

**DEPARTMENT
of
MOLECULAR BIOLOGY & BIOTECHNOLOGY
COTTON UNIVERSITY
Panbazar, Guwahati-78001, Assam**



Undergraduate Syllabus: B.Sc. in Biotechnology (Hons)

2022

PART-I

INTRODUCTION:

The undergraduate course in B.Sc. in Biotechnology is a six-semester programme, which encompasses theory and practical in different areas of biotechnology and allied disciplines of life-sciences. It also contains one research components during sixth semester to enhance the knowledge and research skills in the broad area of life sciences during the course. The programme has 14 Core papers (theory & practical), 4 Generic Electives, 2 Ability Enhancement Compulsory Courses, 2 Skill Enhancement Course and 3 Discipline Specific Elective. The course is an interdisciplinary programme aimed at developing skills to understand the complex biological phenomena at the molecular level. The course will enable the students to apply the gained knowledge and skills to develop sustainable technologies for better future.

Aims of Bachelor's degree programme in Biotechnology:

The broad aims of the Bachelor's Degree Programme in Biotechnology are:

1. To provide an environment that ensures cognitive development of students in a holistic manner. A dialogue about plants and its significance is fostered in this framework, rather than didactic monologues on mere theoretical aspects
2. To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A biotechnology graduate as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
3. To mould a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.
4. To enable the graduate, prepare for national as well as international competitive examinations, especially UGC-CSIR NET and Graduate Aptitude Test- Biotechnology (GAT-B) and Civil Service Examinations

Graduate Attributes

The disciplinary expertise or technical knowledge that has formed the core of the university courses. They are qualities that also prepare graduates as agents for social good in future. Some of the characteristic attributes that a graduate should demonstrate are as follows:

1. **Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines
2. **Research-related skills:** A sense of inquiry and capability for asking relevant/appropriate questions, problematizing, synthesizing and articulating
3. **Analytical reasoning:** Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others
4. **Critical thinking:** Capability to apply analytic thought to a body of knowledge
5. **Problem solving:** Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems
6. **Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally

7. **Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.
8. **Self-directed learning:** Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.
9. **Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams
10. **Scientific reasoning:** Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective
11. **Reflective thinking:** Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.
12. **Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective
13. **Moral and ethical awareness/reasoning:** Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work
14. **Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.
15. **Lifelong learning:** Ability to acquire knowledge and skills, including 'learning how to learn', that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Programme Outcomes (POs)

1. **In depth knowledge:** Understand the concepts and processes related to an academic field of study and to demonstrate applicability of their domain knowledge and its links to related disciplinary areas/subjects of study.
2. **Specialised knowledge and skills:** Demonstrate procedural knowledge and skills in areas related to one's specialization and current developments, including a critical understanding of the latest developments in the area of specialization, and an ability to use established techniques of analysis and enquiry within the area of specialisation.
3. **Analytical and critical thinking:** Demonstrate independent learning, analytical and critical thinking of a wide range of ideas and complex problems and issues.
4. **Research and Innovation:** Demonstrate comprehensive knowledge about current research in the subject of specialisation; critical observation to identify research problems and to collect relevant data from a wide range of sources, analysis and interpretation of data using methodologies as appropriate to the area of specialisation for formulating evidence-based research output.
5. **Interdisciplinary Perspective:** Commitment to intellectual openness and developing understanding beyond subject domains.
6. **Communication Competence:** Demonstrate effective oral and written communicative skills to convey disciplinary knowledge and to communicate the results of studies

undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s) of study

7. **Career development:** Show proficiency in academic, professional, soft skills and employability required for higher education and placements.
8. **Team work:** Work in teams with enhanced inter-personal skills leadership qualities.
9. **Commitment to the society and to the Nation:** Recognise the importance of social, environmental, human and other critical issues faced by humanity at the local, national and international level; appreciate the pluralistic national culture and the importance of national integration.

Qualification descriptors for the graduates (QD)

QD-1: Demonstrate comprehensive knowledge and interdisciplinary skills in the fields of biochemistry, cell and molecular biology, genetics, bioprocess engineering, plant biotechnology, genetic engineering, microbiology and bioinformatics.

