# SYLLABUS OF FOUR YEAR UNDER GRADUATE PROGRAMME

Department of Biotechnology, Bodoland University, Kokrajhar, Assam

**JUNE 18, 2024**
**BODOLAND UNIVERSITY**
**KOKRAJHAR, ASSAM**

**FYUGP STRUCTURE, DEPARTMENT OF BIOTECHNOLOGY, BU**

| Semester | Major paper | Minor paper | IDC | AEC | SEC | YAC | Internship | Project/Dissertation | Total Credits |
|---|---|---|---|---|---|---|---|---|---|
| **SEM I** | BITMAJ1014 Cell Structure and Dynamics | BITMIN1014 Introduction to Biotechnology | BITIDC1013 Bio-entrepreneurship | BITAEC1012 Language/Regional language | BITSEC1013 Instrumentation in Biotechnology | BITVAC1014 VAC I | | | 20 |
| **SEM II** | BITMAJ1024 Biomolecules | BITMIN1024 Basic Biochemistry | BITIDC1023 Bioethics and Biosafety | BITAEC1022 Language/Regional language | BITSEC1023 Plant and animal tissue culture techniques | BITVAC1024 VAC II | | | 20 |
| **SEM III** | BITMAJ2014 Cell Biology<br>BITMAJ2024 Microbiology | BITMIN2014 Biodiversity and Taxonomy | BITIDC2013 Intellectual Property Rights | BITAEC2012 Language/Regional language | BITSEC2013 Microbial Techniques | | | | 20 |
| **SEM IV** | BITMAJ2034 Molecular Biology<br>BITMAJ2044 Immunology<br>BITMAJ2054 Genetics | BITMIN2024 Plant Biotechnology | | BITAEC2022 Language/Regional language | | | BITINT2012 Internship | | 20 |
| **SEM V** | BITMAJ3014 rDNA Technology<br>BITMAJ3024 Bioinformatics<br>BITMAJ3034 Developmental Biology<br>BITMAJ3044 Biostatistics | BITMIN3014 Animal Biotechnology | | | | | | | 20 |
| **SEM VI** | BITMAJ3054 Genomics and Proteomics<br>BITMAJ3064 Industrial Biotechnology<br>BITMAJ3074 Environmental Biotechnology<br>BITMAJ3084 Agriculture Biotechnology | BITMIN3024 Bioprocess Technology | | | | | | | 20 |
| **SEM VII** | BITMAJ4014 Cell and Molecular Biology | BITMIN4014 Scientific Reporting and | | | | | | | 20 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BITMAJ4024 Advanced Biochemistry BITMAJ4034 Advanced Immunology BITMAJ4044 Advanced Genetics/ BITREM4044 Research Methodology | Project Management | | | | | | | |
| **SEM VIII** | BITMAJ4054 Microbial Biotechnology | BITMIN4024 Emerging Technologies | | | | | | BITREP40112 Dissertation/ BITADL4014 Gene Therapy; BITADL4024 Enzyme Technology; BITADL4034 Vaccine Biology | 20 |

**PROGRAMME OUTCOME OF FYUG:: DEPT. OF BIOTECHNOLOGY, BU**

PO1: The four year UG programme in biotechnology will enable the aspirants to demonstrate skill based knowledge to identify, formulate and solve the issues related to bio-industry, pharma industry, health driven technology, regulatory agency and also academia

PO2: The four year UG programme in biotechnology will enable the aspirants to pursue higher studies and research in biotechnology in blue biotechnology/white biotechnology/green biotechnology/red biotechnology

PO3: The four year UG programme in biotechnology will enable the aspirants to disseminate the principles of bioprocess engineering in design, analysis, optimization and simulation of bioprocess operations in various sectors

P.O 4: The four year UG programme in biotechnology will enable the aspirants to gain fundamental knowledge in animal and plant biotechnology and their applications.

P.O 5: The Students perusing the four year UG programme will find employment opportunities in pharma sectors, agri-sectors, environmental conservation, animal husbandry, ecology, textile industry, space technology etc

P.O 6: The students perusing the four year UG programme will be equipped to focus for creating new products from biological systems for human and animal welfare .

P.O 7: The Students perusing the four year UG programme will be equipped to harnesses cellular and biomolecular process driven energy to develop or to improvise technologies, products or servies to help improve lives, health and for welfare of human and animals

P.O 8: The Students perusing the four year UG programme will popularise biotechnology in rural masses to aware general mass about recent trends in biotechnology and its application in day to day life

P.O 9: The students perusing the four year UG programme will purse biotechnological ventures to boost bio-economy and to heal, feed, and fuel the world in sustainable way

## COURSE STRUCTURE

### FOUR YEAR DEGREE PROGRAMME :BIOTECHNOLOGY

| Paper Code | Paper type | Paper Name | Credits | Hours/Week | | | Total Marks (T50+P20+IA30) |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| **SEMESTER I** | | | | | | | |
| BITMAJ1014 | MAJOR | Cell structure and dynamics | 4 | 3 | 0 | 1 | 100 |
| BITMIN1014 | MINOR | Introduction to Biotechnology | 4 | 3 | 0 | 1 | 100 |
| BITIDC1013 | IDC | Bio-entrepreneurship | 3 | 2 | 0 | 1 | 100 |
| BITAEC1012 | AEC | Language/ Regional language | 2 | 2 | 0 | 0 | 100 |
| BITSEC1013 | SEC | Instrumentation in Biotechnology | 3 | 2 | 0 | 1 | 100 |
| BITVAC1014 | VAC | VAC-1 | 4 | | | | 100 |
| | | **Total Credits** | **20** | | | | |
| **SEMESTER II** | | | | | | | |
| BITMAJ1024 | MAJOR | Biomolecules | 4 | 3 | 0 | 1 | 100 |
| BITMIN1024 | MINOR | Basic Biochemistry | 4 | 3 | 0 | 1 | 100 |
| BITIDC1023 | IDC | Bioethics and Biosafety | 3 | 2 | 0 | 1 | 100 |
| BITAEC1022 | AEC | Language/ Regional language | 2 | 2 | 0 | 0 | 100 |
| BITSEC1023 | SEC | Plant and Animal tissue culture techniques | 3 | 2 | 0 | 1 | 100 |
| BITVAC1024 | VAC | VAC-2 | 4 | | | | 100 |
| | | **Total Credits** | **20** | | | | |
| **SEMESTER III** | | | | | | | |
| BITMAJ2014 | MAJOR | Cell Biology | 4 | 3 | 0 | 1 | 100 |
| BITMAJ2024 | MAJOR | Microbiology | 4 | 3 | 0 | 1 | 100 |
| BITMIN2014 | MINOR | Biodiversity and Taxonomy | 4 | 3 | 0 | 1 | 100 |
| BITIDC2013 | IDC | Intellectual Property Rights | 3 | 2 | 0 | 1 | 100 |
| BITAEC2012 | AEC | Language/ Regional language | 2 | 2 | 0 | 0 | 100 |
| BITSEC2013 | SEC | Microbial Techniques | 3 | 2 | 0 | 1 | 100 |
| | | **Total Credits** | **20** | | | | |
| **SEMESTER IV** | | | | | | | |
| BITMAJ2034 | MAJOR | Molecular Biology | 4 | 3 | 0 | 1 | 100 |
| BITMAJ2044 | MAJOR | Immunology | 4 | 3 | 0 | 1 | 100 |
| BITMAJ2054 | MAJOR | Genetics | 4 | 3 | 0 | 1 | 100 |
| BITMIN2024 | MINOR | Plant Biotechnology | 4 | 3 | 0 | 1 | 100 |
| BITAEC2022 | AEC | Language/ Regional language | 2 | 2 | 0 | 0 | 100 |
| BITINT2012 | INT | Internship | 2 | - | - | - | 100 |
| | | **Total Credits** | **20** | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SEMESTER V** | | | | | | | |
| BITMAJ3014 | MAJOR | rDNA Technology | 4 | 3 | 0 | 1 | 100 |
| BITMAJ3024 | MAJOR | Bioinformatics | 4 | 3 | 0 | 1 | 100 |
| BITMAJ3034 | MAJOR | Developmental Biology | 4 | 3 | 0 | 1 | 100 |
| BITMAJ3044 | MAJOR | Biostatistics | 4 | 3 | 0 | 1 | 100 |
| BITMIN3014 | MINOR | Animal Biotechnology | 4 | 3 | 0 | 1 | 100 |
| | | **Total Credits** | **20** | | | | |
| **SEMESTER VI** | | | | | | | |
| BITMAJ3054 | MAJOR | Genomics and Proteomics | 4 | 3 | 0 | 1 | 100 |
| BITMAJ3064 | MAJOR | Industrial Biotechnology | 4 | 3 | 0 | 1 | 100 |
| BITMAJ3074 | MAJOR | Environmental Biotechnology | 4 | 3 | 0 | 1 | 100 |
| BITMAJ3084 | MAJOR | Agriculture Biotechnology | 4 | 3 | 0 | 1 | 100 |
| BITMIN3024 | MINOR | Bioprocess Technology | 4 | 3 | 0 | 1 | 100 |
| | | **Total Credits** | **20** | | | | |
| **SEMESTER VII** | | | | | | | |
| BITMAJ4014 | MAJOR | Cell and Molecular Biology | 4 | 3 | 0 | 1 | 100 |
| BITMAJ4024 | MAJOR | Advanced Biochemistry | 4 | 3 | 0 | 1 | 100 |
| BITMAJ4034 | MAJOR | Advanced Immunology | 4 | 3 | 0 | 1 | 100 |
| BITMAJ4044 | MAJOR | Advanced Genetics | 4 | 3 | 0 | 1 | 100 |
| | | OR | | | | | |
| BITREM4044 | MAJOR | Research Methodology | 4 | 3 | 0 | 1 | 100 |
| BITMIN4014 | MINOR | Scientific Reporting and Project management | 4 | 3 | 0 | 1 | 100 |
| | | **Total Credits** | **20** | | | | |
| **SEMESTER VIII** | | | | | | | |
| BITMAJ4054 | MAJOR | Microbial Biotechnology | 4 | 3 | 0 | 1 | 100 |
| BITMIN4024 | MINOR | Emerging Technologies | 4 | 3 | 0 | 1 | 100 |
| BITADL4014 | MAJOR | Gene therapy | 4 | 3 | 0 | 1 | 100 |
| BITADL4024 | MAJOR | Enzyme Technology | 4 | 3 | 0 | 1 | 100 |
| BITADL4034 | MAJOR | Vaccine Biology | 4 | 3 | 0 | 1 | 100 |
| | | OR | | | | | |
| BITREP40112 | MAJOR | Dissertation/Research Project | 12 | 0 | 0 | 0 | 100 |
| | | **Total Credits** | **20** | | | | |

**Paper Name: CELL STRUCTURE AND DYNAMICS**

| Paper Code: BITMAJ1014 | Semester: I |
|---|---|
| Type: MAJOR | Credit: 4 (3L+1P) |
| Total Classes: 60= 45+15 (L+P) | Total Marks: 100 (T50+P20+IA30) |

**Course Objective:**

To gain the knowledge related to the basics of different types cell structure and morphology

**Course Outcomes (CO):**

**CO1:** Upon completion of the course, the student will be able to understand the structural organization of a prokaryotic and eukaryotic cell.

