**

**(1<sup>st</sup> Semester)**

**Course No.: BIOTECH-C-101**

**Paper Name: BIOCHEMISTRY AND METABOLISM**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

#### **UNIT I: Introduction to Biochemistry:**

A historical prospective. Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

#### **UNIT II**

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

#### **UNIT III**

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

#### **UNIT IV**

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of:  $\text{NAD}^+$ ,  $\text{NADP}^+$ , FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

#### **UNIT V**

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation.  $\beta$ -oxidation of fatty acids.

#### **SUGGESTED READING**

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.



- Buchanan, B., Grissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
- Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
- Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
- Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

## **BIOTECHNOLOGY**

(1<sup>st</sup> Semester)

**Course No.: BIOTECH-C-101-LAB**

**Paper Name: BIOCHEMISTRY & METABOLISM**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

- To study activity of any enzyme under optimum conditions.
- To study the effect of pH, temperature on the activity of salivary amylase enzyme.
- Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
- Estimation of blood glucose by glucose oxidase method.
- Principles of Colorimetry: **(i)** Verification of Beer's law, estimation of protein. **(ii)** To study relation between absorbance and % transmission.
- Preparation of buffers.
- Separation of Amino acids by paper chromatography.
- Qualitative tests for Carbohydrates, lipids and proteins

## **BIOTECHNOLOGY**

(1<sup>st</sup> Semester)

**Course No.: BIOTECH-C-102**

**Paper Name: CELL BIOLOGY**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I**

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

### **UNIT II**

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

### **UNIT III**

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

### **UNIT IV**

Lysosomes: Vacuoles and micro bodies: Structure and functions. Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis. Nucleus: Structure and function, chromosomes and their structure.

### **UNIT V**

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

### **SUGGESTED READING**

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

## **BIOTECHNOLOGY**

**(1<sup>st</sup> Semester)**

**Course No.: BIOTECH-C-102-LAB**

**Paper Name: CELL BIOLOGY**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

**BIOTECHNOLOGY**  
**(2<sup>nd</sup> Semester)**  
**Course No.: BIOTECH-C-201**  
**Paper Name: MAMMALIAN PHYSIOLOGY**  
**(60 Contact hours: Credits: 04)**  
**Full marks: 100 (External: 70 Sessional 30)**  
*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

**UNIT I: Digestion**

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice

**UNIT II: Respiration**

Respiration: Exchange of gases, Transport of O<sub>2</sub> and CO<sub>2</sub>, Oxygen dissociation curve, Chloride shift.

**UNIT III: Circulation**

Composition of blood, Plasma proteins & their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

**UNIT IV: Muscle physiology and osmoregulation**

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

**UNIT V: Nervous and endocrine coordination**

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters. Mechanism of action of hormones (insulin and steroids). Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

**SUGGESTED READING**

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons, Inc.

**BIOTECHNOLOGY**  
(2<sup>nd</sup> Semester)  
**Course No.: BIOTECH-C-201-LAB**  
**Paper Name: MAMMALIAN PHYSIOLOGY**  
(30 Contact hours: Credits: 02)  
**Full marks: 50 (External: 35 Sessional 15)**  
*Pass marks: 20 (External: 14; Sessional 6)*

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

**BIOTECHNOLOGY**  
(2<sup>nd</sup> Semester)  
**Course No.: BIOTECH-C-202**  
**Paper Name: PLANT PHYSIOLOGY**  
(60 Contact hours: Credits: 04)  
**Full marks: 100 (External: 70 Sessional 30)**  
*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

**UNIT I: Anatomy**

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

**UNIT II: Plant water relations**

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

**UNIT III: Micro & macro nutrients**

Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency symptoms of nutrients, mechanism of uptake of nutrients, mechanism of food transport

**UNIT IV: Carbon and nitrogen metabolism**

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point. Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

**UNIT V: Growth and development**

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberellins, cytokinins, abscisic acid, ethylene) Physiological role and mode of action, seed dormancy and seed germination, concept of photo-periodism and vernalization

## **SUGGESTED READING**

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjamin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4<sup>th</sup> edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.

