# M.Sc. Biotechnology

# DRAFT

## Scheme & Syllabus
## For Affiliated Colleges
## (Revised)
**2020**


## University of Kerala
**Thiruvananthapuram**

# M Sc Biotechnology

## (Course Outcomes, Programme Outcomes and Programme Specific Outcomes)

## Course Outcomes (CO):

After successfully completing this course, the student will be able to

**CO1:** Understand the basic knowledge and concepts of biotechnology and other related areas.

**CO2:** Understand the ability to apply their knowledge for practical which they can conduct independently.

**CO3:** Apply their knowledge in other advanced subject area like Nano-biotechnology, immuno-technology and animal and plant biotechnology for the betterment and advancement of their professional career.

**CO4:** Learn the theoretical and practical exposure to the basic and the advanced fields of biotechnology.

## Programme Outcome (PO):

**PO1:** The major outcome of our MSc programme is to introduce competent biotechnologist's who can implement their knowledge base in advanced processes and applications in Biotechnology in the various fields of agriculture, industry, healthcare and environment.

**PO2:** An ability will be developed for the students to apply knowledge of Biotechnology (including other areas of life sciences like Biochemistry, Biophysics, Cell biology, Molecular Biology, rDNA technology, Immunology and Immuno-technology, Pharmaceutical Biotechnology, Nano-biotechnology etc.), for understanding its basic concepts.

**PO3:** Students also attain an ability to standardize and to conduct experiments, as well as to analyze and interpret data accordingly. They will gain an individual and team work ability to function on multi-disciplinary teams.

## Programme Specific Outcomes (PSO):

**PSO1:** Design and execute industry oriented experiments in biotechnology using modern biotechnological tools and techniques.

**PSO2:** Apply the knowledge of Biotechnology to demonstrate research skills and develop technology for industrial applications such as development of new biotech products, process and clinical practices and methodologies.

## SUMMARY OF THE SYLLABUS AND SCHEME

**Semester I**

| Course Code | Title of the Course | Teaching Hours/week | | | |
|---|---|---|---|---|---|
| | | L | T | P | Total |
| BT 101 | Cell Biology and Genetics | 4 | 1 | 0 | 5 |
| BT 102 | Biochemistry | 4 | 1 | 0 | 5 |
| BT 103 | Biophysics and Biostatistics | 4 | 1 | 0 | 5 |
| BT 104 | Biochemistry Lab | 0 | 1 | 4 | 5 |
| BT 105 | Cell Biology /Genetics lab | 0 | 1 | 4 | 5 |
| | **Total Hours /week** | **12** | **5** | **8** | **25** |

**Semester II**

| Course Code | Title of the Course | Teaching Hours/week | | | |
|---|---|---|---|---|---|
| | | L | T | P | Total |
| BT 201 | Basic Microbiology | 4 | 1 | 0 | 5 |
| BT 202 | Molecular Biology | 4 | 1 | 0 | 5 |
| BT 203 | Mathematics, Computer Science, Bioinformatics & Research Methodology | 4 | 1 | 0 | 5 |
| BT 204 | Microbiology Lab | 0 | 1 | 4 | 5 |
| BT 205 | Molecular Biology Lab | 0 | 1 | 4 | 5 |
| | **Total Hours /week** | **12** | **5** | **8** | **25** |

Semester III

| Course Code | Title of the Course | Teaching Hours/week | | | |
|---|---|---|---|---|---|
| | | L | T | P | Total |
| BT 301 | Plant Biotechnology | 4 | 1 | 0 | 5 |
| BT 302 | Animal Biotechnology | 4 | 1 | 0 | 5 |
| BT 303 | Genetic engineering | 4 | 1 | 0 | 5 |
| BT 304 | Plant BT/ Animal BT Lab | 0 | 1 | 4 | 5 |
| BT 305 | Genetic Engineering Lab | 0 | 1 | 4 | 5 |
| | **Total Hours /week** | **12** | **5** | **8** | **25** |

**Semester IV**

| Course Code | Title of the Course | Teaching Hours/week | | | |
|---|---|---|---|---|---|
| | | L | T | P | Total |
| BT 401 | Immunology | 4 | 1 | 0 | 5 |
| BT 402 | Environmental Biotechnology | 4 | 1 | 0 | 5 |
| BT 403 | Food and dairy Biotechnology/Basics of Bioreactor | 4 | 1 | 0 | 5 |
| BT 404 | Project | 0 | 0 | 10 | 10 |
| BT 405 | General Viva -voce | | | | |
| | **Total Hours /week** | **12** | **3** | **10** | **25** |

L –Lecture, T- Tutorial, P-Practical Total Number of Hours /week-25 hrs.
90 working days, 450 hours / semester. 5 months including exams. One seminar

## II. MARK DISTRIBUTION

### 1. PAPER/SEMESTER

| Semester | Papers | CA | ESA | Total Marks |
|---|---|---|---|---|
| **I** | BT-101-105 | 25 x 5 | 75 x 5 | 500 |
| **II** | BT-201-205 | 25 x 5 | 75 x 5 | 500 |
| **III** | BT-301-305 | 25 x 5 | 75 x 5 | 500 |
| **IV** | BT-401-403<br>BT-404<br>BT-405 | 25 x 3<br>50 x 1<br>- | 75 x 3<br>100 x 1<br>50 | 300<br>150<br>50 |
| **Grand Total (From S-1 to S-IV)** | | | | **2000** |

CA- Continuous Assessment
ESA- End Semester Assessment

**Total Marks for a semester 500**
**Total Maximum marks at the end of IV semester 500 x 4=2000**

### 2. DISTRIBUTION OF MARKS FOR PROJECT EVALUATION

| **A. CA** | |
|---|---|
| | Marks |
| Attendance | 10 |
| Work progress | 20 |
| Discussion | 20 |
| **Total** | **50** |
| **B. ESA** | |
| Project Content | 50 |
| Project presentation OR<br>Viva Voce on Project | 50 |
| **Total Marks for Project (CA + ESA)** | **150** |

## III. SCHEME OF EXAMINATION PATTERN OF THE COURSE

| | |
|---|---|
| **Total Number of Hours /Week** | 25 |
| One hour (period) for each subject and keep one hour for tutorial , seminar, discussions etc. | |
| **Number of theory papers/semester and duration** | 3 (5 hrs each) |
| **Number of Lab /Practicals** | 2 (5 hrs each) |
| **Project** | 10 hours |

## EXAMINATION AND EVALUATION

| **Examination** | **CA** | **ESA** | **Total** | **Components of CA** | |
|---|---|---|---|---|---|
| Theory | 25 | 75 | 100 | Attendance | 5 |
| | | | | Seminar | 5 |
| | | | | Assignments | 5 |
| | | | | Test | 10 |
| Lab/ Practical | 25 | 75 | 100 | Attendance | 5 |
| | | | | Record | 5 |
| | | | | Test | 10 |
| | | | | Viva | 5 |
| No. of seminars | | One seminar/paper/student/semester | | | |
| No. of assignments | | One assignment/paper/student/semester | | | |
| Tutorial hour | | May be utilized for seminar and discussion | | | |

## PROJECT

Project work shall be assigned individually and must be carried out under the guidance of a faculty from the same college with or with out an external guide OR in an external institution under the combined guidance of internal and external guides. The student has to submit the dissertation before the examiner for evaluation and may give a presentation on the project work, if asked for.

## PROJECT EVALUATION

The evaluation of the project (Both CA and ESA) through oral presentation or Viva-voce as decided by the Chairman, Board of examinations..

| | **Marks** |
|---|---|
| **Project Content** | 50 |
| **Project presentation OR Viva Voce on Project** | 50 |
| **Maximum marks (including CA)** | **150** |

# 4. DETAILED SYLLABUS

## SEMESTER I

## BT 101 Cell Biology and Genetics

### Aim

- To give a detailed and comprehensive knowledge on the various aspects of cell biology and genetics including cell structure and its functions, Mendelian genetics, and population genetics in detail.