**CO2:** The learner shall know the origin/biogenesis of the cell components

**Theory: 45 lectures**

**Unit 1: Origin of life on Earth** **5 lectures**

The theory of Extra-terrestrial contact - import of life through meteorites. Theory of Chemical Evolution, Abiotic formation of sugars, amino acids, organic acids, purines, pyrimidines, glycerol and formation of nucleotides and their polymerization to RNA on reactive Surfaces, polymerization of amino acids to Polypeptides and Proteins. Ribozymes and RNA World. Formation of DNA, Formation of nucleoproteins, Prions, Natural Selection of Self-replicating Polymers.

**Unit 2: Basic cell structure** **5 lectures**

Discovery of cell and Cell Theory; Prokaryotic and Eukaryotic cell.

**Unit 3: Prokaryotic cell and its components** **10 lectures**

The Slime and the cell wall of bacteria containing peptidoglycan and related molecules; the outer membrane of Gram-negative bacteria, the cytoplasmic membrane. Water and ion transport, mesosomes, flagella, Pilus, fimbriae, ribosomes, carboxysomes, sulphur granules, glycogen, polyphosphate bodies, fat bodies, gas vesicles; endospores, exospores, cysts. Mycelia of fungi and Actinomycetes, Cytoskeleton filament, heterocysts and akinetes of Cyanobacteria, Gliding and motility.

**Unit 4: Eukaryotic cell and its components** **15 lectures**

Comparison between plant and animal cells; Cell wall; Plasma membrane; Models of membrane structure; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex; Lysosome, endosome and microbodies; Ribosome; Centriole; Nucleus. Biogenesis of Cellular organelles viz mitochondria, chloroplast, ER, Golgi complex;

**Practical:** **15 lectures**

1. To study the structure of any prokaryotic cell under the microscope
2. To study the structure of any plant cell under the microscope

3. To study the structure of any plant cell under the microscope
4. Observation of vacuoles (using onion epidermis/rose leaf etc)
5. Observation of mitochondria (using onion epidermis/root tips etc)
6. Study the effect of temperature and organic solvents on semi permeable membrane.

***Suggested readings:***


- *Microbiology- Prescott LM, Harley JP, Klein DA, Wm. C. Brown Publishers*
- *Microbiology: Tortora, G.J., Funke, B.R. and Case, C.L An Introduction Pearson Education.*
- *Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.*
- *De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8$^{th}$ edition. Lippincott Williams and Wilkins, Philadelphia.*
- *Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.*
- *Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7$^{th}$ edition. Pearson Benjamin Cummings Publishing, San Francisco.*

| Paper Name: INTRODUCTION TO BIOTECHNOLOGY | |
|---|---|
| **Paper Code: BITMIN1014** | **Semester: I** |
| **Type: MINOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

To provide foundation in biotechnology by offering students with theoretical and working knowledge of the various principles and techniques employed in biotechnology.

**Course Outcomes (CO):**

**CO1:** Shall learn to apply various tools of biotechnology in agriculture, environment and food sciences.

**CO2:** Understand and solve biological and ecological problems and harness potential of living systems for the benefit of human mankind.

**Theory: 45 lectures**

**Unit 1: Scope and Introduction to Biotechnology 10 lectures**

Historical perspective & Definitions of Biotechnology, Traditional and Modern Biotechnology, Overview of Branches of Biotechnology: Plant, Animal Biotechnology, Marine Biotechnology, Agriculture, Healthcare, Industrial Biotechnology, Pharmaceutical Biotechnology, Environmental Biotechnology, Medical Biotechnology.

**Unit 2: Applications of Biotechnology in Agriculture 15 lectures**

Overview of Applications of Biotechnology in Agriculture: GM Food, GM Papaya, GM Tomato, Fungal and Insect Resistant Plants, BT Crops, BT Cotton and BT Brinjal, Pros and Cons. Biotechnological applications in enhancement of Food Quality, Quality Factors in Pre-processed Food, Microbial role in food products (Yeast and Bacterial based process and products).

**Unit 3: Applications of Biotechnology in Environment 10 lectures**

Overview of Applications of Biotechnology in Environment: Solid Waste Management, Biopesticides, Biofertilizers and Biofuels, Bioremediation.

**Unit 4: Research in Biotechnology 10lectures**

Overview of Biotechnology Research in India. Ethical Issues in Biotechnology. Biosensors and Tissue engineering. Overview of Biotechnology Institutions in India (Public and Private Sector)

**Practical: 15 lectures**

1. Safety, Check-in, Laboratory record keeping
2. Introduction to various laboratory instruments
3. Pipetting techniques
4. Preparation of Solutions, buffers etc
5. Sterilization techniques

***Suggested Readings:***


- *McGregor, C.W.; Membrane separation in Biotechnology; Marcel Dekker, Inc, New York.*
- *Frieferder, S.; Physical Biochemistry; Freeman and Co., New York.*
- *Biotol Series (I - IV); Techniques used in Bioproduct Analysis; ButerworthHeineman,U.K.*
- *Work, T.S.; Lab. Techniques in Biochemistry and Molecular Biology, Elsevier, New York.*
- *Microbiology: Michael J. Pelczar Jr., E. C. S Chan, Noel R. Krieg*
- *Smith J. E., Biotechnology, 3rd Edition, Cambridge University Press (2006 )*

| Paper Name: BIO-ENTREPRENEURSHIP | |
|---|---|
| **Paper Code: BITIDC1013** | **Semester: I** |
| **Type: IDC** | **Credit: 3 (2L+1P)** |
| **Total classes: 45= 30+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objectives:** This bioentrepreneurship course equips students to navigate the world of launching bio-based ventures. They'll gain hands-on skills in producing and analyzing microbial products while learning to strategically apply these products for societal benefit. The course also explores the essential skills and support systems available to bioentrepreneurs and highlights the wealth of entrepreneurial opportunities in the industry.

**Course Outcome:**

**CO1:** Understand skills and the role of various institutional support for an entrepreneur.

**CO2:** Understand the procedure for preparing various microbial products.

**CO3:** Acquire knowledge and analyze the applications of microbial products for human well being.

**CO4:** Retain knowledge of microbiology in entrepreneur development.

**CO5:** Understand formulate the strategy to apply the industrially important products in society.

**Theory: 30lectures**

**Unit I: INTRODUCTION TO ENTREPRENEUR 6 lectures**

Evolution of the concept of entrepreneur – Entrepreneurship; Definitions- concept of Entrepreneurship, development- need- role of resource, talent and spirits – process of Entrepreneurship to socio- economic gains.

**Unit II: SCHEMES FOR ENTREPRENEUR 6 lectures**

Institution and schemes of government of India- scheme and programmes, department of science and technology schemes, nationalized banks – other financial institution- SIDBI- NSIC- NABARD- IDBI- IFCI and ICICI.

**Unit III: NEGOTIATIONS/STRATEGY 6 lectures**

With financiers, bankers etc.; with government/law enforcement authorities; with companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes;Crisis/ Avoiding/Managing; Broader vision–Global thinking.

**Unit IV: MICROBIAL PRODUCTS 6 lectures**

Bread baking bread – leavening- baking process- idli- dosa, fermented products, mushroom cultivation and composting, preparation of compost, filling tray beds – spawing, maintaining optimum temperature, casing, watering, harvesting, storage. Biofertilizer – historical background, chemical fertilizer versus biofertilizer, organic farming, Rhizobium sp, Azospirullumsp, Azotobactersp as biofertilizer.

**Unit V: ROLE OF KNOWLEDGE CENTRE AND R&D** **6 lectures**

Support mechanism for entrepreneurship in India; Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies.

**Practicals** **15 lectures**

1. Preparation of Proposal with novel idea
2. Preparation of SWOT analysis of the proposed idea
3. Preparation of a comprehensive report on the funding sources in India
4. Preparation of a comprehensive report on the funding sources in abroad
5. Preparation of documents needed for Grand-Aid/Extramural/Seed grant requirements from various agencies
6. Identification of novel products from Bacteria
7. Identification of novel products from Fungi
8. Identification of novel products from Plants
9. Development of product and analysis the strategy
10. Preparation of patent application with five claims

***Suggested Readings:***


1. *Mohanty, S.K., ―Fundamentals of Entrepreneurship‖, Sixth Edition, Prentice Hall India Private Limited, New Delhi, 2005.*
2. *Saxena, S., ―Applied Microbiology‖, Springer, New York, 2015.*
3. *Bhatia, B.S. and Batra, G.S., ―Entrepreneurship and small business management‖, Deep & Deep Publications, New Delhi, 2003.*
4. *Hisrich, D.R., ―Entrepreneurship‖, Sixth Edition, Tata McGraw Hill Private Limited, New Delhi, 2008.*
5. *Nagendra, S., ―Entrepreneurship and Management‖, Sanguine technical Publishers, New Delhi, 2008.*
6. *Okafor, N., ―Modern Industrial Microbiology and Biotechnology‖, Second Edition, Science Publishers, New Hampshire, 2007.*

| Paper Name: INSTRUMENTATION IN BIOTECHNOLOGY | |
|---|---|
| **Paper Code: BITSEC1013** | **Semester: I** |
| **Type: SEC** | **Credit: 3 (2L+1P)** |
| **Total Classes: 45= 30+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective**:

This paper will provide an in-depth understanding of various scientific instruments used for analysis of biological samples.

**Course Outcomes (CO)**:

**CO1:** Apply the analytical methods in Biotechnology Industries

**CO2:** Understand the principle and trouble shootings in the analytical instruments.

**Theory: 30 lectures**

**Unit 1: Microscopy** **10 lectures**

Basic Principles and application of Simple Microscope, Compound Microscope, Transmission and Scanning Electron Microscopes; Principles of Fixation and Staining.

**Unit 2: Optical Methods of Analysis** **2 lectures**

Beer-Lambart Law, Basic Principles and application of Colorimeter and UV-Visible Spectrophotometer.

**Unit 3: Chromatographic Methods of Analysis** **5 lectures**

Working Principle, instrumentation and Application of Paper, Thin Layer, Column and High-Pressure Liquid Chromatography

**Unit 4: Electrophoretic Techniques** **10 lectures**

Principle and factors affecting Electrophoresis-pH, voltage, supporting medium in Agarose Gel Electrophoresis, PAGE, SDS-PAGE

**Unit 5:Centrifugation** **3 lectures**

Principle of Centrifugation, differential and density gradient centrifugation, ultracentrifugation, sedimentation analysis and RCF

**Practical:** **15 lectures**

1. Sample preparation, Plant and Animal Tissue fixation and staining technique and microscopic study
2. Quantitative analysis of biological samples by colorimetric/ spectrophotometric methods
3. Separation of amino acids by Paper and Thin Layer Chromatography
4. Electrophoretic separation of nucleic acids/ proteins.