## **BIOTECHNOLOGY**

**(2<sup>nd</sup> Semester)**

**Course No.: BIOTECH-C-202-LAB**

**Paper Name: PLANT PHYSIOLOGY**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6*

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1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by *Tradescantia* leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

## **BIOTECHNOLOGY**

**(3<sup>rd</sup> Semester)**

**Course No.: BIOTECH-C-301**

**Paper Name: GENETICS**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

## **UNIT I**

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms. Mendelian genetics : Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

## **UNIT II**

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes. Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.

## **UNIT III**

Genetic organization of prokaryotic and viral genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

## **UNIT IV**

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abnormalities– Aneuploidy and Euploidy. Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X- syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

## **UNIT V**

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

## **SUGGESTED READING**

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

**BIOTECHNOLOGY**  
**(3<sup>rd</sup> Semester)**  
**Course No.: BIOTECH-C-301-LAB**  
**Paper Name: GENETICS**  
**(30 Contact hours: Credits: 02)**  
**Full marks: 50 (External: 35 Sessional 15)**  
*Pass marks: 20 (External: 14; Sessional 6)*

1. Permanent and temporary mount of mitosis.
2. Mendelian deviations in dihybrid crosses
3. Demonstration of - Barr Body -*Rhoeo* translocation.
4. Karyotyping with the help of photographs
5. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
6. Study of polyploidy in onion root tip by colchicine treatment.

**BIOTECHNOLOGY**  
**(3<sup>rd</sup> Semester)**  
**Course No.: BIOTECH-C-302**  
**Paper Name: GENERAL MICROBIOLOGY**  
**(60 Contact hours: Credits: 04)**  
**Full marks: 100 (External: 70 Sessional 30)**  
*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

**UNIT I**

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

**UNIT II**

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

**UNIT III**

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

**UNIT IV**

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents. Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

## UNIT V

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

### SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). *Introductory Mycology*. 4 th edition. John and Sons, Inc.
  2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7th edition, CBS Publishers and Distributors, Delhi, India.
  3. Kumar HD. (1990). *Introductory Phycology*. 2nd edition. Affiliated East Western Press.
  4. Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th edition. Pearson/Benjamin Cummings.
  5. Pelczar MJ, Chan ECS and Krieg NR. (1993). *Microbiology*. 5th edition. McGraw Hill Book Company.
  6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). *General Microbiology*. 5th edition. McMillan.
  7. Tortora GJ, Funke BR, and Case CL. (2008). *Microbiology: An Introduction*. 9 th edition. Pearson Education.
- Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 7th edition. McGraw Hill Higher Education.

## BIOTECHNOLOGY

(3<sup>rd</sup> Semester)

Course No.: BIOTECH-C-302-LAB

Paper Name: GENERAL MICROBIOLOGY

(30 Contact hours: Credits: 02)

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Study of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.



**BIOTECHNOLOGY**  
**(3<sup>rd</sup> Semester)**  
**Course No.: BIOTECH-C-303**  
**Paper Name: CHEMISTRY-1**  
**(60 Contact hours: Credits: 04)**  
**Full marks: 100 (External: 70 Sessional 30)**  
*Pass marks: 40 (External: 28; Sessional 12)*  
**(2 questions from each unit of 14 marks)**

**Inorganic and Physical Chemistry**

**UNIT I: Atomic Structure**

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's uncertainty principle and its significance, Schrödinger's wave equation, significance of  $\psi$  and  $\psi^2$ . Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

**UNIT II: Periodicity of Elements:**

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block: (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) and (c) Electronegativity

**UNIT III: Liquid state:**

Physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension.

**UNIT IV: Viscosity**

Introduction to viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.

**UNIT V: Ionic equilibria:**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and triprotic acids. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid – base indicators; selection of indicators and their limitations.