### Course Objectives

- The course gives the life activities at cellular and molecular level and basic functions of the various cellular compartments and organelles.
- It also gives the structural- functional and biochemical details of all cellular activities.
- This explains the basic principles of Mendelian, population genetics and heredity and gives an overview on the classical genetics- Linkage & Crossing over.

### Course Outcome

On completion of the course, students shall be able to,

- Identify and present relevant information from research publications dealing with issues of cell biology and genetics.
- They will be able to assess and relate the information to the context of cell biology.
- Plan and carry out simple experiments on the basis of cell.
- The course enables students to analyse hereditary data and apply fundamental coupling analyses and genetic calculations.

### Course Content

#### Cell Biology

**Module 1**

1. An overview of Cells and Cell Research- Microscopy – Light Microscopy, Electron Microscopy, Applications of electron microscopy in Cell biology. Confocal Microscopy, Fluorescence Microscopy and FRET. Cells - structure and size and shape, Prokaryotic and eukaryotic cells.
2. Cell membrane - structure and function, transport of nutrients and ions across the membranes, Mechanism of vesicle transport and vesicle fusion. Functional diversity of cellular membranes. Plasmodesmata, Tight junctions, Gap junctions – Structure and role in movement of molecules.

**Module 2**

3. Tissues- major types of plant tissues- simple tissue, complex tissues and tissue systems. Animal tissues- major types of tissues. Organs and organ systems
4. Cell organelles -structure and function. Plant and animal cells - similarities and differences.

**Module 3**

5. Cell cycle- Mitosis and meiosis, chromosomes- structure and organization,

nucleosomes organization karyotypes and ideograms. Cytological, genetical and evolutionary significance of Mitosis and Meiosis. Molecular events and regulation of cell cycle in eukaryotes. Check points, Cyclins and protein kinases, MPF (maturation promoting factor).

6. Cell -cell communication, cellular response to the environment, and mechanism of signal transduction.
7. Cancer Biology – cellular and genetic basis of cancer, apoptosis, carcinogens, environmental and diet factors in cancer.

## Genetics

**Module 4**

8. Mendelian Genetics- Mendelian inheritance, Non-Mendelian inheritance

**Module 5**

9. Chromosome theory of inheritance- Linkage and crossing over. Recombination frequency. Extra-chromosomal inheritance
10. Chromosome aberrations- associated genetic diseases.

**Module 6**

11. Population genetics- genetic variation, polymorphism, gene pool, gene frequency, distribution pattern. Hardy-Weinberg equilibrium. Disequilibrium, factors affecting gene equilibrium

**References**


| | | | |
|---|---|---|---|
| 1. | Genetics | AVSS Sambamoorthy | Narosa , New Delhi |
| 2. | Principles of genetics | DP Snustad, MJ Simmons JB Jenkins | John Wiley |
| 3. | Genetics | PK Gupta | Rastogi, Meerut |
| 4. | Cell & Molecular Biology | PK Gupta | Rastogi, Meerut |
| 5. | Genetics | PJ Russell | Benjamin Cummings |
| 6. | The science of genetics | AG Atherly, JR Girton, JF Mc Donald | Harcurt Brace College Publishers New York |
| 7. | Basic Human Genetics | EJ Mange, AP Mange | Sinauer Associates Inc, Massachusetts |
| 8. | The cell –A molecular approach | GM cooper | Sinauer Associates Inc, Massachusetts |
| 9. | Essential Cell Biology | Alberts, Bray, Johnson | Garland Pbl. NY |
| 10. | Concepts of genetics | Klug and Cummings | Person education N. Delhi |


**Online resources:**
Authentic Web based resources like NCBI, PubMed, Science direct etc.

# Semester I
# BT 102 Biochemistry

## Aim

- To give an introduction about the basic biochemistry related to the biological molecules, their diversity and biosynthesis, degradation and role in the biological systems.
- This also aims to develop a thorough knowledge among the students about the the various biochemical reactions- metabolic pathways- responsible for the manifestation of life disease and metabolic errors.

## Course Objectives

- The overall objective of the course is for the student to gain a basic working knowledge of biochemical concepts and techniques which will be necessary for future scientific endeavors.
- This course gives an idea on different biological molecules, their origin, biological role and its degradation according to the needs and demand of the system under various conditions.
- The interrelation of each of these metabolic pathways and their contribution in various metabolic disorders are also explained in detail.
- The application of the knowledge generated in the practical aspects of Biotechnology.

## Course Outcome

On completion of the course, the student should achieve an understanding of the following:

- The structures of amino acids, their chemical properties and their organization into polypeptides and proteins.
- Methods for isolating and characterizing proteins the basic elements of protein structure key
- Principles of protein function.
- Enzymes and how they catalyze reactions as well as enzyme kinetics
- Structure of fundamental monosaccharides and polysaccharides structure
- Basic function of nucleotides structure of different classes of lipids and their roles in biological systems

## Course Content

### Module 1

1. Macromolecules - structure, classification and properties of Carbohydrates, Proteins and Lipids and Nucleic acids.

   Carbohydrates- Monosaccharides-classification and structure, Isomerism in monosaccharides, Disaccharides- mclassification and types of disaccharides, its biological significance and finctions, Oligosaccharides-hetero-oligosaccharides and homo-oligosaccharides, Polysaccharides- classification- hetero-polysaccharides,and homo-polysaccharides, storage polysaccharides and structural polysaccharides.

### Module 2

Proteins- classification of proteins, building units of proteins- Amino acids- structure, properties and function, classification of Amino acids, peptide bonds, ramachandran plot, oligo peptides polypeptides, Structure of proteins- primary , secondary and tertiary

structures, quaternary structures, supra-secondary structures- motifs and domains,

Isolation and purification of proteins- different molecular and instrumental methods involved. Characterization of protein- structural and amino acid composition, Functions of proteins.

**Module 3**

Lipids- structure and classification, various types of lipids – Oils and fats, Triglycerides- structure and function, Phospholipids- structure, classification and functions, Biological significance of various types of Phospholipids, Glycolipids and lipoproteins, serum lipids and its significance, Cholesterol and its derivatives,

Nucleic acids- classification of Nucleic acids, Building blocks of Nucleic acids, structure of Nucleotides, classification of nucleotides, Purines, Pyramidines, structure and function of DNA and RNA, Non-genetical function of Nucleic acids and its derivatives.

**Module 4**

2. Metabolism of carbohydrates - Glycolysis, TCA cycle, Gluconeogenesis, Pentose Phosphate pathway, Glycogen metabolism-Glycogenesis, glycogenolysis. Biosynthesis of starch, glycogen and glucose. Photosynthesis.
3. ETS and bioenergetics of cellular respiration. Redox reactions, standard oxidation reduction potential, mitochondrial electron transport chain, Oxidative phosphorylation, structure of ATP synthase, chemiosmotic hypothesis
4. Metabolism of Lipids- Oxidation of lipids. Beta-oxidation, Biosynthesis of lipids, Ketone bodies

**Module 5**

5. Metabolism of proteins and amino acids – Digestion and absorption, Biosynthesis and degradation of amino acid. Urea cycle, regulation.
6. Metabolism of Nucleotides –biosynthesis, degradation and regulation of nucleotides and related molecules. Energy compounds and its biosynthesis- ATP, NAD, NADP, FAD, Creatin phosphates
7. Secondary metabolism- classification and role of secondary metabolites of plants and microbes - Role of secondary metabolites
8. Metabolic network - Interrelationship of metabolisms Krebs cycle, amino acid synthesis,

**Module 6**

9. Enzymes -Enzyme classification and nomenclature. General properties of enzymes, factors affecting enzyme activity. Steady state kinetics. Michaelis – Menten equation and constants, maximum velocity, enzyme specificity, linear plot Lineweaver-Burke plot, Eadie-hofstee plot. Enzyme activation, inhibition-competitive and non competitive. Enzyme kinetics, mechanism of enzyme action, Allosteric interactions and product inhibition; Enzyme purification. Coenzyme; Clinical and Industrial applications of enzymes. Immobilization of enzymes and their application. Ribozymes and their applications. Enzyme engineering.