***Suggested Readings****:*


- *Wilson and Walker: Principles and Techniques in Practical Biochemistry, Cambridge University Press*
- *Jayaram: Laboratory Manual in Biochemistry, New Age International Publications.*

| Paper Name: WASTE AND ENERGY MANAGEMENT | |
|---|---|
| **Paper Code: BITVAC1014** | **Semester: I** |
| **Type: VAC** | **Credit: 4**<br>**NCC/NSS-2 + 2 (1L+1P)** |
| **Total Contact hours: 30= 15+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Objective:**

**The objective of the paper is to encourage trash to gold and the concept shall explore the genesis of circular economy.**

**Course Outcomes (CO):**

**CO1: The paper shall enable the students to learn utilize the waste material for initiating entrepreneurship**

**CO2: The paper shall enable the student to understand how important is waste and how waste can be cheaper raw materials to initiate a process**

**Theory: 15 lectures**

**Unit 1:Introduction and future perspectives of waste and energy management5 lectures**

Identification of waste streams in your area, mushroom cultivation on different agricultural wastes, Gobar Gas, Vermicompost, Bioleaching and biohydrometallurgy, pyrolysis, biofertilizers from organic wastes.

**Unit 2: Waste sources, classification and characterization7lectures**

Waste production in domestic, industrial, agriculture, postconsumer waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria.

**Unit 3: Identifying alternative source of energy and mitigation 3 lectures**

Biofuel, Bioethanol production, hydroenergy, green energy, solar energy

**Practical: 15 Lectures**

1. Cultivation of Banana and the stem of the Banana in utilization of Vermicomposting
2. Culture of Earthworm *(Eiseniafetida)*
3. Gobar and utilization in methane gas genesis
4. Areaca nut leaf plate making
5. Formation of ethanol from waste of sugarcane

*Suggested readings:*


1. *Industrial and Urban Waste Management in India, TERI Press.*
2. *Wealth from Waste: Trends and Technologies by Banwari Lal and Patwardhan, TERI Press.*
3. *Fundamentals of waste and Environmental Engineering, S.N Mukhopadhyay, TERIPress.*

4. *Gazette Notification on Waste Management Rules 2016.*
5. *Report of the task Force on Waste to Energy, NitiAyog (Formerly Planning Commission) 2014.*
6. *Municipal Solid Waste Management Manual, CPHEEO, 2016*

| Paper Name: BIOMOLECULES | |
|---|---|
| **Paper Code: BITMAJ1024** | **Semester: II** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**COURSE OBJECTIVE:**

This course aims to equip students with a foundational understanding of life's building blocks, exploring the structures and functions of various molecules. It delves into the fundamentals of biochemistry and molecular biology, ultimately enabling students to grasp genetic principles.

**COURSE OUTCOME:**

**CO1:** After the completion of the course students will understand significance water as a solvent of life and know the relationship with biomolecules.

**CO2:** Understand the structure and function of proteins as building block of life.

**CO3:** Understand the knowledge on carbohydrates as monosaccharides and polysaccharides.

**CO4:** Understand the structures, function, and classification of lipids.

**CO5:** Understand the structure of nucleic acids, along with basic steps in the processing of genetic engineering.

**Theory: 45 lectures**

**Unit I: Chemical bonds and biomolecules 5 lectures**

Physical properties and hydrogen bonding of water; structure of water and its solvent properties; hydrophobic interactions. Ionization of water and ion product of water; the pH scale; relationship between pH and pKa (HendersonHasselbalch equation); buffers and its properties.

**Unit II: Protein 10 lectures**

Biological functions of proteins; structure of alpha-amino acids, abbreviations and classification of 20 amino acids; zwitterion nature of amino acid in aqueous solutions; essential amino acids; peptide bond formation; backbone structure of Proteins/polypeptides; basic understanding of primary, secondary, tertiary, and quaternary structure of proteins/peptides; fibrous and globular proteins; elementary ideas on protein denaturation and renaturation.

**Unit III: Carbohydrates 10 lectures**

Definition and biological functions of carbohydrates; classification into monosaccharides, oligosaccharides and polysaccharides; optical isomerism, open chain and ring structures of carbohydrates; mutarotation; structure of biologically important carbohydrates (D-glucose, D-galactose, D-mannose, Dfructose, D-ribose, D-2-deoxyribose, D-maltose, D-lactose, D-

sucrose); polysaccharides starch, cellulose, glycogen and mucopolysaccharides; suitability of polysaccharides as storage material.

**Unit IV: Lipids** **10 lectures**

Introduction of lipids, biological functions; general formulae, nomenclature and properties of fatty acids; essential and non-essential fatty acids; classification of lipids; general structure and function of major lipid subclasses: acylglycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins; saponifiable and non-saponifiable lipids; suitability of triglycerides as storage lipids; saponification number and iodine number; bio membranes structure.

**Unit V: Nucleic acid** **10 lectures**

Nucleosides and nucleotides; generalized structural plan of nucleic acids. Evidence of DNA as genetic material; Watson-Crick model of DNA; size of DNA in prokaryotic and eukaryotic cells. Central dogma of molecular biology; gene, genome and chromosome. Basic ideas of DNA replication, transcription and protein biosynthesis; genetic code and codons. RNA structure and functions, types of DNA and RNA.

**Practicals** **15 lectures**

1. Preparation of Phosphate Buffer Saline at pH7.
2. Qualitative analysis of proteins from given samples.
3. Qualitative analysis of carbohydrates from given samples
4. Qualitative analysis of Lipids from given samples
5. Qualitative analysis of Nucleic acid from given samples
6. Protein estimation by Lowry's method.

***Suggested Readings:***


1. *Lehninger: Principles of Biochemistry (2017) by Nelson and Cox. Seventh edition. WH Freeman and Co. 2. Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition. WH Freeman and Co.*
2. *Outlines of Biochemistry by Conn and Stumpf (5th Edition, 1987) Wiley, New Delhi.*
3. *Introducing Biochemistry (1982) by Wood and Pickering. ELBS/John Muray.*
4. *Nelson D. L, Cox M. M. Lehninger's Principle of Biochemistry. 5th Ed.,W. H. Freeman, 2008.*
5. *Martin D. W, Mayer P. A. and Rodwell V. W. Harper's Review of Biochemistry 30th Ed., Maruzen Asian Lange Med.,2010.*
6. *Dixon M, Webb E. C,Thorne C.J.R and Tipton K.F.Enzymes. 3rd Ed., Longmans, Green &Co.,Academic Press, New York, 1979.*
7. *Wilson K., Walker J, Practical biochemistry Fifth Edition Cambridge Press.*
8. *R David Freifelder., Physical biochemistry: Application to biochemistry and Molecular biology Second edition. W.H. Freeman and Company, New York.*

| Paper Name: BASIC BIOCHEMISTRY | |
|---|---|
| **Paper Code: BITMIN1024** | **Semester: II** |
| **Type: MINOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**COURSE OBJECTIVE:**

This course dives into core principles and experimental foundations of biochemistry. Students gain specialized knowledge through lectures and research projects. The curriculum explores energy pathways (glycolysis, TCA cycle, gluconeogenesis) , fatty acid metabolism, and the mechanics of photosynthesis

**COURSE OUTCOME:**

**CO1:** Provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis

**CO2:** Enable students to acquire a specialized knowledge and understanding of selected aspects by means of a stem/branch lecture series and a research project.

**CO3:** Studentss acquire knowledge in energy yielding pathways such as Glycogen metabolsim, TCA cycles and Gluconeogenesis

**CO4:** Students will acquire knowledge in fatty acid metabolism

**CO5:** Students will learn the mechanism of photosynthetic process

**Theory: 45 lectures**

**Unit I: Water, acids, bases and buffer** **10 lectures**

Dissociation of water, ionic product of water, concepts of pH, pOH, simple numerical problems of pH, determination of pH using indicators, pH meter and theoretical calculations. Dissociation of weak acids and electrolytes, Brönsted theory of acids and bases, shapes of titration curve of strong and weak acids and bases. Meaning of Ka and pKa values, buffers and buffer action. Buffers in biological system, Henderson -Hasselbalch equation with derivation, simple numerical problems involving application of this equation, simple numerical problems on buffer composition.

**Unit II: Metabolism I:Glycolysis and Gluconeogenesis** **8 lectures**

Carbohydrate metabolism: Embden-Meyerhof pathway, regulation of glycolysis in Liver and Muscles, fermentation, anaerobic fate of pyruvate, Entry of different sugars in glycolysis, gluconeogenic pathway and its regulation

**UnitIII: Metabolism II: Glycogen metabolism, TCA cycle and electron transport chain**

**7 lectures**

Glycogen metabolism (glycogenolysis and glycogenesis), regulation of glycogen metabolism, TCA cycle and its regulation- ATP production. Electron transport chain system: ATP synthase structure and function, Boyer's conformational model.

**UnitIV: Fatty acid and amino acid metabolism 10 lectures**

Lipid Metabolism: Lipolysis, β-oxidation, energy yield, role of Carnitine. Essential aminoacids, nonessential aminoacids, glucogenic and ketogenic amino acids, amino acids biosynthesis (glutamate, glutamine, alanine, aspartate, asparagine serine, glycine, praline, cysteine, tyrosine), pathways of amino acids degradation (acetyl CoA family α- ketoglutarate family, succinyl CoA family), Urea cycle.

**Unit V: Photosynthesis 10 lectures**

Introduction, Significance, Historical aspects, Photosynthetic pigments, Concept of two photosystems, Light phase: Cyclic and Non cyclic photophosphorylation (z scheme), Dark phase: Calvin cycle (C3), Hatch and slak cycle (C4) and CAM pathway, Photorespiration (C2 cycle), significance of Photosynthesis.

**Practicals 15 lectures**

1. Introductory class for biochemistry lab instrumentations.
2. pH measurements and preparation of buffers.
3. Qualitative tests for Carbohydrates.
4. Estimation of reducing sugars.
5. Estimation of proteins by Biuret method
6. Estimation of cholesterol by Zak's method.

***Suggested Readings:***


1. *Biochemistry by LubertStryer. W. H. Freeman & Company, NY, 2000 2. Biochemistry by Lehninger. McMillan publishers, 2003 3.*
2. *Biochemistry by Zubey. Wm. C. Brown publishers, 2007*

| Paper Name: BIOETHICS AND BIOSAFETY | |
|---|---|
| **Paper Code: BITIDC1023** | **Semester: II** |
| **Type: IDC** | **Credit: 3 (2L+1P)** |
| **Total Classes: 45= 30+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objectives:**

To introduce basic concepts of ethics and safety that is essential for Life Science Labs.

**Course Outcomes (CO):**

**CO1:** Know about the biosafety regulations and ethical concepts in biotechnology.

**CO2:** Understand the importance of bioethics and biosafety procedures to be followed, with knowledge of the basic concepts, its principles, and use.

**CO3:**Recognize the importance of biosafety practices and guidelines in research.

**Theory: 30 lectures**

**Unit 1: Bioethics** **10 lectures**

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies. Legal and socioeconomic impacts of biotechnology, health and safety issues.

**Unit 2: Biosafety** **10 lectures**

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Objectives, Risk assessment in biotechnological research and their regulation, physical and biological contaminants, field trial and planned introduction of GMOs.