**SUGGESTED READING**

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
4. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

5. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8 th Ed., Oxford University Press (2006).
6. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
7. Castellan, G. W. Physical Chemistry 4 th Ed. Narosa (2004).
8. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

## **BIOTECHNOLOGY**

**(3<sup>rd</sup> Semester)**

**Course No.: BIOTECH-C-303-LAB**

**Paper Name: CHEMISTRY-1**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

### **(A) Titrimetric Analysis**

- (i) Calibration and use of apparatus
- (ii) Preparation of solutions of different Molarity/Normality of titrants

### **(B) Acid- Base Titrations**

- (i) Estimation of carbonate and hydroxide present together in mixture.
- (ii) Estimation of carbonate and bicarbonate present together in a mixture.
- (iii) Estimation with hydrochloric acid and sodium hydroxide by titration.

### **(C) Oxidation- Reduction Titrimetry**

- (i) Estimation of Fe(II) and oxalic acid using standardized KMnO<sub>4</sub> solution.
- ii) Estimation of lactic acid present in a solution by using KMnO<sub>4</sub>.
- (iii) Estimation of Fe (II) with K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> using internal (diphenylamine, anthranilic acid) and external indicator.

## **BIOTECHNOLOGY**

**(4<sup>th</sup> Semester)**

**Course No.: BIOTECH-C-401**

**Paper Name: MOLECULAR BIOLOGY**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I: DNA structure and replication**

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

## **UNIT II: DNA damage, repair and homologous recombination**

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

## **UNIT III: Transcription and RNA processing**

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA

## **UNIT IV: RNA processing**

Splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

## **UNIT V: Regulation of gene expression and translation**

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation., Posttranslational modifications of proteins.

## **SUGGESTED READING**

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

## **BIOTECHNOLOGY**

**(4<sup>th</sup> Semester)**

**Course No.: BIOTECH-C-401-LAB**

**Paper Name: MOLECULAR BIOLOGY**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity

**BIOTECHNOLOGY**  
**(4<sup>th</sup> Semester)**  
**Course No.: BIOTECH-C-402**  
**Paper Name: IMMUNOLOGY**  
**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

**UNIT I**

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

**UNIT II**

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

**UNIT III**

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms.

**UNIT IV**

Pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

**UNIT V**

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnosics – RIA, ELISA.

**SUGGESTED READING**

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6<sup>th</sup> edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11<sup>th</sup> edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6<sup>th</sup> edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7<sup>th</sup> edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2<sup>nd</sup> edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6<sup>th</sup> edition. Wiley Blackwell Publication

## BIOTECHNOLOGY

(4<sup>th</sup> Semester)

Course No.: BIOTECH-C-402-LAB

Paper Name: IMMUNOLOGY

(30 Contact hours: Credits: 02)

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

## BIOTECHNOLOGY

(4<sup>th</sup> Semester)

Course No.: BIOTECH-C-403

Paper Name: CHEMISTRY-2

(60 Contact hours: Credits: 04)

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### UNIT I ORGANIC CHEMISTRY

**Basics of Organic Chemistry:** Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment

### UNIT II Organic Compounds

Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

### UNIT III: Stereochemistry

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

### UNIT IV: Chemistry of Aliphatic Hydrocarbons :

Carbon-Carbon sigma bonds Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz- Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and

selectivity. B. Carbon-Carbon pi bonds Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

#### **UNIT V: Aromatic Hydrocarbons and Aromaticity:**

Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism.

#### **SUGGESTED READING**

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.

### **BIOTECHNOLOGY**

(4<sup>th</sup> Semester)

**Course No.: BIOTECH-C-403-LAB**

**Paper Name: CHEMISTRY-2**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Checking the calibration of the thermometer.
2. Purification of organic compounds by crystallization using the following solvents: a. water b. Alcohol
3. Separation of mixture of two amino acids by paper chromatography.
4. Separation of mixture of compounds by thin layer chromatography.
5. Separation of plant pigments by paper chromatography.
6. Estimation of total free amino acids using plant's material.
7. Estimation of fat by Soxhlet apparatus.
8. Estimation of total sugar by anthrone method.