**References**


| | | | |
|---|---|---|---|
| 1. | Harpers Biochemistry | RK Murray, DK Grammer, PA Mayes VW Rodwell | MC Graw Hill USA |
| 2. | Text Book of Biochemistry | DM Vasudebvan and Sreekumari | Jaypee Brothers Medical Publishers New Delhi |
| 3. | Biochemistry | U Satyanaryana | Becks & Allied Kolkotta |
| 4. | A text book of plant Physiology and Biochemistry | SK Verma | S Chand New Delhi |
| 5. | Instant notes Biochemistry | Hames, Hooper & Houghton | VIVA books Pvt ltd, N. Delhi |
| 6. | Biochemistry | Stryer, Jermy, Berg | Freeman Newyork |
| 7. | Biochemistry | Voet & Voet | Wiely & Sons |
| 8. | Principles of Biochemistry | GL Zubay, WW Parson & DE Vance | Wm C Brown Publishers Australia |
| 9. | Bioorganic chemistry | HR Hortan, LA Moran, RS Ochs | Prentice Hall USA |
| 10. | Environmental Biochemistry | CP Jrasa | Saup & Sons N Delhi |
| 11. | Biochemistry of Green plants | DW Krogman | Prentice Hall USA |
| 12. | Fundamentals of Enzymology | NC Price & L Stevens | Oxford science publications NY |
| 13. | Principles of Biochemistry | AL LEHINGER, DL NELSON & COX | Worth publishers NY |


**Online resources:**
Authentic Web based resources like NCBI, PubMed, Science direct etc.

**SEMESTER I**

**BT 103 BIOPHYSICS AND STATISTICS**

## Aim

- To equip the students with knowledge of thermodynamics of biological system and bioenergetics. Also to give an introduction to the biophysical aspects of various biological physiological activities at cellular and molecular level.
- To get introduced to the fields of various instruments used in biotechnology- including the basic principle - application and working.
- To help students to have an idea on basic mathematical problems and calculations needed in Biotechnology aspects

## Course Objective

- The course is designed to train the students in biophysics and bioinstrumentation techniques essential for the understanding of life sciences and biotechnology, for which basic knowledge in physics or Biophysics at graduate level is expected and is necessary for the proper understanding of this topic at postgraduate level.
- This course consists of basics of thermodynamics as applicable in the field of Biological systems- bio energetics- energy trapping and its transactions methods- biophysics of various biological activities.
- The course helps to attain knowledge on mathematical calculations and problems helping in competitive exams.

## Course outcome

On completion of the course,

- The students will develop the capability to demonstrate a multiscale nature of biophysics by exploring macroscopic and microscopic applications.
- The students will learn to approach a research problem logically and will be able to do statistical analyses in research.

## Course Content

**BIOPHYSICS**

**Module 1**

1. Stucture of atoms, molecule, Physico-chemical forces- ions, ionic bonds, covalent bonds, Hydrogen bonds, vander Wals forces, hydrophobic interactions, polar and non-polar molecules
2. Major Biological Macromolecules – role of various interatomic and molecular interactions in the formation and stability of macromolecules, supra-molecular assemblies and cellular components.

**Module 2**

3. Concept of Energy- matter and energy, thermodynamics- entropy, enthalpy

Bioenergetics- life as an energy system- major energy transformations mediated by life- Photochemical reaction of photosynthesis- Oxidative photophosphorylation, ATP, GTP, Creatin phosphate, muscle contraction, generation and transmission of nerve impulse.

4. Biophysics of Muscle movement , Impulse generation and impulse transmission

**Module 3**

5. Electromagnetic radiation- electromagnetic spectrum, photoreceptors- types of radiations-visible spectrum, absorption spectrum. Plant pigments and hormones as receptors of radiations- light receptors of animals. Biophysics of Vision.
6. Spectroscopy- various types of spectroscopic techniques, spectrophotometer- UV-Visible spectroscopy- Beer Lambert Law, IR spectroscopy, Raman Spectroscopy, X-ray diffraction technique-principle and application, NMR spectroscopy-principle and application, Fluorescent spectroscopy-principle and application.

**Module 4**

7. Microscopy- Light microscopy- Phase contrast Microscopy, Fluorescent microscopy, Modern Developments in Microscopy- FRET Microscopy, Confocal Microscopy, Electron Microscopy- Transmission and Scanning Electron Microscopy- Principle and applications, Resolution of a Microscope.
8. Centrifugation - Principle and application of various types of centrifugation- sedimentation coefficient, Svedberg unit.
9. Chromatography- Principle and application, Classification of Chromatography Adsorption and Partition chromatography, Paper Chromatography, TLC, Liquid Chromatography - ion exchange chromatography, Gel permeation chromatography, affinity chromatography, HPLC and GC.

**Module 5**

10. Electrochemical instruments - pH meter and Mass spectrometry.
11. Electrophoresis- principle and application, PAGE- Native and SDS-PAGE, Isoelectric focusing, 2D -gel Electrophoresis, immune electrophoresis.
12. Molecular hybridization Techniques- southern blotting. Northern blotting and Western blotting, Electro blotting
13. Principle and applications of tracer technique in biology: Radioactive Isotopes and half life of isotopes; Effect of radiation on biological system; autoradiography; radiation dosimetry; scintillation counting, safety aspects

## BIOSTATISTICS

**Module 6**

1. General principles, sampling, sampling errors
2. Mean, Median, Mode, standard deviation and standard error
3. Probability- normal and binomial distribution, Poisson distribution- Frequency distribution - representation of frequencies.
4. Testing and Significance - Paired T- test. Unpaired T-test, Chi-squire test Correlation and regression.
5. Graphs and diagrams - Bar diagrams, pie chart. Histograms and frequency curves

## References


| | | | |
|---|---|---|---|
| 1. | Principles of Biochemistry | AL LEHINGER, DL NELSON & COX | Worh publishers NY |
| 2. | A text book of Biophysics | RN Roy | New Central book Agency Kolkotta |
| 3. | Biophysics | Dr. S Thiravia Raj | Saras Publications Tamil Nadu |
| 4. | Principles of Biostatistics | M Paggana & Gaurveeau | Duxbery Australia |
| 5. | Essentials of Biophysics | P Naryananan | New age International PVt ltdN. Delhi |
| 6. | Biochemistry | Stryer, Jermy, Berg | Freeman Newyork |
| 7. | Principles of Biochemistry | GL Zubay, WW Parson & DE Vance | Wm C Brown Publishers Australia |
| 8. | Harpers Biochemistry | RK Murray, DK Grammer, PA Mayes VW Rodwell | MC Graw Hill USA |
| 9. | Basic Evaluation methods | Breakwell and L Millwart | Uty. Press Hyderabad |
| 10. | Biophysics An Introduction | RMJ Cotterill | John Wiely and Sons NYork |
| 11. | Basic Biophysics for Biotechnologist | M Daniel | Agrobios Jodhpur |


**Online resources:**

Authentic Web based resources like NCBI, PubMed, Science direct etc.

## SEMESTER I

## PRACTICAL

## BT 104 BIOCHEMISTRY LAB

## Aim

- To train students on the basic techniques of biochemistry

## Course Objectives

- The course gives an idea for the maintenance of laboratory and the practices that should be accomplished in a laboratory.
- The course explains how to prepare buffers and reagents, various methods of estimation of proteins, enzyme extraction and purification

## Course Outcomes

At the end of this course,

- The students will equip themselves with the basic biochemistry techniques which can later applied for their laboratory research and also for many other industrial researches.
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## Course Content

**Laboratory techniques**

1. Titration curve of acetic acid and Glycine
2. Titration of acetic acid to determine the pKa value.
3. Preparation of buffer of a known pH (phosphate buffer, acetate buffer)
4. Determination of isoelectric pH of a given amino acid.
5. Methods of protein estimation- spectrophotometric determination of proteins by Lowry's method and Bradford method.
6. Enzyme extraction and purification - ammonium sulphate precipitation, protein purification by Gel permeation chromatography, ion exchange chromatography
7. Electrophoretic separation of proteins- SDS-PAGE Chromatography- column chromatography and Thin Layer Chromatography (TLC).