**Unit 3: Biosafety Guidelines** **10 lectures**

Biosafety guidelines in India, Biosafety levels for plant, animal and microbial researches. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

**Practical:** **15 lectures**

1. General safety measures and study of safety notices
2. Study of symbols and warnings on reagent bottles
3. Study of preventive measures and first aid during laboratory hazards
4. Demonstration of handling of fire extinguisher
5. Case study on handling and disposal of radioactive waste
6. Case study on handling and disposal of medical/microbial waste
7. Study of components and design of a Biosafety laboratory

***Suggested Readings / Books***

- *Bioethics and Biosafety in Biotechnology by Sree Krishna V., New Age International (P) Ltd., Publ., Mumbai. 2007*
- *The Indian Environmental Protection Act (EPA), 1986*
- *Rules for manufacture, use/import/export and storage of hazardous microorganisms or cells Act, 1989*
- *Food Safety and Standards act (Government of India), 2006*

| Paper Name: PLANT AND ANIMAL TISSUE CULTURE TECHNIQUES | |
|---|---|
| **Paper Code: BITSEC1023** | **Semester: II** |
| **Type: SEC** | **Credit: 3 (2L+1P)** |
| **Total Classes: 45= 30+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

This paper shall enable the students to understand the plant and animal tissue-based application and utility which opens the scope for various scale ups and start-ups.

**Course Outcomes (CO):**

**CO1:** Learners will be acquainted with the laboratory knowledge and skill for plant tissue culture-based research

**CO2:**This course shall help the students to know about the functional utility of various animal tissue application including insights in medical biotechnology and diagnostics

**Theory: 30 lectures**

**Unit 1**: **Introduction to tissue culture** **8 lectures**

Introductory history, Laboratory organization, Cell culture, Cellular Totipotency, Somatic Embryogenesis.

Composition of culture media, Growth hormones, Vitamins, Unidentified supplements, selection of media

**Unit 2: Plant tissue culture techniques** **7 lectures**

Preparation steps for tissue culture, surface sterilization of plant tissue material, sterilization of medium components, basic procedure for aseptic tissue transfer, incubation of culture. Callus Culture, Cell Suspension Culture, Organ Micro-culture, plant micro-propagation, Somatic Embryogenesis, Artificial seed.

**Unit 3: Introduction to laboratory set up for animal tissue culture** **7 lectures**

Understanding Laboratory set up for animal tissue culture. Various media of animal tissue culture. Understanding various instruments like Laminar Air Flow Cabinet, Bio safety Cabinet, Autoclave, Centrifuge, CO2 Incubator etc.

**Unit 4: Animal tissue culture** **8 lectures**

Karyotype, soma clonal studies. Primary and Secondary culture, monolayer and suspension culture. Various hormones and bioactive components and their utility. Application of animal tissue culture. Tissue grafting

**Practical:** **15 lectures**

1. Handling of autoclave, LAF, centrifuge etc
2. Preparation of different types of plant tissue culture media
3. Preparation of various media for animal tissue culture.
4. Sterilization of medium components and other tools used in plant and animal tissue culture.
5. Initiate a callus culture
6. Preparation of artificial seed
7. Culture of lymphocyte for karyotype

***Suggested readings:***


- *Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.*
- *Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.*
- *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications: R. Ian Freshney:: John Wiley & Sons, Inc.*
- *Animal Cell Culture: A Practical Approach:John Masters::Publisher : OUP Oxford*
- *Animal Cell Culture: Concept and Application:Sheelendra M. Bhatt :Publisher : Alpha Science International Ltd*
- *Animal Tissue Culture:P Ramadass and A Wilson Aruni:Publisher : Mjp Publishers*

| Paper Name: SERICULTURE | |
|---|---|
| **Paper Code: BITVAC1024** | **Semester: II** |
| **Type: VAC** | **Credit: 4**<br>**NCC/NSS-2 + 2 (1L+1P)** |
| **Total Contact hours: 30= 15+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

**The objective of the paper is to encourage students to know about host plant of silk and also various species of silk worm including weaving**

**Course Outcomes (CO):**

**CO1: The paper shall enable the students to learn and utilize the bioresource for production of silk.**

**CO2: The students shall be equipped with the knowledge of sericulture starting from rearing to post-cocoon technology and weaving.**

**CO3:The paper shall enable the student to understand the utility of host plant of silk work**

**Theory: 15 lectures**

**Unit 1: Introduction to Sericulture 5Lectures**

Origin and history of sericulture, Characteristic features of the order Lepidoptera, Life cycle of *Samiacynthiaricini* (Eri) and *Antheraeaassama*(Muga), anatomical structure of silk gland, Food habits of silkworms, different varieties of mulberry with special reference to Assam, silkworm as food, thread spinning, Diseases of silkworm and its control, Perspectives of sericulture and textile industry, Role of women in sericulture.

**Unit 2: Silkworm Rearing 5 lectures**

**Rearing appliances, disinfection, disinfectants, bed cleaning, feeding of worms. Maintaining optimum condition of rearing, brushing, frequency of spacing, care during mounting. Mounting and mountage, process of spinning, cocoon harvesting. Rearing method: chawki rearing or young age worm rearing. Late age Silkworm rearing.**

**Unit 3:Post Cocoon Technology and Silk Technology 5 lectures**

Cocoon stifling (sun drying, steam stifling, hot air stifling), storage of cocoon, sorting of cocoons. Deflossing, cocoon riddling, mixing or blending, cocoon cooking, brushing. Concept of different reeling machines, reeling operation, reeling end formation. Degumming, bleaching, dyeing of silk yarn. Twisting, Reeling, Re-reeling, lacing, skeining and testing of raw silk material.Weaving of silk.

**Practical: 15 lectures**

1.Selection and plantation of host plant of Silk worm

2.Rearinig of silk worm.

3.Spining of thread of cocoon

4. Weaving cloths with the threads spined from the silk

***Suggested Readings:***


1. *Rangaswami, G.; Narasimhanna, M.N.; Kasiviswanathan, K., Sastry, C.R. And Jolly, M.S. (1976) Sericulture Manual-1- Mulberry Cultivation. Agriculture Services Bulletin, FAO, Rome.*
2. *Rajanna, L., Das, P.K., Ravindran, S., Bhogesha, K., Mishra, R.K., Singhvi, N.R., Katiyar, R.S. and Jayaram, H. (2005) Mulberry Cultivation and Physiology. Central Silk Board, Bangalore.*

| Paper Name: CELL BIOLOGY | |
|---|---|
| **Paper Code: BITMAJ2014** | **Semester: III** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

The objective of the cell biology course is to provide students with a comprehensive understanding of the fundamental principles and mechanisms of cellular organization, function, and communication.

**Course Outcomes (CO):**

**CO1:** Understand the basic structure and functions of cells, including the plasma membrane, organelles, and cytoskeleton.

**CO2:** Explain the process of cell division and cell differentiation.

**CO3:** Describe the mechanism of cellular communication and signaling, including the role of receptors, hormones, and second messengers.

**CO4:** Discuss the cellular basis of disease, including the mechanism of cell death and the role of cellular process in disease pathogenesis.

**CO5:** Understand the fundamental practical experiments that are conducted in the field of cell biology, particularly those that pertain to significant topics.

**Theory: 45 lectures**

**Unit 1: Introduction to cell structure** **10 Lectures**

History of the discovery of the cell, cell as the structural and functional unit of life, cell theory, the structure of prokaryotic, and eukaryotic cells, microscopic techniques for the study of cells, plasma membrane structure and functions, membrane composition and dynamics, transport of ions and macromolecules, membrane vacuolar system.

**Unit 2**: **Cell Organelles** **10 Lectures**

Cell organelles and their structure and functions: structure and functions of Mitochondria, Chloroplast, Nucleus, Gogi body, Endoplasmic reticulum, Lysosome, Peroxisome, and Ribosome. Origin of Mitochondria and Chloroplast.

**Unit 3: Cell Division and Cell Death:** **9 Lectures**

Mitosis, Meiosis, Cell Cycle, and its regulation, Diseases caused due to the dysregulation of cell division and cell cycle, Cell division in prokaryotes; Cell death mechanisms: Necrosis, Apoptosis, Autophagy; Clearance of dead cells: Efferocytosis.

**Unit 4**: **Extracellular Matrix and Cell Signalling** **16 Lectures**

Composition, molecules that mediate cell adhesion, membrane receptors for extracellular matrix, macromolecules, regulation of receptor expression and function. Cell-to-cell communications; overview- types of cell-signaling- mechanism of various types of signal transduction pathways of cells.

**Practical:** **15 Lectures**

1. Study of the structure of any Prokaryotic and Eukaryotic cell.
2. Study the effect of temperature and organic solvents on the plasma membrane.
3. Preparation of Nuclear, Mitochondrial & Cytoplasmic fractions.
4. Study of mitosis.
5. Study of meiosis.
6. Total cell count by suitable method

***Suggested readings:***


- *Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.*
- *Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.*
- *Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007*
- *Karp, G, Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc, 2010.*
- *Becker, W.M et al., The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco, 2009.*
- *Albert Bruces et al., Molecular Biology of the Cell. 5$^{th}$ edition. Garland Science, 2008.*

| Paper Name: MICROBIOLOGY | |
|---|---|
| **Paper Code: BITMAJ2024** | **Semester: III** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

To acquaint the students with history, classification and role of microbiology in agriculture, food and environment.

**Course Outcomes (CO):**

**CO1:** Classify microbes through basic techniques and know their evolutionary relationship.

**CO2:**Analyze the diversity, distribution and demonstrate the morphology and structure of microbial cells.

**CO3:** Culture microbes and demonstrate microbial growth kinetics and metabolic pathways.

**CO4:** Discuss on bacterial recombination techniques of bacterial reproduction.

**CO5:** Gain knowledge on microflora associated to the human body and the environment.

**CO6:** Gain hands on experience to prepare culture media, isolate, identify microbes and perform microbial cell count.

**Theory: 45 lectures**

**Unit 1: Microbial classification 15 Lectures**

History of microbiology. Classification of Bacteria and Archaea, Fungi, Algae, Protozoa, Helminthes and Viruses. Basic principles and techniques used in bacterial classificationEvolutionary relationship among prokaryotes. Phylogenetic and numerical taxonomy. Use of DNA and r-RNA sequencing in classifications.

**Unit 2: Microbial growth and Metabolism10 Lectures**

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation; Growth curve, Generation time, synchronous batch and continuous culture,measurement of growth and factors affecting growth of bacteria; Metabolic pathways, amphi-catabolic and biosynthetic pathways

**Unit 3: Bacterial Reproduction10 Lectures**

Bacteriophages: Morphology and Life cycles, Conjugation, Transformation and Transduction. Endospores and sporulation in bacteria.

**Unit 4: Normal microflora 10 Lectures**

Bacterial pollutants of water, coliforms and non coliforms

Microorganism in food: Moulds, Yeasts, bacteria. Major food born infections and intoxications. Symptoms, pathogenesis and transmission of bacterial, viral, protozoan and fungal diseases in plants and animals;Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

**Practical:** **15Lectures**

1. Preparation of culture media (solid and liquid) and sterilization
2. Pure culture techniques (Spread, pure, streak)
3. Determination of air microflora
4. Determination of soil microflora
5. Determination of water microflora
6. Gram staining technique.