**BIOTECHNOLOGY**  
(5<sup>th</sup> Semester)  
Course No.: **BIOTECH-C-501**  
**Paper Name: BIOPROCESS TECHNOLOGY**  
(60 Contact hours: Credits: 04)  
**Full marks: 100 (External: 70 Sessional 30)**  
*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

**UNIT I**

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

**UNIT II**

Design of bioprocess vessels; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes.

**UNIT III**

Principles of upstream processing – Media preparation, Inocula development and sterilization.

**UNIT IV**

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

**UNIT V**

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

**SUGGESTED READING**

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
  2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
  3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
- Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

## **BIOTECHNOLOGY**

**(5<sup>th</sup> Semester)**

**Course No.: BIOTECH-C-501-LAB**

**Paper Name: BIOPROCESS TECHNOLOGY**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

## **BIOTECHNOLOGY**

**(5<sup>th</sup> Semester)**

**Course No.: BIOTECH-C-502**

**Paper Name: RECOMBINANT DNA TECHNOLOGY**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I**

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR) and RT- (Reverse transcription) PCR.

### **UNIT II**

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription.

### **UNIT III**

Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

### **UNIT IV**

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins.

### **UNIT V**

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene



targeting in plants.

### **SUGGESTED READING**

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Appling the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

### **BIOTECHNOLOGY**

(5<sup>th</sup> Semester)

**Course No.: BIOTECH-C-502-LAB**

**Paper Name: RECOMBINANT DNA TECHNOLOGY**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

### **BIOTECHNOLOGY**

(6<sup>th</sup> Semester)

**Course No.: BIOTECH-C-601**

**Paper Name: BIO-ANALYTICAL TOOLS**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I**

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

## **UNIT II**

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra-red).

## **UNIT III**

Centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

## **UNIT IV**

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

## **UNIT V**

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

## **SUGGESTED READING**

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

## **BIOTECHNOLOGY**

**(6<sup>th</sup> Semester)**

**Course No.: BIOTECH-C-601-LAB**

**Paper Name: BIO ANALYTICAL TOOLS**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of protoplasts from leaves.
4. Separation of amino acids by paper chromatography.
5. To identify lipids in a given sample by TLC.

**BIOTECHNOLOGY**  
(6<sup>th</sup> Semester)  
Course No.: **BIOTECH-C-602**  
Paper Name: **GENOMICS & PROTEOMICS**  
(60 Contact hours: Credits: 04)  
**Full marks: 100 (External: 70 Sessional 30)**  
*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

**UNIT I**

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

**UNIT II**

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

**UNIT III**

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions.

**UNIT IV**

Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

**UNIT V**

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.

**SUGGESTED READING**

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). *iGenetics- A Molecular Approach*. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications

of recombinant DNA. ASM Press, Washington.  
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons

**BIOTECHNOLOGY**

**(6<sup>th</sup> Semester)**

**Course No.: BIOTECH-C-602-LAB**

**Paper Name: GENOMICS & PROTEOMICS**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database

## **Syllabi for DSC/GE papers**

### **BIOTECHNOLOGY**

(1<sup>st</sup> Semester)

**Course No.: BIOTECH-DSC-101/BIOTECH-GE-101**

**Paper Name: BIOETHICS AND BIOSAFETY**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

#### **UNIT I**

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

#### **UNIT II**

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc.