## SEMESTER I

### BT 105 CELL BIOLOGY, GENETICS AND BIOSTATISTICS LAB

## Aim

- To train students on the basic techniques of cell biology and Genetics
- To make aware of the students a basic knowledges on computing biological problems statistically.

## Course Objectives

- The course gives an idea for the maintenance of laboratory and the practices that should be accomplished in a laboratory.
- The course explains how to make slides for cytological examinations, other histochemical analysis, solving problems based on genetics and statistical analysis.

## Course Outcomes

At the end of this course,

- The students will equip themselves with the basic cytology aspects to be performed in the laboratory.
- The students will be able to analyze genetic problems and will be able to approach a research problem statistically.

## Course Content

**Laboratory techniques**

1. Cytological and Histological techniques- determination of number of viable cells in a cell population
2. Mitosis - Onion root tip squash preparation- Preparation of Karyotypes, Determination of Mitotic index.
3. Meiosis - squash preparation of immature anther- identification of different stages.
4. Microtomy and histochemical techniques - Preparation of thin sections of tissues and developing embryos and staining with tissue specific stains
5. Isolation and estimation of chloroplasts
6. Solving the problems of genetics
7. Calculation of mean, standard deviation, standard error and student's t-test Preparation of histograms, frequency polygon and pie diagram.

SEMESTER II

**BT 201 BASIC MICROBIOLOGY**

## Aim

- To give an introduction about the microbial world- their distribution- morphology and reproduction and about the role of microorganism in various fields of human life and Industry.

## Course Objectives

- Imparts advanced training in Microbiology for the students
- Makes the student aware the role of microbes in the daily life as well as in the various fields of science. How it can be controlled is also dealt with.

## Course outcome

At the end of this course,

- The students get trained in all aspects of microbiology as it is required for Biotechnology.

## Course Content

**Module 1**

1. Ultra structure of bacteria, fungi, algae, protozoa and viruses.
2. Classification of microbes, molecular taxonomy, Artificial and Natural systems of classification, Traditional characters used for the classification of Microorganisms.

**Module 2**

3. Current methods of identification, characterization, classification of Microorganisms. Microscopic examination of Microorganisms, Microscopes and Microscopy – Principle and applications for the study of Microorganisms.
4. Morphology and Fine structure of bacteria, cultivation of Bacteria, growth of bacteria – growth curve, Reproduction and growth, Pure culture and cultural characteristics. Microbial techniques, Staining techniques

**Module 3**

5. Characteristic features of eubacteria, archae, fungi- Molds and Yeasts, algae, protozoa and viruses- Viruses of bacteria, Viruses of plants and animals.
6. Biology of *Escherichia coli, Bacillus subtilis, Rhizobium sp., Agrobacterium tumefaciens, Saccharomyces cerevisiae,* and phage lambda.

**Module 4**

7. Microbial nutrition. Growth, Microbial metabolism and energy production, bacterial photosynthesis and chemosynthesis
8. Microbial interaction (human microbe interaction, normal biota of the human body, plant microbe interaction).

**Module 5**

9. Control of Microorganisms- Physical chemical methods, Disinfectants, Antibiotics and mechanisms of antibiosis.
10. Microbial physiology and microbial genetics.

**Module 6**

11. Microbial ecology and Biogeochemical cycles
12. Environmental microbiology - Microbial deterioration of pesticides and organic compounds- cellulose- lignin- steroids- hydrocarbons; microbial deterioration of textiles- paper- wood- leather; microbial fouling and corrosion- Biodegradation of agricultural waste to biogas- Microbial leaching of ores.
13. Industrial microbiology- Microbes used in industrial processes- bioengineering of microbes for industrial purposes-

## References


| | | | |
|---|---|---|---|
| 1. | A text book of Microbiology | P Chakraborthy | New central Book agency culcutta |
| 2. | Modern Concepts of Microbiology | H.D. Kumar, S. Kumar | Vikas Publishing House, Pvt. Ltd. New Delhi |
| 3. | Advances in Microbial Biotechnology | J.P. Tewari, T.N. Lakhanpal, J. Singh, R. Gupta, B.P. chamola | A.P.H. Publishing Corporation, New Delhi |
| 4. | Instant notes in Microbiology | J. Nicklin, K. Graeme- cook, T. Paget & R. Killington | Viva books Pvt. Ltd., New Delhi |
| 5. | Principles of Microbiology | R.M. Atlas | Mc Giraw Hill, NY |
| 6. | Introductory Microbiology | J. Heritage, E.G.V. Evans, R.A. Killington | Cambridge University Press |
| 7. | Human Parasitology | B.J. Bogitsh , T.C. Cheng | Academic Press, NY |
| 8. | Microbiology | Pelczar, Chan, Krieg, Tala Mc. GrawHill | Publishing Company, New Delhi |
| 9. | Microbiology- An Introduction | G.J. Tortora, B.R. Funke, C.L. Case | Wesley Longman, NY |
| 10. | Microbiology | L.M. Prescott, J.P. Harley, D.A. Klein. | Wm. C. Brown Publishers, Australia |
| **11.** | Environmental Microbiology 3rd Edition | Academic Press | Ian Pepper Charles Gerba Terry Gentry |


**Online resources:**
Authentic Web based resources like NCBI, PubMed, Science direct etc.

**SEMESTER II**

# BT 202 MOLECULAR BIOLOGY

## Aim

- To understand biological activities and metabolism at DNA and protein level

## Course Objectives

- The course gives an in-depth insight into the molecular aspects of life - the central dogma.
- It explains molecular aspects of genes and its regulation- genome- gene expressions- heredity- recombination- protein synthesis- molecular basis of diseases- mutations- genetic analysis etc.

## Course Outcome

At the end of the course,

- The student will get an idea about the principles behind molecular biology which makes students to understand the basic molecular tools and its application in basic research and applied research in various fields of life sciences.

## Course Content

### Module 1

1. **Nucleic acids** - DNA and RNA structure and functions, DNA as genetic material. Griffth, Avery- McCarty-MCLeod, Hershy- Chase, Franklin Conrat Experiments

2. **DNA Structure**: Chemistry of DNA, Forces stabilizing DNA structure, Helix parameters, Forms of DNA (A,B,C,D,T and Z), Watson – Crick and Hoogsteen base pairing , Physical Properties of ds DNA (UV absorption spectra Denaturation and renaturation ), Chemical that react with DNA.

### Module 2

3. **DNA topology**: DNA supercoiling, Supercoiled form of DNA, Superhelical density, Energetic of supercoiled DNA, Biology of supercoiled DNA (Topological domain of DNA,DNA topoisomerases, Mechanisms of supercoiling in cells, mechanisms of action of topoisomerase I and II, effect of supercoiling on structure of DNA and role of supercoiling in gene expression and DNA replication).

4. **Organization of DNA into chromosome**s: Packaging of DNA and organization of chromosome in bacteria and eukaryotic cells; packaging of DNA in eukaryotic nucleosome and chromatin condensation assembly of nucleosomes upon replication. Chromatin modification and genome expression.

**Module 3**

5. **Mutations-** molecular mechanism - types of DNA mutations and its significance. DNA repair - repair mechanisms - need of DNA repair, DNA recombination - molecular mechanism of recombination- relationship between repair and recombination, SOS mechanism. Proteins and enzymes involved DNA repair and recombination.

6. **DNA – Protein Interactions**: General features interaction of Helix- turn Helix motif, B sheet, Zn- DNA binding domain etc with DNA.

**Module 4**

7. **DNA Replication**: Mechanism of DNA polymerase catalyzed synthesis of DNA, types of DNA polymerases in bacteria and their role. Initiation of chromosomal DNA replication and its regulation in prokaryotes assembly of replisome and progress of replication fork, termination of replication. Types and function of eukaryotic DNA polymerases initiation of replication in eukaryotes, role of telomerases in replication of eukaryotic chromosomes. Inhibitor of DNA replication (Blocking precursor synthesis nucleotide polymerization, altering DNA structure).