***Suggested Readings:***


- *Microbiology – Pelczar, Chan, Krieg, Tata McGraw Hill Publications.*
- *Microbiology- Prescott LM, Harley JP, Klein DA, Wm. C. Brown Publishers*
- *Microbiology: Tortora, G.J., Funke, B.R. and Case, C.L An Introduction Pearson Education.*
- *Brock Biology of Microorganisms- Madigan MT, Martinko JM and Parker J. Pearson/Benjamin Cummings.*
- *General Microbiology- Stainier RY, Ingraham JL, Wheelis ML & Painter PR. MacMillan*

| Paper Name: BIODIVERSITY AND TAXONOMY | |
|---|---|
| **Paper Code: BITMIN2014** | **Semester: III** |
| **Type: MINOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

To gain the knowledge related to the basic concept of biodiversity and conservation and also different types taxonomy

**Course Outcomes (CO):**

**CO1:** Upon completion of this course, Students will gain knowledge about biodiversity exploration, estimation and conservation.

**CO2:** Upon completion of this course, Students will know the concept of methodology in taxonomy.

**CO3:** Upon completion of this course, Students will learn about the different tools in the taxonomy so that they can relocate the phylogenetic position of plant or taxa.

**Theory: 45 Lectures**

**Unit 1: Basic concept and global pattern of Biodiversity 13 Lectures**

What is Biodiversity, why should we conserve it, Elements of Biodiversity - Ecosystem Diversity, Genetic Diversity, Species Abundance & Diversity, Patterns of Species Diversity.Measuring biodiversity, Cataloguing and Discovering Species, Geographical Patterns of Species Richness, Biogeography, Importance of Distribution Patterns (Local Endemics, Sparsely Distributed Species, and Migratory Species), GAP Analysis.

**Unit 2: Biodiversity & Conservation 14 Lectures**

Overexploitation threatening living species, International Trade,Animalsthreatenedbyinternationaltrade,ProblemsinControllingInternationalTrade(Enforcement ,Reservations,IllegalTrade),FreeTrade&theEnvironment,FreeTrade&Conservation,CommonpatternsofOverexploitation. TheUSEndangeredSpeciesAct,StateEndangeredSpecies Acts Successes and Failures of the Endangered Species Act Role of ESA in HabitatProtection, Critical Habitat, Problems with the Endangered Species Act, Habitat ConservationPlans.

**Unit 3: BasicconceptofTaxonomy 8 Lectures**

Classification,ConstructionofPhylogenetictree,Systematics,Cladistics,Cladograms,Phenetics,Nomenclature.

**Unit 4: Molecular Taxonomy in relation to DNA characteristics & Protein sequences**

**10 Lectures**

Modes ofmolecularevolution,NeutraltheoryofMolecularevolution,geneticmarkersfortaxonomicpurposes,comparingtotalgenomebyDNA-DNAhybridization, comparingDNAsequences,Cladistics, biological identification through DNA barcodes, chromosome painting, establishingmolecularhomologyusingproteinsequences.

**Practical:** **15 classes**

1. Acquaintance with open-source databases of biodiversity.
2. Sampling of plant and animal biodiversity of the College/University campus
3. Determine species location in a given study area.
4. Microtome technique to study the biological characters of the samples.
5. Taxonomic identification of wild and cultivated plants represented in local flora.
6. Pollen preparations by Acetolysis method (Semi-permanent) and study of different pollen morphophytes.

***Suggested readings:***


- *Plant Taxonomy (2nd Edition McGraw Hill Education) by O.P. Sharma*
- *Plant taxonomy (1st Edition Eastern Book House, Guwahati) by AkhilBaruah*
- *Plant Taxonomy & Biodiversity (Santra Publications Pvt. Ltd.) by N.D. Paria*
- *Textbook of Biodiversity (Notion Press) by AnupamRajak*

| Paper Name: INTELLECTUAL PROPERTY RIGHTS | |
|---|---|
| **Paper Code: BITIDC2013** | **Semester: III** |
| **Type: IDC** | **Credit: 3 (2L+1P)** |
| **Total Classes: 45= 30+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objectives:**

The course is designed to provide comprehensive knowledge to the students regarding the general concepts and importance of IPR.

**Course Outcomes (CO):**

**CO1:** Acquaint the learners with the basic concepts of Intellectual Property Rights and the types of IPRs.

**CO2:** Acquire the knowledge on world trade organization, trade agreements and investments.

**CO3:** Understand the process of patenting and patent laws in India.

**CO4:** Learn the role of IPR in biodiversity protection.

**Theory: 30 Lectures**

**Unit 1: Introduction to Intellectual Property Right: 7 Lectures**

Introduction, intellectual property and on, types of Intellectual Property Rights: Patent, copyright, Trademark, Design, trade secret, Traditional Knowledge and Geographical indication. Commercial Exploitation, and Protection of IPR.

**Unit 2: National and International agencies: 6 Lectures**

WIPO, World Trade Organization (WTO), Trade- Related Aspects of Intellectual Property Rights (TRIPS), General Agreement on Tariffs and Trade (GATT).

**Unit 3: Patents 10 Lectures**

Basics of patents - Types of patents; Patentable and Non-Patentable inventions, Process Product patent, Utility Patent (Short term patent). Indian Patent Act 1970; Recent amendments; Patent Cooperation Treaty (PCT) and implications. Process of patenting. Types of patent applications: Provisional and complete specifications; Concept of "prior art", patent databases (USPTO, EPO, India). Financial assistance, schemes, and grants for patenting.

**Unit 4: Protection of Biodiversity 7 Lectures**

Indian Biodiversity Act, Plant variety protection, plant breeder's rights, Protection of Plant Varieties and Farmer's Right Act (2001) , Choice and management of IPRs, advantage and limitations of IPRs.

**Practical and Field Visits: 15 Lectures**

1. Patent infringement-Case Studies (Basmati rice, Turmeric, Neem)
2. Proxy filing of Indian Product patent
3. Proxy filing of Indian Process patent
4. Exploring patent database

***Suggested readings/books:***


- *Intellectual Property Rights by Deborah E. Bouchoux., Delmar Cenage Learning. 2005*
- *Intellectual Property Rights on Biotechnology by Singh, KC, BCIL, New Delhi*
- *Fundamentals of lP for Engineers: K.Bansl&P.Bansal*
- *Intellectual property right, Deborah, E. Bochoux, Cengage learning.*
- *Intellectual property right - Unleashing the knowledge economy, PrabuddhaGanguli, Tata McGraw Hill Publishing Company Ltd.*

| Paper Name: MICROBIAL TECHNIQUES | |
|---|---|
| **Paper Code: BITSEC2013** | **Semester: III** |
| **Type: SEC** | **Credit: 3 (2L+1P)** |
| **Total Classes: 45= 30+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

The objective of the course is to train the students on the various aspects of a microbiology laboratory.

**Course Outcomes (CO):**

**CO1:** Learners with get acquainted with the various tools, equipment's, instruments used in a microbiology laboratory.

**CO2:** They will be able to identify microorganisms based on various parameters such as size, shape, morphology, biochemical**.**

**CO3:** The students will be able to culture, sub-culture and also to preserve the microorganisms.

**Theory: 30 Lectures**

**Unit 1: Microscopy-Principles, part and function 10 Lectures**

Light microscope (Bright-field microscope, Phase-Contrast Microscope, Dark-field Microscope, Fluorescence Microscope and Differential Interference Contrast (DIC) microscope).

Electron Microscope (Transmission electron microscope and Scanning electron microscope)

**Unit 2: Dyes and staining techniques 5 Lectures**

Types of dyes (acidic and basic), simple staining (positive staining & negative staining), differential staining (Gram's stain, acid fast stain), special staining (endospore stain)

**Unit 3: Media for culture of microorganisms and sterilizing techniques 5 Lectures**

Basic components of a microbial growth media, Dry heat (red heat, incineration, hot air) and moist heat sterilization (autoclave)

**Unit 4: Techniques for enumeration of microorganisms, Pure culture & Maintenance and preservation 10Lectures**

Shape of the microorganism and arrangement of the cells (microscopic), colonial morphology (macroscopic)

Serial dilution, pour plate method, spread plate method, sub-culturing (streak plate method), Culture plate, culture tube, freeze drying (lyophilisation)

Characterization using different biochemical analysis

**Practical:** **15 Lectures**

1. Preparation of slides
2. Observe the different classes of Microbes for morphology and arrangement under a microscope after appropriate staining procedures

i. Bacteria

ii. Fungi

iii. Yeast

3. Preparation of microbial media for bacteria, fungi, yeast and algae
4. Enumerate the microorganisms from soil, water and air sample
5. Obtain a pure culture of bacteria, fungi and yeast
6. Characterization of microbes based on various biochemical test.

***Suggested readings:***


- *Microbiology: A laboratory manual. James Cappuccino and Natalie Sherman.*
- *Microbiology- Prescott LM, Harley JP, Klein DA, Wm. C. Brown Publishers*
- *Microbiology: Tortora, G.J., Funke, B.R. and Case, C.L An Introduction Pearson Education.*
- *Brock Biology of Microorganisms- Madigan MT, Martinko JM and Parker J. Pearson/Benjamin Cummings.*

| Paper Name: MOLECULAR BIOLOGY | |
|---|---|
| **Paper Code: BITMAJ2034** | **Semester: IV** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

The objective of the molecular biology course is to equip students with a deep understanding of the molecular processes that underlie the organization, replication, and expression of genetic information in living organisms.

**Course outcomes (CO):**

**CO1**: Understand the basic structure and significance of DNA.

**CO2:** Understand the basic principles of molecular biology, including the central dogma of biology, DNA replication, transcription, and translation.

**CO3:** Describe the mechanisms of gene expression, including transcriptional and post-transcriptional regulation.

**CO4:** Explain the techniques used to study DNA, RNA, and proteins, such as PCR, gel electrophoresis, DNA sequencing, and protein purification.

**CO5:** Discuss the role of molecular biology in biotechnology, medicine, and other fields of science.

**CO6:** Understand the fundamental practical experiments that are conducted in the field of molecular biology.

**Theory: 45 lectures**

**Unit 1:Nucleic Acids and their organization 7 lectures**

Watson and Crick model of DNA structure, A, B & Z forms of DNA, Nucleic acid as the genetic material, Genome and its organization in prokaryotes, eukaryotes, and viruses.

**Unit 2:DNA Replication 10 lectures**

DNA replication in prokaryotes, eukaryotes, and viruses. Proteins and enzymes involved in DNA replication.

**Unit 3:Expression Studies 14 lectures**

Transcription in prokaryotes and eukaryotes. Proteins and enzymes involved in transcription**.** Post-transcriptional modification of RNAs, translation in prokaryotes and eukaryotes. Proteins and enzymes involved in translation. Post-translational modification, analysis of transcription, translation,

**Unit 4:Gene Regulation**, **Recombination, and its application 14 lectures**

Gene regulation in prokaryotes, eukaryotes, and viruses. Gene regulation by non- coding RNAs, DNA-protein interactions, Recombination and its molecular mechanism, gene targeting (Cre-Lox*p*, Flp-Frt, CRISPER-Cas9) and antisense RNAs, Site-directed mutagenesis, model organisms in molecular biology.