#### **UNIT III**

The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

#### **UNIT IV**

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

#### **UNIT V**

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

#### **SUGGESTED READING**

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship : Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

## **BIOTECHNOLOGY**

(1<sup>st</sup> Semester)

**Course No.: BIOTECH-DSC-101-LAB/BIOTECH-GE-101-LAB**

**Paper Name: BIOETHICS AND BIOSAFETY**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Proxy filing of Indian Product patent
2. Planning of establishing a hypothetical biotechnology industry in India
3. A case study on clinical trials of drugs in India with emphasis on ethical issues.
4. Case study on women health ethics.
5. Case study on medical errors and negligence.
6. Case study on handling and disposal of radioactive waste

## **BIOTECHNOLOGY**

(2<sup>nd</sup> Semester)

**Course No.: BIOTECH-DSC-201/BIOTECH-GE-201**

**Paper Name: BIOTECHNOLOGY & HUMAN WELFARE**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I**

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

### **UNIT II**

Agriculture: N<sub>2</sub> fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

### **UNIT III**

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

### **UNIT IV**

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

### **UNIT V**

Health: e.g. development of non- toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

### **SUGGESTED READING**

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.

2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

## **BIOTECHNOLOGY**

(2<sup>nd</sup> Semester)

**Course No.: BIOTECH-DSC-201-LAB/BIOTECH-GE-201-LAB**

**Paper Name: BIOTECHNOLOGY & HUMAN WELFARE**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

*(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)*

1. Perform of ethanolic fermentation using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

## **BIOTECHNOLOGY**

(3<sup>rd</sup> Semester)

**Course No.: BIOTECH-DSC-301/BIOTECH-GE-301**

**Paper Name: DEVELOPMENTAL BIOLOGY**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I: Gametogenesis and Fertilization**

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

### **UNIT II: Early embryonic development**

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

### **UNIT III: Embryonic Differentiation**

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome.

### **UNIT IV: Transcription & Translation**

Transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

### **UNIT V: Organogenesis**

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers

Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

### **SUGGESTED READING**

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

### **BIOTECHNOLOGY**

(3<sup>rd</sup> Semester)

**Course No.: BIOTECH-DSC-301-LAB/BIOTECH-GE-301-LAB**

**Paper Name: DEVELOPMENTAL BIOLOGY**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Identification of developmental stages of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of developmental stages of *Anopheles*.
4. Study of the developmental stages of *Drosophila* from stock culture/ photographs.
5. Study of different types of placenta.

### **BIOTECHNOLOGY**

(4<sup>th</sup> Semester)

**Course No.: BIOTECH-DSC-401/BIOTECH-GE-401**

**Paper Name: ENTREPRENEURSHIP DEVELOPMENT**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

#### **UNIT I INTRODUCTION**

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

#### **UNIT II ESTABLISHING AN ENTERPRISE**

Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

#### **UNIT III FINANCING THE ENTERPRISE**

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

#### **UNIT IV MARKETING MANAGEMENT**



Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

#### **UNIT V ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS**

Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

#### **SUGGESTED READING**

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.

### **BIOTECHNOLOGY**

**(4<sup>th</sup> Semester)**

**Course No.: BIOTECH-DSC-401-LAB/BIOTECH-GE-401-LAB**

**Paper Name: ENTERPRENEURSHIP DEVELOPMENT**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

**Project Report on a selected product should be prepared and submitted.**

## Syllabi for BIOTECHNOLOGY-DSE Papers

### BIOTECHNOLOGY

(5<sup>th</sup> Semester)

Course No.: BIOTECH-DSE-501

Paper Name: PLANT DIVERSITY I

(60 Contact hours: Credits: 04)

Full marks: 100 (External: 70 Sessional 30)

Pass marks: 40 (External: 28; Sessional 12)

(2 questions from each unit of 14 marks)

#### UNIT I

##### Algae:

General character, classification and economic importance. Life histories of algae belonging to various classes: Chlorophyceae – *Volvox*, *Oedogonium*, Xantho phyceae – *Vaucheria*, Phaeophyceae – *Ectocarpus*, Rhodophyceae-*Polysiphonia*

#### UNIT II

##### Fungi:

General characters, classification & economic importance. Life histories of Fungi: Mastigomycotina- *Phytophthora*, Zygomycotina- *Mucor*, Ascomycotina- *Saccharomyces*, Basidiomycotina-*Agaricus*, Deutromycotina-*Colletotrichum*

#### UNIT III

##### Lichens :

Classification, general structure, reproduction and economic importance. Plant diseases: 4 of 36 Casual organism, symptoms and control of following plant diseases. Rust & Smut of Wheat. White rust of Crucifers. Late blight of Potato. Red rot of Sugarcane. Citrus Canker.