**Module 5**

8. **Transcription**: RNA polymerases, features of prokaryotic and eukaryotic promoters. Strong and weak promoters. Assembly of transcription initiation complex in prokaryotes and eukaryotes and its regulation; synthesis and processing of prokaryotic and eukaryotic transcripts. Transport of RNA within eukaryotic cell. Regulatory elements of genes-promoters. Fate of mRNA.

9. **Translation- Synthesis and Processing of Proteome**: Structure and role of tRNA in protein synthesis, ribosome structure, basic feature of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes), Post translational processing of protein (protein folding, processing by proteolytic cleavage, processing by chemical modification, inteins). Protein degradation.

**Module 6**

10. **Regulation of Gene expression in prokaryotes and eukaryotes**: Positive and negative regulation. lac-, ara-, his- and trp- operon regulation; antitermination, global regulatory responses; Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms.

11. **DNA- transposable elements**- types of transposable elements, its importance in variation and evolution. Possible origin of virus, Oncogenes.

## References

| | | | |
|---|---|---|---|
| 1. | Advanced Molecular Biology | H.S. Bhamrah | Viva Books, Pvt. Ltd., New Delhi |
| 2. | Plant Biochemistry and Molecular Biology | Hans, Walter Held | Oxford, NY |
| 3. | Molecular Cell Biology | H.S. Bramrah | Anmol Publications Pvt. Ltd., New Delhi |
| 4. | Molecular Biology of the Gene | Watson, Baker, Bell, Gann, Levine, Losick | Pearson Education Pvt. Ltd., New Delhi |
| 5. | Apoptosis and Cancer chemotherapy | John A. Hickman & Caroline Dive | Humana Press, NJ |
| 6. | Molecular Modelling | Principles and Application, Andrew R. Leach | Longmann, England |
| 7. | PCR 3 | Practical Approach, C. Simon Herrington & John O'Leary | Oxford, NY |
| 8. | Essential Molecular Biology | A Practical Approach, T.A. Brown | Oxford, NY |
| 9. | Cell & Molecular Biology | Concepts & Experiments Gerald Karp, John Wiley & Sons | NY |
| 10. | Gene Vlll | Benjamin Lemin | Oxford University Press |


**Online resources:**
Authentic Web based resources like NCBI, PubMed, Science direct etc.

## SEMESTER II

**BT 203 MATHEMATICS, COMPUTER SCIENCE, BIOINFORMATICS & RESEARCH METHODOLOGY**

## Aim

- To give an introduction to basic computational analysis and its applications
- To make the students understand what is Bioinformatics and Computational Biology- To make them aware the application of various computational tools in Bioinformatics and related subjects.
- To introduce to the world of various databases and its importance in biological research.
- Enable students to conduct scientific research. and also to analyze data and communicate the results in an appropriate fashion

## Course Objectives

- The course explains the applications of computer in biotechnology and statistical analysis of experimental data and also basic research methodology adopted.
- The course gives an introduction on the origin and evolution of Bioinformatics and its importance in Biotechnology, Genomics and Proteomics.
- Various methods of genome analysis and proteome analysis is also described.
- It gives an outline on the various bioinformatics and computational tools used in analyzing protein, gene and genome data bases.
-

## Course outcome

At the end of the course,

- The student will be aware with a basic knowledge of modern molecular biology and genomics.
- The student will understand how theoretical approaches can be used to model and analyze complex biological systems.
- The students will also be able to understand the basics of how to perform scientific researches and also how to analyze and interpret a research problem

## Course Content

**MATHEMATICS**

**Module 1**

**1. Algebra**

Complex numbers; algebra of complex numbers; geometrical representation; real and imaginary parts; modulus and arguments of a complex number; conjugate of a complex number- triangle inequality; club roots of unity.

**2. Logarithms**

Properties of logarithms- Common and Natural logarithms- Characteristics and Mantissa

3. **Progression**- arithmetic progression- Geometrical progression- harmonic progression.

4. **Quadratic equations and Expressions**

   Theory of quadratic equations- relationship between their roots and coefficients; quadratic expressions; linear and quadratic inequations in one variable;

5. **Binomial Theorem**

   Binomial expressions- Permutations and Combinations.

6. **Calculus**

   Functions- into- onto and one-to-one functions; sum- difference- product and quotient of two functions; composite functions- inverse of a function- constant absolute value- greatest integer- polynomial - rational- trigonometric- exponential and logarithmic functions.

6. **Analytical Solid Geometry**

   Analytical geometry of two dimensions and three dimensions, Central coincides, Paraboloids, Transformation of rectangular axes.

**COMPUTER SCIENCE**

**Module 2**

1. Computers- its application in biology- Basics
2. Basics of computer- Parts of a computer- hardware and software, operating systems- standard operating systems- MS DOS, Windows- Linux, Unix

**Module 3**

3. Programming - algorithms, binary language. Elements of programming languages- C++ and Perl
4. Standard software packages- Sigmaplot etc
5. Databases, Internet, Searching databases. Portals

**BIOINFORMATICS**

**Module 4**

1. **Information theory and biology:** Entropy, Shannon's formula, Divergence from equiprobability and independence, mark of chains, ergodic processes, redundancy.

2. **History and development of Bioinformatics, Database:** Various types of databases and its importance Use of databases in biology, - sequence databases, structural databases. Sequence Analysis- proteins and nucleic acids, structural comparisons, genome projects.

3. Sequence alignment-various methods, DNA sequence annotation and various programmes for sequence comparison and analysis.

**Module 5**

4. **Proteomics:** Sequence analysis of proteins, and nucleic acids, tools and techniques in proteomics, protein-protein interactions; post translational modification, methods of 2D structure predictions.
5. **Genomics:** Structural genomics- sequence analysis software like GCG etc, Functional genomics- Gene finder, genetic mapping, and linkage analysis, application of genetic maps, human genome project.

**RESEARCH METHODOLOGY**

**Module 6**

1. Introduction to research – The role of research, type of researches
2. Understanding research Concepts, Constructs, Variables, and Definitions
3. Problems and Hypotheses – Defining the research problem, Formulation of the research hypotheses, The importance of problems and hypotheses
4. Research design – Experimental and Non-experimental research design, Field research, and Survey research
5. Methods of data collection – Secondary data collection methods, qualitative methods of data collection, and Survey methods of data collection
6. Sampling techniques – The nature of sampling, Probability sampling design, Nonprobability, sampling design, Determination of sample size
7. Processing and analysis of data
8. Ethical issues in conducting research
9. Report generation, report writing

**References**


| | | | |
|---|---|---|---|
| 1. | Bioinformatics- Concepts, skills and Application | S.C. Rastogi, N. Mendiratta, P. Rastogi , | CBS Publishers and Distributors, New Delhi |
| 2. | Bioinformatics | M.M. Ranga, | Agrobios, Jodhpur |
| 3. | A Handbook of Bioinformatics | N. Yadav | Anmol Publication Pvt. Ltd, New Delhi |
| 4. | Fundamentals of Bioinformatics | I.A. Khan and A. Khanum | Ukaaz Publications, Andra Pradesh |
| 5. | Bioinformatics | The Machine Learning Approach | The MIT Press, USA |
| 6. | Proteomics | S.R. Pennington, M.J. Dunn | Viva Books Pvt. Ltd., New Delhi |
| 7. | Microarray Bioinformatics | Dov Stekel | Cambridge University Press |
| 8. | Aloagarithms on strings, trees, and sequences- Computer Science and Computational Biology | Dan Gusfield | Cambridge University Press |
| 9. | Analysis of DNA Microarray data | Steen Knudsen, | Wiley Liss NY |
| 10. | Mathematical models in | E.S. Allman, J.A. Rhodes | Cambridge University Press |

| | | | |
|---|---|---|---|
| | Biology- An Introduction | | |
| 11. | Bioinformatics- Sequence, structure and databanks | D. Higgins, W. Taylor | Oxford University Press |
| 12. | Bioinformatics for Geneticists | M.R. Barnes, I.C. Gray, | Wiley USA |
| 13. | Experimental Design and Data Analysis for Biologist | G.P. Quinn, M.J. Keough | Cambridge University Press |
| 14. | Research Methodology – Methods and Techniques", 2nd Edition | C. R. Kothari | New Age International Publishers |
| 15. | Scientific Papers and Presentations-3rd Edition, Elsevier Inc | Davis, M., Davis K., and Dunagan M | Elsevier Inc |
| 16. | Research Methods for Science | Michael P. Marder | Cambridge University Press |


**SEMESTER II**

**BT 204 MICROBIOLOGY LAB**

## Aim

- To train students on the basic techniques of microbiology

## Course Objectives

- The course gives an idea for the maintenance of laboratory and the practices that should be accomplished in a laboratory.
- The course explains the isolation and screening techniques of microbes and quality analysis of water.