**Practical:** **15 Lectures**

1. Preparation of solutions/buffers for Molecular Biology experiments.
2. Isolation of DNA from bacterial cells/plant cells/animal cells.
3. Estimation of DNA.
4. Agarose gel electrophoresis of DNA
5. Preparation of restriction enzyme digestion of DNA.
6. Preparation and transformation of competent cells.
7. Protein estimation and preparation of SDS-PAGE.

***Suggested readings:***


- *Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Laboratory Press, Pearson Publication.*
- *Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John*
- *Wiley & Sons. Inc.*
- *De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII*
- *Edition. Lippincott Williams and Wilkins, Philadelphia.*
- *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.*
- *Jocelyn E Krebs (2009). Genes X, Jones & Bartlett Learning.*
- *Review articles.*

| Paper Name: IMMUNOLOGY | |
|---|---|
| **Paper Code: BITMAJ2044** | **Semester: IV** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

This paper shall enable the student to understand various processes of immune system

**Course Outcomes (CO):**

**CO1**. Enables the students for understanding of basic immunological process in the mammalian body.

**CO2.** Enable the students for understanding of humoral immunity.

**CO3**. Enables better understanding of Antigens and immunogenicity

**CO4**. Enables the student to understand disorders and cancer immunology

**Theory: 45 Lectures**

**Unit 1: Introduction to Immune System 15 Lectures**

Immune system of vertebrate and invertebrate. Componentsofinnateandacquiredimmunity. Organsandcellsoftheimmunesystem-primaryandsecondarylymphoidorgans. Humoral and cellular immune response.

**Unit 2: Antibody 15 Lectures**

Immunoglobulins-basicstructure,classes&subclassesofimmunoglobulins. Class switching and allelic exclusion of antibodies. B cell receptor and T cell receptor

**Unit 3: Antigen and Immunogenicity 10 Lectures**

Antigen, types, MHC molecules. Antigen processing and presentation. Hapten-carriersystem. Self and non-self-recognition. Precipitation and agglutination

**Unit 4:Disorders Related to Immunity5 Lectures**

Autoimmune disorders, immune deficiency, Tuberculosis, Vaccines and edible vaccines. Cancer immunology

**Practical: 15 Lectures**

1. Total blood Count
2. Separation of serum and plasma from blood
3. Practical leading to agglutination and precipitation
4. Demonstration of Double diffusion and immunoprecipitation
5. Determination of blood group
6. Demonstration of ELISA, Western Blotting

7. Determination of microbial load

***Suggested readings:***


- *Immunology,JanisKuby,Freeman.*
- *EssentialsofImmunology,I.M.Roitt,Wiley-Blackwell.*
- *Immunology,NandiniSethi.*
- *EssentialClinicalImmunology:JohnBZabriskie:CambridgeMedicinePublishing*
- *ImmunologyandEvolutionofInfectiousDiseases: StevanAFrank*

| Paper Name: GENETICS | |
|---|---|
| **Paper Code: BITMAJ2054** | **Semester: IV** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective**:

To understand how genes, chromosomes and different genetic information function and also to understand the pathways related to functionality of traits

**Course Outcomes (CO):**

**CO1:** Enable students to understand the basic of genetic and flow of genetic information

**CO2:** Enable students to understand macromolecules, its mutation, its repair and genetic markers

**CO3:** Enable students to understand population and population genetics

**CO4:** Enables students to understand molecular genetics, gene expression and gene regulation

**Theory: 45 Lectures**

**Unit 1: Introduction to Genetics: 10 Lectures**

Mendelian Genetics (Mendelian Laws, concept of alleles and multiple alleles, dominance, incomplete dominance, co-dominance), Genomes Organization (Prokaryotes and Eukaryotes), Organelle genome, genome mapping and genome evolution, Non-Mendelian Genetics (Gene interaction)

**Unit 2: Nucleic Acid, mutation, repair and markers: 15 Lectures**

Structural aspects – Components of DNA and RNA, Nucleosides & Nucleotides, Double helical structure of DNA (Watson-Crick model), Various forms of DNA. Kinds of Mutation, Mutagens, influence of Mutation, Molecular basis of Mutation, Significance of Mutation. Concept of DNA Repair. Concept of markers, molecular markers, gene mapping, use of molecular Marker

**Unit 3: Population Genetics 10 Lectures**

Phenotype & Genotype. Genetic Drift, Gene flow, Migration, Island Effect, Bottle Neck Effect,HumanGeneticDiversity. HardyWenbergLaw,&PopulationGenetics.

**Unit 4: Molecular Genetics 10 Lectures**

DNA Replication, Protein Expression, Genetic Code, Comparative genomics, molecularphylogenetics, Molecular Taxonomy

**Practical: 15 Lectures**

1. Study of chromosome in suitable metaphase plate
2. DNA Isolation and quantification
3. Staining of nucleus and cytoplasm of animal and plant cells
4. Estimation of DNA by suitable method.
5. Study of different Karyotypes

6. Blood group determination
7. Study of mitosis and meiosis

***Suggested readings:***


- *Genetics:AConceptualAppraoch,B.A.Pierce,W.H.FreemanandCompany.*
- *CellBiology;G.Karp;JohnWileyandSons,Inc.*
- *NewClinicalGenetics,AndrewReadandDianDonnai,ScionPublishingLtd.*
- *HumanMolecularGenetics,T.StrachalandA.Read,GarlandScience.*
- *HumanGenetics:ConceptsandApplications,R.Lewis,McGrawHillHigherEducation.*
- *Genetics:MonroeW.Strickberger.Prentice-Hall India,Publication.*
- *PrinciplesofGenetics:Gardner,Simmons,Snustad.WileyPublications*

| Paper Name: PLANT BIOTECHNOLOGY | |
|---|---|
| **Paper Code: BITMIN2024** | **Semester: IV** |
| **Type: MINOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

The objective of the course is to familiarize and train the students on various techniques involved in plant tissue culture.

**Course Outcomes (CO):**

**CO1:** Have aclear theoretical concept on micropropagation, tissue culture media, sterilization techniques and different techniques for culturing shoot tip, embryo, pollen, anther and ovary etc. and developing haploids, hybrids and homozygous lines.

**CO2:** Have an understanding about the different plant transformation terms and technology viz. Ti-plasmid &Ri-plasmid, binary vectors, vector-less DNA transfer, promoters for plant transformation and chloroplast transformation.

**CO3:** Have a concept on the application of plant transformation technologies on developing herbicide resistance, insecticide resistance, disease resistance, nematode resistance and for increased productivity and performance.

**CO4:** Understand and apply the knowledge of transformation technologies for the production and purification of industrially significant products from genetically engineered plants.

**CO5:** Explain and apply the knowledge of recombinant DNA technology for plant breeding. Also have a clear concept on techniques involved in germplasm conservation.

**Theory: 45 Lectures**

**Unit 1: Introduction to plant tissue culture 15 Lectures**

Scope of plant tissue culture, Composition of plant tissue culture media, Callus and suspension culture. Plant tissue culture techniques: Seed, Embryo, Callus, Organs, Cell and Protoplast culture, anther, Meristem and shoot tip culture. Organogenesis, Embryogenesis, Micropropagation, advantages and disadvantages of micropropagation.

**Unit 2: Hybridization and significance 10 Lectures**

Methods of protoplast isolation and fusion, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Soma-clonal variation and their significance. Artificial seeds and their application.

**Unit 3: Plant transformation technology 10 Lectures**

Ti and Ri plasmid, *Agrobacterium* mediated gene transformation, Direct DNA transfer methods to plants. Application of Plant transformation technology in herbicide resistance & insect resistance. Plant secondary metabolites and their production using transgenic plants.

**Unit 4: Molecular Markers** **10 Lectures**

Plant molecular markers - RFLP, RAPD, AFLP, microsatellites, SNP, SSCP, SCAR.

**Practical: 15 Classes**

1. Preparation of plant tissue culture media (Murashige& Skoog's medium)
2. Methods of sterilization of glassware, media
3. To select, prune, sterilize and prepare an explant for culture.
4. Micropropagation of selected plants using nodal explants
5. Preparation of artificial seeds
6. To demonstrate various steps of Micropropagation.

***Suggested reading***


- *Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.*
- *Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.*
- *Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.*
- *Sambrook& Russel. Molecular Cloning: A laboratory manual. (3rd edition)*
- *Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.*


**Paper Name: rDNA TECHNOLOGY**

| Paper Code: BITMAJ3014 | Semester: V |
|---|---|
| Type: MAJOR | Credit: 4 (3L+1P) |
| Total Classes: 60= 45+15 (L+P) | Total Marks: 100 (T50+P20+IA30) |

**Course Objective:**

The objective of the recombinant DNA technology course is to educate students on the principles and techniques used to manipulate genetic material and create genetically modified organisms for research, biotechnology, and therapeutic purposes.

**Course Outcomes (CO):**

**CO1:** Understand the basic principles of recombinant DNA technology, including DNA cloning, restriction enzymes, and DNA sequencing.

**CO2:** Explain the techniques used to create and manipulate recombinant DNA molecules, such as PCR, gel electrophoresis, and DNA sequencing.

**CO3:** Describe the methods used to express recombinant proteins in bacteria, yeast, and other systems.

**CO4:** Understand the principles of gene editing and the use of CRISPR/Cas9, and Cre-LoxP technology to modify the genome of cells and organisms.

**CO5:** Discuss the applications of recombinant DNA technology in biotechnology, medicine, and other fields, including the development of genetically modified organisms, gene therapy, and vaccine production.

**CO6:** Understand the fundamental practical experiments that are conducted in the recombinant DNA technology.

**Theory: 45 Lectures**

**Unit 1**: **Restriction enzymes** **8 Lectures**

Types of restriction enzymes, cohesive and blunt end ligation, linkers, adaptors, and homopolymeric tailing.

**Unit 2**: **Gene Cloning** **10 Lectures**

Concept of gene cloning and its importance, proteins, and enzymes involved in gene cloning, the concept of vectors, and different types of vectors for gene cloning, the concept of cloning vectors and expression vectors.

**Unit 3**: **Transformation methods and library preparation** **10 Lectures**

Different ways of insertion of foreign DNA into host cells, Cloning, and expression in E. coli, yeasts (Saccharomyces, Pichia), DNA Libraries: Construction of cDNA libraries in plasmids and screening methodologies.

**Unit 4**: **Concept of Polymerase Chain Reaction**, **Sequencing, and Application**

**17 Lectures**

Primer designing, Concept of PCR and its importance, different types of PCR, and their applications. DNA sequencing and its importance, different types of DNA sequencing, and its mechanism, Application of rDNA technology in medicine, agriculture, veterinary sciences, and protein engineering.