#### UNIT IV

##### Bryophytes:

General characters, classification & economic impotence. Life histories of following: *Marchantia*. *Funaria*.

#### UNIT V

Applications of algae, fungi, lichens and bryophytes in biotechnology and human welfare.

### SUGGESTED READING

1. Agrios, G.N. 1997 Plant Pathology, 4<sup>th</sup> edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4<sup>th</sup> edition, John Wiley and Sons (Asia) Singapore.
3. Bold, H.C. & Wayne, M.J. 1996 (2<sup>nd</sup> Ed.) Introduction to Algae.
4. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.

8. Van den Hoek, C.; Mann, D.J. & Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
  9. Vander-Poorteri 2009 Introduction to Bryophytes. COP.
  10. Webster, J. and Weber, R. 2007 Introduction to Fungi. 3<sup>rd</sup> edition, Cambridge University Press, Cambridge.
- Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

## **BIOTECHNOLOGY**

**(5<sup>th</sup> Semester)**

**Course No.: BIOTECH-DSE-501-LAB**

**Paper Name: PLANT DIVERSITY I**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory
2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lectophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of Marchantia and Funaria
6. Collection of algae, fungi, plant diseases materials and bryophytes available locally.

## **BIOTECHNOLOGY**

**(5<sup>th</sup> Semester)**

**Course No.: BIOTECH-DSE-502**

**Paper Name: ANIMAL BIOTECHNOLOGY**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I**

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

### **UNIT II**

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

### **UNIT III**

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

#### **UNIT IV**

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy.

#### **UNIT V**

Molecular engineering, human genetic engineering, problems & ethics.

#### **SUGGESTED READING**

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California, USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

### **BIOTECHNOLOGY**

(5<sup>th</sup> Semester)

**Course No.: BIOTECH-DSE-502-LAB**

**Paper Name: ANIMAL BIOTECHNOLOGY**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

## **BIOTECHNOLOGY**

**(6<sup>th</sup> Semester)**

**Course No.: BIOTECH-DSE-601**

**Paper Name: PLANT BIOTECHNOLOGY**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I**

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropropagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

### **UNIT- II**

In vitro haploid production Androgenic methods: Anther culture, Microspore culture androgenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

### **UNIT – III**

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclature, methods, applications basis and disadvantages.

### **UNIT – IV**

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation.

### **UNIT – V**

Introduction to Biocontrol and its principles, Biocontrol of pathogens, Growth promotion by free-living bacteria.

### **SUGGESTED READING**

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8<sup>th</sup> edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3<sup>rd</sup>edition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3<sup>rd</sup> edition)
- Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

## **BIOTECHNOLOGY**

**(6<sup>th</sup> Semester)**

**Course No.: BIOTECH-DSE-601-LAB**

**Paper Name: PLANT BIOTECHNOLOGY**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. To selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.

## **BIOTECHNOLOGY**

**(6<sup>th</sup> Semester)**

**Course No.: BIOTECH-DSE-602**

**Paper Name: BIOSTATISTICS**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I**

Characteristics, capabilities and generations of computers; Organization of a computer; Hardware and software; Input, output and memory of a computer; Introduction to operating systems and programming languages; Networking system: Internet and intranet, LAN, WAN and MAN; Introduction to MS Office package; Application of computers in Biological Sciences; Biological database searching and retrieval

### **UNIT II**

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

### **UNIT III**

Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

### **UNIT IV**

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test.

### **UNIT V**

Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA). Correlation and Regression. Emphasis on examples from Biological Sciences.