## Course outcome

On completion of the course candidates will achieve the following objectives,

- A detailed knowledge of structure, function and application of microorganisms.
- Skills in handling microorganisms in the laboratory.
- An understanding of applications of microorganisms in the industry, health-care, environmental protection, food agriculture and research.

## Course Content

1. Isolation of bacteria from soil, water and air
2. Gram staining of bacteria
3. Methods of streaking of bacterial culture
4. Microbial analysis of drinking water by MPN
5. Microbial analysis of solid and liquid food items
6. Determination of dissolved oxygen of water
7. Estimation of Biological Oxygen demand (BOD) of wastewater or factory effluents, Determination of chemical oxygen demand (COD) of waste water
8. Estimation of nitrates in drinking water.
9. Study of bacterial flora of environment – Laboratories, soil, water, fermented foods and spoiled foods, commercial samples of water and drinks etc,
10. Bacterial growth - growth curve

## BT 205 MOLECULAR BIOLOGY LAB

## Aim

- To train students on the basic techniques of Molecular biology
-

## Course Objectives

- The course gives hands on training on the practical experiments and techniques in molecular biology

## Course outcome

At the end of the course,

- The students will be made proficient in basic molecular biology skills and molecular biology laboratory techniques

## Course Content

### Laboratory techniques

1. Preparation of Buffers arid solution for Molecular biology- TE buffer
2. Isolation of genomic DNA Preparation of Plasmid from known bacteria by alkaline lysis method- Preparation of solutions needed for the experiment
3. Estimation of DNA and purity checking by UV spectrophotometer
4. Agarose gel electrophoresis of plasmid and genomic DNA
5. Restriction analysis of plasmid DNA and evaluation of restriction sites
6. Construction of a recombinant plasmid Preparation of competent cells for transformation.

**BT 301 PLANT BIOTECHNOLOGY**

## Aim

- To give an idea of plant tissue culture
- To introduce the various plant genetic engineering and transformations and its applications in various fields.

## Course Objectives

- It gives introduction to the various transformation techniques employed in plant systems.
- It also describes the application of genetically modified plants in the various fields of science.

## Course Outcome

At the end of the course,

- The students will gain an insight into the concepts and techniques of plant biotechnology and its application to crop plants
- They can also go for further research works during M.Phil and PhD courses

## Course Content

### Module 1

1. Plant cell -Plant cell and tissue and organ culture, principle - historical background
2. Plant tissue culture practical application and conventional plant breeding
3. Tissue culture media - composition and preparation- solid media and liquid media
4. Micro propagation of plants- initiation and maintenance of callus and suspension cultures- single cell clones.

### Module 2

5. Organogenesis and somatic embryogenesis in plant tissue culture- development of whole -plants - Root formation, transfer of plant lets to the soil, hardening
6. Advantages of micropropagation in agriculture and horticulture
7. Shoot-tip meristem culture - raising virus free plants for rapid clonal multiplication of agricultural and horticultural plants

### Module 3

8. Cell suspension cultures and its application in the production of secondary metabolites and single cell clones
9. Embryo culture and embryo rescue
10. Protoplast technology -protoplast isolation, fusion, protoplast culture, somatic hybridization, selection of somatic hybrid cells, culturing and development of somatic hybrid plants, symmetric and asymmetric hybrids, cybrids - Application of somatic hybridization plant improvement and breeding

### Module 4

11. Somaclonal variation- significance in plant breeding
12. Production of haploid plants - anther and pollen culture, homozygous plants and its importance in genetics and plant breeding
13. Cryopreservation of plant cells, tissues and organs for germplasm conservation

**Module 5**

14. Plant genetic engineering - transgenic plants and its application in agriculture, different methods of plant genetic transformation
15. *Agrobacterium* mediated genetic engineering of plants, *Agrobacterium tumifaciens*, infection and molecular mechanism of tumor formation , Ti plasmids and RI plasmids, binary vectors, genetic markers, reporter genes and its application in genetic engineering,
16. Other methods of plant genetic transformation

**Module 6**

17. Metabolic engineering, Molecular plant breeding
18. Application of plant genetic engineering in agriculture, forestry and horticulture and industry, industrial application of transgenic plants, transgenic plants as bioreactors Chloroplast transformation.

## References


| | | | |
|---|---|---|---|
| 1. | Modern Concepts of Biotechnology | H.D. Kumar | Vikas Publishing House Pvt. Ltd., New Delhi |
| 2. | Role of Biotechnology in Medicinal and Aromatic Plants | Irfan A. Khan and Atiya Khanum | Ukaaz Publications, Hydreabad |
| 3. | Plant Tissue Culture | Kalyan Kumar D. | New Central Book Agency (P) Ltd, Calcutta |
| 4. | An introduction to Plant tissue Culture | M.K. Razdan | Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi |
| 5. | Biotechnology | B.D. Sigh | Kalyan Publishers New Delhi |
| 6. | Introduction to Plant Biotechnology | H.S. Chawla | Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi |
| 7. | Plant Biotechnology Recent Advances | P.C. Trivedi | Panima Publishing Corporation, New Delhi |
| 8. | Biotechnology | J.E. Smith | Cambridge University Press |
| 9. | Plant Biochemistry and Molecular Biology | Hans, Walter Held | Oxford, NY |
| 10. | Plant Cell, Tissue, and Organ Culture- Fundamental Methods | O.L. Gamborg, G.C. Philips | Narasa Publishing House, New Delhi |


**Online resources**

Authentic Web based resources like NCBI, PubMed, Science direct etc.

**BT 302 ANIMAL BIOTECHNOLOGY**

## Aim

- To give an idea of animal tissue culture
- To introduce the various genetic and transformation techniques in animals and and its applications in various fields.
-

## Course Objectives

- It gives introduction to the various transformation techniques employed in animal systems.
- It also describes the application of genetically modified animals in the various fields of science.
- The techniques of animal cell culture and its industrial and medical applications are described.

## Course Outcome

At the end of the course,

- The students will gain an insight into the concepts and techniques of animal biotechnology and its wide industrial and medicinal applications.
- They can also go for further research works during M.Phil and PhD courses

## Course Content

**Module 1**

1. Animal cell - structure and organization, animal physiology.
2. Animal cell culture- Equipments and facilities for animal cell culture. Media and its preparation, pH and pH maintenance in culture media, role of carbon dioxide, serum and- serum free media, artificial media.

**Module 2**

3. Types of animal cell culture- primary and secondary cell culture, development cell lines or established cultures.
4. Biological characterization of cell cultures, contact inhibition, cell transformation, cancer cells, indefinite cell lines.
5. Measurement of cell viability, cytotoxicity.
6. Screening of cytotoxic compounds and its importance.

**Module 3**

7. Basic techniques of mammalian cell culture, methods of sub culturing.
8. Scaling up of cell cultures, bioreactors for animal cell cultures.

**Module 4**

9. Application of animal cell culture- industrial application, and clinical application- production. Stem cell research- types of stem cells, application of stem cells.
10. Somatic cell genetics, animal cloning and micromanipulation, apoptosis.

**Module 5**

11. Genetic engineering of farm animals - cloning vectors, viral vectors.
12. Methods of genetic transformations.
13. Transgenic animals and its uses.