**Practical:** **15 Lectures**

1. Isolation of DNA from plant cells/E.coli/Animal cells
2. DNA estimation.
3. Agarose gel electrophoresis
4. Plasmid DNA isolation
5. Demonstration of PCR
6. Restriction digestion of DNA
7. Preparation of rDNA
8. Preparation and transformation of competent cells with plasmid
9. Screening of transformed cells

***Suggested readings:***

*1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.*

*2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying 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.*

| Paper Name: BIOINFORMATICS | |
|---|---|
| **Paper Code: BITMAJ3024** | **Semester: V** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

To understand basic and applied aspects in Bioinformatics and to know how the biological data can be extracted for solving biological problems.

**Course Outcomes (CO):**

**CO1:** Understand the basic concepts in Bioinformatics and its applications in various fields

**CO2**: Understand biological databases available online and sequence alignment using bioinformatics tools

**CO3**: Understand algorithms used for the computational calculations

**CO4:** Understand the concepts of genes, genomes and Human Genome Project.

**Theory: 45 Lectures**

**Unit 1:Bioinformatics- 5 Lectures**

Definition, History, Scope and Applications. Opportunities in Bioinformatics. Emerging areas of Bioinformatics

**Unit 2:Biological databases- 10 Lectures**

Nucleotide and protein sequence databases- secondary database, Specialized database, Protein Structure Database- PDB, Genomic Databases, metabolic pathway database- KEGG. Database Search Tools- Entrez, SRS

**Unit 3:Sequence alignment**: **10 Lectures**

Pair-wise sequence alignment, Dotplot. Global and local alignment: methods, Dynamic Programming- Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, scoring matrices (PAM, BLOSUM). Database similarity searching- FASTA and BLAST.

**Unit 4:Sequence analysis and Phylogeny 10 Lectures**

Multiple sequence alignment: methods, tools and applications. Phylogenetic analysis. Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees

**Unit 5:Human Genome Project**: **10 Lectures**

Genomes, Need of Human Genome Project, goals of HGP, uses and application with examples.

**Practical**: **15 Lectures**

1. Introduction to Bioinformatics software and different databases

2. Introduction to NCBI, EMBL, KEGG, DDBJ, SwissProt and PDB servers
3. Analysis of phylogeny and construction of phylogenetic trees.
4. Sequence alignment studies, *In silico* primer designing

***Suggested readings:***

- *Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery by Rastogi, Mendiratta and Rastogi; PHI publications.*

| Paper Name: DEVELOPMENTAL BIOLOGY | |
|---|---|
| **Paper Code: BITMAJ3034** | **Semester: V** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

The objective of the developmental biology course is to provide students with a comprehensive understanding of the cellular and molecular processes involved in the growth, differentiation, and morphogenesis of organisms, from fertilization to adulthood.

**Course outcomes (CO):**

**CO1:** Understand the basic principles of developmental biology, including embryonic development, morphogenesis, and cell differentiation.

**CO2:** Explain the molecular mechanisms that control developmental processes, including gene regulation, signalling pathways, and epigenetic modifications.

**CO3:** Describe the methods used to study developmental biology, including imaging techniques, genetic analysis, and cell culture.

**CO4:** Understand the developmental processes that occur in different organisms.

**CO5:** Discuss the role of developmental biology in understanding and treating developmental disorders and diseases.

**CO6:** Understand the fundamental practical experiments that are conducted in the field of developmental biology.

**Theory: 45 Lectures**

**Unit 1: Introduction to Developmental Biology 10 Lectures**

History, Anatomical tradition, Principles of development-life cycles, Role of genes in development, Amniocentesis, Development of C. elegans, Concept of Gametogenesis – Spermatogenesis, Oogenesis, Fertilization - Definition, mechanism, types of fertilization, Different types of eggs.

**Unit 2: Stages of Development 7 Lectures**

Cleavage and its types, pattern, and mechanisms, early development of Xenopus, mechanism of blastulation, gastrulation, primary germ layers.

**Unit 3: Mechanism of Differentiation 10Lectures**

Cell commitment and determination, model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level, Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction, and induction of vertebrate lens.

**Unit 4: Mechanism of Organogenesis and Cell Cycle 18 Lectures**

Neurulation, notogenesis, development of the vertebrate eye, Fate of different primary germ layers, Development of behaviour: constancy & plasticity, Extra embryonic membranes, the concept of metamorphosis, placenta in mammals. Concept and mechanism of programmed cell death, aging, and senescence, model organisms for developmental biology, medical implications of developmental biology.

**Practical:** **15 Lectures**

1. Study of developmental stages of frog/chick/drosophila.
2. Demonstration of developmental stages of Anopheles.
3. Examination of sperm/ova.
4. Preparation of temporary stained mount of the chick embryo.
5. Study of different types of placenta.

***Suggested readings:***


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

| Paper Name: BIOSTATISTICS | |
|---|---|
| **Paper Code: BITMAJ3044** | **Semester: V** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Objectives:**

To study concepts of statistics and its applications in the biotechnology

**Course Outcomes (CO):**

**CO1:** Learn about types of data and collection of data.

**CO2:** Learn how to determine the measures of central tendency and dispersion.

**CO3:** Understand the concept of hypothesis and hypothesis testing.

**CO4:** Learn to test level of significance using t-test, chi-square test and ANOVA

**Theory: 45 Lectures**

**Unit 1: Data and measurement 15 Lectures**

Types of Data, Collection of data; Primary; Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency- Mean, Median, Mode. Measures of Dispersion-Standard Deviation, Standard Error. Measures of Skewness and Kurtosis.

**Unit 2: Sampling Techniques 15 Lectures**

Methods of sampling, confidence level, critical region, testing of hypothesis; large sample test and small sample test. Types of Biological Variables- Measurement Variables, Independent and Dependent Variables, Ratios, Circular Variables, Nominal Variables, Ranked Variables.

**Unit 3: Statistical Analysis 15Lectures**

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.

**Practical: 15 Lectures**

1. Calculation of Mean, Median, Mode
2. Calculation of Standard Error, Standard Deviation
3. T-Test
4. Chi-Square Test
5. ANOVA
6. Correlation and Regression

***Suggested readings:***

- *Fundamentals of Biostatistics; K. Janardhan, P. Hanmanth Rao*
- *Principles and Practice of Biostatistics; B. Antonisamy, Prasanna S. Premkumar*
- *Biostatistics: Basic Concepts and Methodology for the Health Science; Wayne W. Daniel and Chad L. Cross*
- *Biostatistics; Veer BalaRastogi*

| Paper Name: ANIMAL BIOTECHNOLOGY | |
|---|---|
| **Paper Code: BITMIN3014** | **Semester: V** |
| **Type: MINOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

This paper shall enable the student to understand different processes of animal biotechnology and their applications.

**Course Outcomes (CO):**

**CO1:** Enables the students about understanding of design and layout of tissue culture lab and basic instrumentation.

**CO2:** Enables the students to understand different medias used for animal tissue culture

**CO3:** Enables the students to understand various types of tissue culture processes

**CO4:** Enables the students to understand various application of animal biotechnology

**Theory: 45 Lectures**

**Unit 1: CellcultureLaboratorydesign&Equipment-AnIntroduction 10 Lectures**

Animal cell and tissue culture facility, layout of tissue culture laboratory. Instruments related to animal cell and tissue culture like Cold handling Cabinet, fluid dispensing system, Bio-safety cabinet, Laminar Air flow Cabinet, Air curtain, Air shower, $CO_2$ Incubator, -60 Deep freezer, Cryo-CAN, Inverted Microscope.

**Unit 2: MediaandReagents 10 Lectures**

Types of cell culture media; Ingredients of media; Physiochemical properties; $CO_2$ and bicarbonates;Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions;Antibiotics, growth supplements; Foetal bovine serum; Serum free media;Trypsin solution; Selectionof medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization ofcellculturemedia, serumand otherreagents, Knockout media.

**Unit 3: CellCulture Types 15 Lectures**

Different tissue culture techniques, Types of primary culture, Secondaryculture, sub culture, scale up, Trypsinization; Cell separation, Suspension culture. Behavior of growing cells, cell metabolism, cell lines, characterization and maintenance of cell line, cryopreservation, MaintenanceofCultureCellLines

**Unit 4: Applications 10 Lectures**

Transfection and transformation of cells, Commercial scale production ofanimal cells, stem cells and their application; Application of animal cell culture for *in vitro* testing ofdrugs, IVF, Hybridoma technology, vaccine testing, Assisted Reproductive Technology

**Practical:** **15 Lectures**

1. Demonstration of operation of Autoclave, LAF, Inverted microscope
2. Study of ovulation in fishes, ovine and caprine
3. Lymphocyte Culture and metaphase plate chromosome
4. Animal cell culture media preparation
5. Study of somites in prepared slides

***Suggested Readings:***


- *AnimalCellCultureTechniques,Ed.N.Cynes;Springer.*
- *AnimalCellCulture;R.I.Freshney,GarlandScience.*
- *ElementsofBiotechnology,P.K.Gupta,Kalyani Publishers.*
- *FundamentalsofBiotechnology,P.Prave,V.Paunt,W.SittingandD.A.Sukatesh*


| **Paper Name: GENOMICS AND PROTEOMICS** | |
|---|---|
| **Paper Code: BITMAJ3054** | **Semester: VI** |

| Type: MAJOR | Credit: 4 (3L+1P) |
|---|---|
| Total Classes: 60= 45+15 (L+P) | Total Marks: 100 (T50+P20+IA30) |

**Course Objectives:**

1. To Understand applications of Genomics and Proteomics in clinical settings
2. To introduce the students to pharmacogenomics

**Course Outcome**:

**CO1:** Be able to describe the development of Omics technologies, with emphasis on genomics and proteomics;

**CO2:** Be able to synthesize information to discuss the key technological developments that enabled modern genomic and proteomic studies;

**CO3:** Be able to describe advanced genomics and proteomics technologies and the ways in which their data are stored

**Theory: 45 lectures**

**Unit 1:Introduction to Genomics and Proteomics**: **10 lectures**

Introduction – Organization and structure of genomes, Genome size, Sequence complexity, Introns and Exons, Genome structure in viruses and prokaryotes, Isolation of Chromosomes, chromosome micro dissection, Retrofitting. Introduction to Proteomics – The Proteome, mining proteomes, Bridging Genomics and Proteomics. Proteomics and the new biology.

**Unit 2:Gene Identification and Expression**: **10 lectures**

Genome annotation, traditional routes of gene identification, detecting open-reading Frames, software programs for finding genes, Identifying the function of a new gene, gene ontology, overview of comparative genomics, Protein structural genomics, determining gene function by sequence comparison and through conserved protein structure Global expression profiling – Introduction, traditional approaches to expression profiling, Analysis of RNA expression, applications of genome analysis and genomics.

**Unit 3:Analysis of Proteomes I** **5lectures**

Analysis of proteomes - Two-dimensional polyacrylamide gel electrophoresis, Sample Preparation, Solubilization, Reduction, Resolution, Reproducibility of 2-DEDetecting proteins in polyacrylamide gels, Image analysis of 2-DE gels.

**Unit 4:Analysis of Proteomes II** **10 lectures**

Mass spectrometry-based methods for protein identification- De novo sequencing using mass spectrometric data- Correlative mass spectrometric based identification strategies, 2-DE gel electrophoresis coupled with mass spectrometry, Micro array techniques- Types of micorarrays, designing a microarray experiment, Microarray Technology in Treating Disease.