## **SUGGESTED READING**

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield<sup>TM</sup> Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
- Daniel W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

## **BIOTECHNOLOGY**

(6<sup>th</sup> Semester)

**Course No.: BIOTECH-DSE-602-LAB**

**Paper Name: BIOSTATISTICS**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Introduction to computer hardware devices; Installing and handling application software, formatting computers.
2. Handling of files and folders, Use of DOS commands; Use of MS Office package and MS-DOS commands.
3. Basics programming languages.
4. Searching biological database and Introduction to bioinformatics software
5. Based on graphical Representation
6. Based on measures of Central Tendency & Dispersion
7. Based on Distributions Binomial Poisson Normal
8. Based on t, f, z and Chi-square

## **BIOTECHNOLOGY**

(6<sup>th</sup> Semester)

**Course No.: BIOTECH-DSE-602**

**Paper Name: BIOINFORMATICS**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

### **UNIT II**

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

### **UNIT III**

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments,

### **UNIT IV**

Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

### **UNIT V**

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission.

### **SUGGESTED READING**

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

## **BIOTECHNOLOGY**

**(6<sup>th</sup> Semester)**

**Course No.: BIOTECH-DSE-602-LAB**

**Paper Name: BIOINFORMATICS**

**(30 Contact hours: Credits: 02)**

**Full marks: 50 (External: 35 Sessional 15)**

*Pass marks: 20 (External: 14; Sessional 6)*

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.



## **Syllabi for Skill Enhancement Course (SEC)**

### **BIOTECHNOLOGY**

**(3<sup>rd</sup> Semester)**

**Course No.: BIOTECH-SEC-301**

**Paper Name: ENZYMOLOGY**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

#### **UNIT - I**

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

#### **UNIT – II**

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation,

Different plots for the determination of  $K_m$  and  $V_{max}$  and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

#### **UNIT – III**

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition.

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: specific examples of enzyme action: chymotrypsin, Isozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.

Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

#### **UNIT – IV**

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

#### **UNIT – V**

Enzyme Technology: Methods for large scale production of enzymes.

Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution.

Methods for protein sequencing.

## **SUGGESTED READING**

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons, 1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic P

## **BIOTECHNOLOGY**

**(4<sup>th</sup> Semester)**

**Course No.: BIOTECH-SEC-401**

**Paper Name: MOLECULAR DIAGNOSTICS**

**(60 Contact hours: Credits: 04)**

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### **UNIT I**

#### **Enzyme Immunoassays:**

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays.

Applications of enzyme immunoassays in diagnostic microbiology

### **UNIT II**

Molecular methods in clinical microbiology:

Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide and plasmid finger printing in clinical microbiology

Laboratory tests in chemotherapy:

### **UNIT III**

Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests:Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

### **UNIT IV**

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

## UNIT V

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting.  
Transgenic animals.

### SUGGESTED READING

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Century-Crofts publication.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert

## BIOTECHNOLOGY

(5<sup>th</sup> Semester)

Course No.: BIOTECH-SEC-501

Paper Name: BASICS OF FORENSIC SCIENCE

(60 Contact hours: Credits: 04)

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### Unit I

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation.

### Unit II

Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

### Unit III

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

### Unit IV

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

## Unit V

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

### SUGGESTED READING

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001). \_
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002). \_
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005). \_
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997). \_
6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene \_Investigation, CRC Press, Boca Raton (2013).

## BIOTECHNOLOGY

(6<sup>th</sup> Semester)

Course No.: BIOTECH-SEC-601

Paper Name: INDUSTRIAL FERMENTATIONS

(60 Contact hours: Credits: 04)

**Full marks: 100 (External: 70 Sessional 30)**

*Pass marks: 40 (External: 28; Sessional 12)*

**(2 questions from each unit of 14 marks)**

### UNIT I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel; Microbial polysaccharides; Microbial insecticides; newer antibiotics, anti cancer agents, amino acids.

### UNIT II

Microbial products of pharmacological interest, steroid fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity.

### UNIT III

Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

### UNIT IV

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

#### **UNIT V**

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations. Metabolic engineering of antibiotic biosynthetic pathways.

#### **SUGGESTED READING**

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2<sup>nd</sup> edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology,

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