**Module 6**

14. Gene therapy- methods of gene therapy
15. Ethical issues in animal biotechnology.

## References


| | | | |
|---|---|---|---|
| 1. | Modern Concepts of Biotechnology | H.D. Kumar | Vikas Publishing House Pvt. Ltd., New Delhi |
| 2. | Biotechnology- Fundamentals and Applications | S.S. Purohit & S.KMathur | Agrobotanica , India |
| 3. | Agricultural Biotechnology | S.S Puroht | Agrobotanica , India |
| 4. | Fungi in Biotechnology | Anil Prakash | CBS Publishers, New Delhi |
| 5. | Biotechnology | B.D Singh | Kalyan Publishers, New Delhi |
| 6. | Biotechnology | J.E Smith | Cambridge University Press |
| 7. | Biotechnology | D. Balasubramanium, etal K.Dharnmalingam, K.Jayaraman. | University Hydrabad |
| 8. | Animal Cell Culture | John R.W. Masters | Oxford University Press |
| 9. | Culture of Animal Cells | R.Ian Fresheny, | Wiley Liss Publication, New York |


**Online resources**

Authentic Web based resources like NCBI, PubMed, Science direct etc.

## BT 303 GENETIC ENGINEERING

## Aim

- To acquaint the students to the versatile tools and techniques employed in genetic engineering and recombinant DNA technology.

## Course objectives

- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineering techniques.

## Course outcome

At the end of the course,

- The student will achieve a sound knowledge on methodological repertoire which allows them to innovatively apply these techniques in in basic and applied fields of life science researches.

## Course content

**Module 1**

1. Genetic engineering as tool in biotechnology.
2. Milestones in the development of genetic engineering. Application of genetic engineering in biotechnology.
3. Molecular tools in genetic engineering - vectors, enzymes - restriction endonuclease.
4. DNA ligase, acid phosphatase and other DNA modifying enzymes.
5. Restriction enzymes - restriction analysis of genomes- restriction sites- cloning of blunt end DNA, adapters.

**Module 2**

6. DNA libraries- cDNA library. Genomic Library- Preparation of cDNA libraries and Genomic DNA libraries application of DNA libraries.
7. Gene cloning, gene expression.
8. DNA analysis: labeling of DNA and RNA probes. Southern and fluorescence *in situ* hybridization, DNA fingerprinting, chromosome walking.

**Module 3**

9. Techniques for gene expression: Northern and Western blotting, Gel retardation technique, DNA foot printing, Primer extension, S1 mapping, Reporter assays.
10. DNA sequencing and sequence assembly. Maxam-Gilbert's and Sanger's methods, techniques of in vitro mutagenesis, Site-directed mutagenesis, gene replacement and gene targeting, Shot gun sequencing, chemical synthesis of oligonucleotides; sequencing strategies for large genomes.

11. PCR- Principle and applications , Various types PCR.

**Module 4**

12. DNA mapping and DNA fingerprinting: Physical and molecular mapping, Hybridization and PCR based methods of fingerprinting.
13. Vectors- and its uses in Genome sequencing.
14. Cloning for gene expression- industrial production of animal and plant proteins in microbes - industrial application of genetic engineering- industrial production of recombinant proteins.

**Module 5**

15. Genetic engineering of eukaryotes- genetic engineering of plants and animals- vectors used for transformations - shuttle vectors.
16. Protein engineering Metabolic Engineering, site directed mutagenesis.
17. Application of genetic engineering in gene expression studies.
18. Transgenic and gene knockout technologies to study molecular biology, chromosome engineering.

**Module 6**

19. Molecular markers. DNA based and **PCR - based markers** , RFLP, RAPD,RLGS, AFLP STS, EST, SSCP, VNTR, Multi locus probes, Microsatellites and minisatellites, STMS, DAF, AP-PCR .
20. Gene therapy.

## References


| | | | |
|---|---|---|---|
| 1. | Biotechnology - Fundamentals and Applications | S.S. Purohit & S.K Mathur | Agrobotanica , India |
| 2. | Agricultural Biotechnology | S.S. Purohit | Agrobotanica , India |
| 3. | Biotechnology - Fundamentals and Applications | S.S. Purohit & S.K Mathur | S.S. Purohit & S.K Mathur |
| 4. | Molecular Biotechnology | S.B. Primrose | Panima Publishing Corporation, New Delhi |
| 5. | Text Book of Biotechnology | C.R. Chhatwal | Anmol Publications pvt Ltd, New Delhi |
| 6. | Applied Molecular Genetics | R .L. Miesfeld , | Wiley Liss ,New York |


**Online resources**

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER III

**Practicals**

**BT 304 PLANT BIOTECHNOLOGY/ ANIMAL BIOTECHNOLOGY LAB**

## Aim

- To train students on basic and plant and animal cell and tissue culture techniques.

## Course Objectives

- The course gives hands own experience in the tissue culture of plant and animal cells.

## Course outcome

At the end of the course,

- The student will be well versed with the theoretical as well as practical background knowledge in plant and animal sciences need for understanding plant and animal biotechnology.
- The will gain working knowledge of laboratory techniques used in plant biotechnology.

## Course Content

**Laboratory techniques**

1. Preparation tissue culture Media, methods surface sterilization of explants
2. Stock preparation and calculations
3. Organ culture. Induction of callus, callus propagation, Organogenesis and transfer of plantlets to soil
4. Protoplast isolation, cell counting viability studies
5. Culturing of protoplast and regeneration of plants/ tissues from protoplasts
6. Production of haploids by anther culture, cytological examination of chromosomes in regenerated plants
7. Estimation of phenols from callus cultures
8. Preparation media for animal cell culture, sterilization by membrane filtration
9. Cell counting and viability checking by vital staining Sub culturing
10. Cytological examination of cultured cells

Practicals

**BT 305 GENETIC ENGINEERING LAB**

## Aim

To introduce the students to the concepts and practice of genetic engineering.

## Course Objectives

- To understand the basics of genetic engineering.
- To learn different methodologies in genetic engineering.
- To enable students to design a cloning experiment.

## Course Outcome

At the end of the course,

- Students obtain a thorough knowledge in basic Molecular biology and genetic engineering methods practiced in research.

## Course content

**Laboratory techniques**

1. Isolation of plasmids and purification
2. Electrophoretic separation of plasmid by agarose gel electrophoresis
3. Quantification and quality checking by UV spectrophometry and electrophoresis
4. Restriction analysis and construction of restriction map of plasmid
5. Preparation of competent *E.coli* cells, Construction of recombinant plasmid
6. Genetic Transformation of *E.coli* with a recombinant plasmid
7. Screening transformed cells for the presence of recombinant plasmid and gene
8. Transformation frequency and cloning efficiency

**BT 401 IMMUNOLOGY**

## Aim

- To get introduced to the principles of immune systems of animals.
- To introduce to the world of molecular and diagnostic techniques of immunology, immunotechniques and its application.

## Course Objectives

- This course is designed to impart the students the importance of immunology and its theoretical aspects and on the principles of immunology and immunotechnology
- The application of immunology in medicines is also dealt with.
- It also explains the various antigen-antibody reactions involved in diseases, stem cell technology and vaccine development.

## Course Outcome

At the end of the course the students will,

- Get a deep foundation in the immunological processes.
- Students will gain knowledge on how the immune system works and also on the immune system network and interactions during a disease or pathogen invasion.

## Course Content

**Module 1**

1. History and scope of immunology. Types of immunity- innate, acquired, passive and active. Brief account on Immune system, Physiology of immune response- HI and CMI specificity and memory. Antigen-antibody reactions. Antigens- types- hapten.
2. Immunoglobulins- structure, distribution and function.

**Module 2**

3. Lymphoid tissues- ontogeny and physiology of immune system- origin and development, differentiation of lymphocytes.
4. Antigen distribution in population- HLA in human health and disease. Transplantation immunity- organ transplantation and HLA tissue typing.

**Module 3**

5. Effector mechanisms in immunity- macrophage activation. Cell mediated cytotoxicity.
6. Humoral and cell mediated immunity, Hypersensitivity reactions. Cellular interactions in human response.

**Module 4**

7. Antigen recognition. Lymphocyte activation, colonal proliferation, differentiation.

8. Cytokines in immunity, Interleukines and their role.

**Module 5**

9. Genetic Immuno regulations. Introduction to tumour immunology, autoimmune disorders.
10. Use of transgenic animals in mmunology, experimental immunology, vaccine, development, stem cell technology. Immunodiagnostics.