**Unit 5:Applications of Genomics and Proteomics Analysis** **10 lectures**

Analysis of Genomes – Human, Mouse, *Plasmodium faciparum*, *Saccharomyces cerevisiae*, *Mycobacterium tuberculosis*. Application of proteome analysis- drug development and toxicology, Pharmaceutical Applications, Proteomics in drug Discovery in human, phage antibodies as tools, Glycobiology and Proteomics in plant genetics and breeding.

**Practical:** **15 lectures**

1. Phylogenetic analysis of protein and nucleotide sequences, Use of gene prediction methods (GRAIL, Genscan, Glimmer),
2. Use of RNA structure prediction tools
3. Use of various primer designing and restriction site prediction tools,
4. Use of different protein structure prediction databases (PDB, SCOP, CATH).

***Suggested readings:***


- *S. B. Primrose and R.M. Twyman - Principles of Genome Analysis and Genomics, Blackwell Publishing*

| Paper Name: INDUSTRIAL BIOTECHNOLOGY | |
|---|---|
| **Paper Code: BITMAJ3064** | **Semester: VI** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

The objective of this course is to understand the fundamentals of industrial processes for production of various commercially important products.

**Course Outcomes (CO):**

**CO1:** The learner shall know about the fundamentals of operating a bioprocess

**CO2:** The student will be thorough in their knowledge about the various processes for the production of a few industrially important products.

**Theory: 45 lectures**

**Unit 1:Biotechnology: Scope and importance 10 lectures**

Commercial potential of Biotechnology in India. Historical overview of industrial fermentation process -traditional and modern Biotechnology. Industrial Fermentation- microorganisms, mode of operation, fermentation processes-pictorial representation.

**Unit 2: Scale Up Process-I 10 lectures**

A brief outline of processes for the production of some commercially important organic acids (citric acid, lactic acid & acetic acid); amino acids (glutamic acid & tryptophan) and alcohols (ethanol & butanol).

**Unit 3: Scale Up Process-II 10 lectures**

Production processes for various classes of secondary metabolites: antibiotics: (penicillin streptomycin & erythromycin), vitamins (Vit B12 and Vit B2) and steroid biotransformation.

**Unit 4: Scale Up Process-III 15 lectures**

Production of industrial enzymes (proteases & amylases), Production of biopesticide, Biofertilizers, bio-preservative (Nisin), biopolymers (xanthan gum & PHB), cheese, SCP.

Production of recombinant proteins having therapeutic and diagnostic applications (insulin, human growth hormone), Production of recombinant vaccines (Hepatitis B vaccine, cholera vaccine), production of monoclonal antibodies.

**Practical: 15 lectures**

1. Isolation of industrially important microorganism from natural resource.
2. Production and analysis of amylase.
3. Production and analysis of ethanol.
4. Production and analysis of lactic acid.

***Suggested readings:***

- *Lee, S.Y., Nielsen, J. and Stephanopoulos, G., "Industrial Biotechnology: Products and Processes", John Wiley & Sons, 2016.*
- *Waites, M.J., Morgan,N.L., Rockey,J.S., Higton, G., "Industrial Microbiology: An Introduction" Blackwell, 2001.*
- *Cruger, W., Cruger, A., "A Textbook of Industrial Microbiology", Panima Publishing Corporation, 2nd Edition, 2005.*

| Paper Name: ENVIRONMENTAL BIOTECHNOLOGY | |
|---|---|
| **Paper Code: BITMAJ3074** | **Semester: VI** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objectives:**

To give an in-depth knowledge in environmental biotechnology and make the learners acquire knowledge on the application and scope of environmental biotechnology.

**Course Outcomes (CO):**

**CO1:** Become aware about the environment and use of biotechnology to solve problems related to biodiversity and pollution.

**CO2:** Understand the concept of biodegradation and role of bacteria in metabolism of xenobiotics.

**CO3:** Learn about renewable and non-renewable sources of energy.

**Theory: 45 lectures**

**Unit 1: Introduction to Environmental Biotechnology 8lectures**

Role of Biotechnology in Environment Protection and Management. Biotechnological methods for pollution detection, Biological indicators. Waste water treatment. Bioremediation of soil. Phyto-remediation. Treatment of municipal waste and Industrial effluents.

**Unit 2: Pesticides and their hazards 10lectures**

Biopesticides. Bio-fertilizers. Importance of Biofertilizers in agriculture (Rhizobium, Azotobacter, Mycorrhiza, Actinorhiza) advantages and current status, vermiculture, composting, current practices and production of biofertilizers. Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

**Unit 3: Bioremediation 7lectures**

Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (in situ, ex situ).Application of bacteria and fungi in bioremediation.

**Unit 4:Role of microorganisms in bioremediation 10 lectures**

Bioinsecticides: *Bacillus thuringiensis*, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (e.g. Trichoderma, Pseudomonas fluorescens); Biofertilizers: Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.

**Unit 4: Biofuels 10lectures**

Conventional fuels and their environmental impact. Renewable and Non-renewable sources of energy; Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

**Practical:** **15 lectures**

1. Estimation of Total Dissolved Solids (TDS) of water sample.
2. Estimation of BOD of water sample.
3. Estimation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.
5. Determination of Nitrate from the water
6. Determination of Sulphate from the water.
7. Estimation of coliform bacteria from water by MPN test
8. Determination of Turbidity

***Suggested readings/books:***


- *Environmental Biotechnology by Alan Scragg (1999); Longman.*
- *An Introduction to Environmental Biotechnology by Milton Wainwright (1999): Kluwer Academic Press.*
- *Bruce. E.Rittaman and Perry. L. Mc Carty, 2004, "Environmental Biotechnology-Principles and applications" McGraw Hill.*
- *N. Ahmed, F.M. Quershi and D. Y.Khan, 2001, "Industrial Environmental Biotechnology" Horizon press.*

| Paper Name: AGRICULTURAL BIOTECHNOLOGY | |
|---|---|
| **Paper Code: BITMAJ3084** | **Semester: VI** |
| **Type: MAJOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

To gain the knowledge related to the basic concept of how genetic transformation occurs in plants and the modern methods of farming along with marketing strategy for export.

**Course Outcomes (CO):**

**CO1:** Upon completion of this course, Students will gain knowledge about plant genetic transformation methods.

**CO2:** Upon completion of this course, Students will be acquainted with the modern methods of farming for increasing yield.

**CO3:** Upon completion of this course, Students will know about the marketing strategies for the export of the developed products through agricultural biotechnology.

**Theory: 45 lectures**

**Unit 1: Introduction to agricultural biotechnology and Plant genetic transformation**

**10 lectures**

History of agricultural biotechnology and Plant genetic transformation, Major Discoveries in field of agricultural biotechnology and Plant genetic transformation, Definition and applications of agricultural biotechnology and Plant genetic transformation. Introduction, Principle behind *Agrobacterium* mediated gene transfer, how it is transferred and what are its applications.

**Unit 2: Genetic transformation using *Agrobacterium*, liposome, Polyethylene glycol**

**15 lectures**

Introduction, Principle behind *Agrobacterium* mediated gene transfer, how it is transferred and what are its applications. Introduction, Principle behind liposomes and

PEG gene transfer methods, how it is transferred and what are its applications.

**Unit 3: New Agriculture Technology in Modern Farming 8lectures**

Various types and methods in farming and their benefits, issues arising from certain agricultural practices.

**Unit 4: Marketing and Export of Biotechnological Products 12 lectures**

External trade in Agricultural products, Present status, policy and prospects under WTO regime, Export import policy, Regulation of Agricultural marketing system, Infrastructural facilities for exporting efficiency, Biotechnological Products in India, Quality parameters and quarantine

procedures of export. Market integration: Types and effects Marketing costs margins and price spread. Biotech industries & institutes in India & world, Concepts of Biotech park/ Biotech Hub

**Practical:** **15 lectures**

1. *Agrobacterium* mediated gene transfer method.
2. Polyethylene glycol (PEG) can induce genetic transformation in both bacteria (*Escherichia coli*) and yeast (*Saccharomyces cerevisiae*).
3. Visit to different small scale and large scale Agro-based products. Study the production techniques of biotech products. Collecting the information on export import data on biotech products, quality standards for export and their potential. Analyse data in relation to demand and supply.
4. Home assignments/ Projects

***Suggested readings:***


- *New techniques in agricultural biotechnology by Directorate-General for Research and Innovation (European Commission) (DOI: 10.2777/574498)*
- *Biotechnology (Kalyani Publisher) by BD Singh*
- *Science in Agriculture: Advanced Methods for Sustainable Farming (Halcyon House Publishers) by Arden Anderson*
- *Organic Farming: Methods, Economics & Structure (Nova Science PublisersInc) by Ivan Artamova and Michael Nelson*
- *Agriculture Marketing in India (Oxford IBH, N. Delhi) by Acharya and Agrawal*
- *Principles of Marketing (Prentice-Hall, N. Delhi) by Kotlar and Armstrong*

| Paper Name: BIOPROCESS TECHNOLOGY | |
|---|---|
| **Paper Code: BITMIN3024** | **Semester: VI** |
| **Type: MINOR** | **Credit: 4 (3L+1P)** |
| **Total Classes: 60= 45+15 (L+P)** | **Total Marks: 100 (T50+P20+IA30)** |

**Course Objective:**

The objective of this course to learn the basic principles of fermentation process, to understand the basic configuration and parts of a fermenter and to gain an in-depth idea about upstream and downstream processing.

**Course Outcomes (CO):**

**CO1:**Understand the general requirements of a fermentation process.

**CO2:**Understand the basic configuration of a fermentor and its ancillaries.

**CO3:**Demonstrate an ability to design good media.

**CO4:**Explain the sterilization kinetics and design the sterilization equipments for batch and continuous process.

**CO5:**Able to model microbial growth, substrate utilization and product formation.

**Theory: 45 lectures**

**Unit 1: Introduction and development of bioprocess technology 8 lectures**

Types of fermentation, Modes of fermentation (Batch, continuous, fed-batch culture), Submerged and Solid-State fermentation.

**Unit 2: Bioreactors 10 lectures**

Design of a bioreactor. Significance of various parts of a bioreactor.

Types of submerged and solid-state Bioreactors

**Unit 3:Principles of upstream processing 15 lectures**

Media preparation:Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media.Sterilization of media, air and equipment; Inoculum development, Introduction to oxygen requirement in bioprocess, $K_La$.

**Unit 4:Principles of downstream processing 12 lectures**

Bio-separation techniques: filtration, centrifugation, sedimentation, flocculation; Storage and packaging

**Practical: 15 lectures**

1. Establishing a bacterial growth curve

2. Effect of different substrates on the growth/biomass production of a bacteria/fungi
3. Effect of pH on the growth/biomass production of a bacteria/fungi
4. Comparative study of ethanol production using different substrates.

***Suggested readings:***


1. *Peter F. Stanbur., Stephen J. Hall., A. Whitaker., "Principles of Fermentation Technology" Science & Technology Books.*
2. *Shuler., Michael L., FikretKargi. "Bioprocess Engineering", Prentice Hall.*