**Module 6**

11. Hybridoma technology and monoclonal antibody production, application and their uses. Cloning for vaccine development
12. Immunotechniques – ELISA, RIA, Immuno-electrophoresis, Immuno Diffusion, Western Blotting.

## References


| | | | |
|---|---|---|---|
| 1. | Immunology | Joshi. Osma | Agro Botanica N.Delhi |
| 2. | Instant notes in Immunology | Lydyard, helean, Fanger | Viva Books N.Delhi |
| 3. | An introduction to Immunology | CV Rao | Narosa N.Delhi |
| 4. | Immunology | Janus Kuby | Freeman NY |
| 5. | Principles of cellular and molecular Immunology | Jonathan Austin, Kathyryn Wood | Oxford NY |
| 6. | Immunology | Goldsby, Kindt, Osborne, Janus Kuby | Freeman NY |
| 7. | Medical Immunology | Parslow, Stites, Tera, Imboden | Mc Graw Hill NY |
| 8. | Cellular and molecular Immunology | Abbas, Lichman, Pobea, | Harcourt & Brace Co. |


**Online resources**
Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER IV

**BT 402 ENVIRONMENTAL BIOTECHNOLOGY**

## Aim

- To give an introduction to the various aspects of environmental biotechnology to students.

## Course Objectives

- The course explains the application of biotechnology in environment.

## Course outcome

At the end of the course the students will,

- Obtain knowledge on basic principles and technologies of decontamination of persistent organic pollutants (dangerous contaminants of the environment) mainly by means of the biological approaches i.e. using bioremediation etc.

- The students will know about the principles and techniques underpinning the application of biosciences to the environment

## Course Content

**Module 1**

1. Issues and scopes of environmental biotechnology.
2. Pollution- types of pollution, methods for measurement of pollution, Environmental management-problem solving approaches- its limitations.

**Module 2**

3. Biological wastewater treatment- Waste water characterization: COD, BOD,
4. Inorganic constituents, solids, biological components.
5. Principles and aims of biological wastewater treatment processes,
6. Biochemistry and microbiology of inorganic phosphorus and nitrogen removal.

**Module 3**

7. Suspended growth technologies: Activated sludge, oxidation ditches, waste stabilization ponds etc. Fixed film technologies: Trickling filters, rotating biological contactors, fluidized bed etc.
8. Anaerobic waste water treatment systems: RBC, UASB, Anaerobic filters.

**Module 4**

9. Environmental problems and treatment of industrial waste waters: Distillery, tannery, paper pulp etc.
10. Toxicity testing in waste water treatment plants.
11. Solid waste management: Anaerobic digestion, Composting.

**Module 5**

12. Biodegradation of organic pollutants:

Mechanisms and factors affecting biodegradation. Pollution problems and biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes, lignin and pesticides.

13. Bioremediation: Biostimulation and bioaugmentation , *In situ* and *ex situ* bioremediation technologies for various pollutants and sites. Bioremediation of oil spills and heavy metal pollution. Use of GMO in bioremediation. Biofilteration of polluted air.

**Module 6**

14. Biogeotechnology: Bioleaching of metals, biobeneficiation, microbially enhanced oil recovery, biodesulfurization of coal.
15. Microbes in the environment- Biofilms and its relevance in microbial survival, its effect in the environment.
16. Microbial Insecticides: Biopesticides. Bacterial, fungal and viral insecticides

## References


| | | | |
|---|---|---|---|
| 1. | Biotechnology – Fundamentals and application | SS Purohit SK Mathur | Agrobotanica, India |
| 2. | Agricultural Biotechnology | SS Purohit | Agrobotanica, India |
| 3. | Concepts in Biotechnology | Balasubraminan, Bryce, Dhramalingam, Jayraman | UTY Press. Hydrabad |
| 4. | Fungi In Biotechnology | Anil Praksah | CBS N. Delhi |
| 5. | Biotechnology | BD Singh | Kalyani Publishers |
| 6. | Environmental Biotechnology | Alan Scragg | Longman England |
| 7. | Biotechnology Unzipped | EricS grace | UTY Press. Hydrabad |
| 8. | Biotechnology | JE Smith | Cambridge UTY Press |


**Online resources**
Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER IV

**BT 403 FOOD AND DAIRY BIOTECHNOLOGY/ BASICS OF BIOPROCESS**

**TECHNOLOGY**

## Aim

- To introduce Food and Dairy biotechnology to non-biotechnology students
- To introduce the subject of bioprocess technology in details
- To explain the industrial aspects of Biotechnology for the production of various of industrial products of biological origin.

## Course Objectives

- The course explains the role of biotechnology in food and dairy technology.
- It gives details about the conversion of a small scale laboratory process in to a large scale industrial process.
- It also deals with the various important products produced by the bioprocess techniques.

## Course Outcome

At the end of the course the students will,

- Get a detailed insight into the industrial processes carrying out in the food and dairy sector as well as how to transfer a small scale laboratory process to a large scale industrial process.

### Basics of Bioprocess Technology

#### Module 1

1. Introduction to Bioprocess Technology – Scaling up of a Bioprocess , Upstream Processing , Downstream Processing,
2. Fermentation- Types of Fermentation, Its significance in Industry, Submerged Fermentation and Solid state fermentation, batch fermentation and continuous fermentation, Chemo stat Fermentation.

#### Module 2

3. Upstream Processing – Sterilization, Media Components, Cell cultures, its iisolation and maintenance, strain improvements –methods of strain improvements, inoculation of microorganisms
4. Upstream Processing – Importance of downstream processing and methods of downstream processing , centrifugation, filtration, precipitation, dialysis,, Chromatographic techniques- gel filtration, ion exchange chromatography and affinity chromatography, electrophoresis, capillary electrophoresis, Quality assurance techniques and its importance in marketing.

#### Module 3

5. Bioreactors - types of bioreactors , factors affecting the design of bioreactors
6. Industrial microorganisms and cultivation of microorganisms in bioreactors, Kinetics of microbial growth.
7. Culture media sterilization for industrial application. Air in Bioreactors, pH maintenance in bioreactors

**Module 4**

8. Down stream processing and purification of products
9. Industrial bio-production of chemicals - and antibiotics

**Module 5**
**Food and Dairy Biotechnology**

10. Introduction to Food Technology - application of biotechnology in food processing use of food modifying enzymes - amylase, proteases, lipases etc.
11. Elementary idea of canning and packing - sterilization and pasteurization of food products

**Module 6**

12. Introduction to Food microbiology, Dairy microbiology, Microbial processing of milk and milk products. Sterilization and Pasteurization of milk and dairy products, Fermentation of milk, biochemical and physical changes associated with the process- Industrial processing of milk and production of food products - bread, cheese, butter, ghee and other value added products.

## References


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|---|---|---|---|
| 1. | Modern Concepts in Biotechnology | HD Kumar | Vikas N. Delhi |
| 2. | Food Science | Potterr & Hotchkins | CBS N. Delhi |
| 3. | Food Microbiology | MR Adams and Moss | Panima N. Delhi |
| 4. | Food Processing- Biotechnological applications | Marwah &Arora | Asiatic Publ. N. Delhi |
| 5. | Biotechnology | JE Smith | Cambridge UTY Press |
| 6. | Perspectives in Nutrition | Gordon M Warlow | Mc Graw Hill NY |


**Online resources**
Authentic Web based resources like NCBI, PubMed, and Science direct etc.

**BT 404 PROJECT**

- Project work shall be assigned individually / a group of students not exceeding 4 nos.
- It must be carried out under the guidance of a faculty from the same college with or without an external guide OR in an external institution under the combined guidance of internal and external guides.
- The student has to submit the dissertation before the external examiner appointed by the University for Evaluation and may give a presentation on the project work, if asked for.

## BT 405 GENERAL VIVA VICE EXAMINATION

General viva voce on theoretical and practical aspects based on the courses covered from semester I to IV.