QD-2: Use knowledge and skills in the fields of molecular and cell biology, bioprocess engineering and biotechnology to identify research questions to design new products and test them.

QD-3: Apply disciplinary knowledge and transferable skills in areas related to biotechnology and bioinformatics to design and develop new products for solving problems in pharma, healthcare, and agriculture sectors.

QD-4: Communicate the results of studies undertaken in the fields of biotechnology and bioinformatics to biomedical scientific journals and in popular science forums.

QD-5: Demonstrate knowledge and transferable skills in the fields of biotechnology and bioinformatics suitable for employment in pharma and biotech industry, government research institutes or agencies and journal publishers.

Program Specific Learning Outcomes (PSOs) for BSc. Biotechnology

| Program Specific Learning Outcomes | Description of the Program Learning Outcomes of Graduates |
|------------------------------------|--|
| PSO1 | Demonstrate a holistic understanding and comprehension of the core, interdisciplinary and allied fields of biotechnology |
| PSO2 | Demonstrate aptitude for critical thinking and analytical reasoning to address real-time research problems. |
| PSO3 | Understand the need and impact of biotechnological solutions for addressing endemic societal and environment problems and attempt solutions for sustainable global development. Acquire hands on training on entrepreneurial ventures for sustainable livelihood. |
| PSO4 | Develop competencies for effective communication (oral/written/ICT) at various levels, capacities and situations. |
| PSO5 | Demonstrate the ability to comprehend/ identify moral, ethical and professional values and be responsible for the same |
| PSO6 | Acquire practical skills and the ability to apply theoretical concepts for designing, conducting, analysing and interpreting experimental data. Develop an inclination for future research based on the aforementioned skills |

Teaching-learning process:

The department of MBBT, Cotton University has student-centric teaching-learning pedagogies to enhance the learning experiences of the students. All classroom lectures are interactive in nature, allowing the students to have meaningful discussions and question and answer sessions. Apart from the physical classes, lectures are also held in online mode where students can have doubt clearing and discussions with the teachers. Most of the teachers use ICT facilities with power-point presentations, e-learning platforms and other innovative e- content platforms for student-centric learning methods.

The Department has adopted participative teaching-learning practices, which includes seminars, presentations and group discussions. These participative teaching-learning practices are included in the curricula of almost all the courses. Apart from these, exposure visits, special lectures by invited experts, workshops, and National/International seminars are held to augment knowledge, encourage innovative ideas and expose the students to global academic and research advancement.

The short-term projects, research projects, assignments and field work, which are the integral components of all the courses, enable the students to solve practical problems. Students are also being engaged in sample surveys, data collection and analysis works of the in-house and external research projects for acquiring experiential learning. The laboratories of the department offer hands-on learning experiences to the students.

Assessment methods:

A variety of assessment methods that are appropriate to the discipline are used to assess progress towards the course/programme learning outcomes. Priority is accorded to formative assessment. Progress towards achievement of learning outcomes is assessed using the following: closed-book examinations; problem-based assignments; practical assignment; laboratory reports; individual project reports (case-study reports); team project reports; oral presentations, including seminar presentation; viva-vice interviews; computerised testing and any other pedagogic approaches as per the context.

PART-II

Outline of the courses under Choice Based Credit System:

Each course of a program will be of one of the following categories-

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.1 **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2 **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

2.3 **Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. **Ability Enhancement Courses (AEC):** The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. These are mandatory for all disciplines. SEC courses are value- based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

3.1 **Ability Enhancement Compulsory Courses (AECC):** Environmental Science, English Communication/MIL Communication.

3.2 **Skill Enhancement Courses (SEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

COURSE STRUCTURE: 3 Year B.Sc. Biotechnology Programme (Hons)

| Semester | Courses | Paper Code | Course Names | Credits (L+T+P) | Total |
|----------|---------|------------|---|-----------------|-------|
| I | Core-1 | BTN101C | Biochemistry and Metabolism | 4+0+2 | 6 |
| | Core-2 | BTN102C | Cell Biology | 4+0+2 | 6 |
| | AECC1 | | English/EVS/MIL communication | 2+0+0 | 2 |
| | GE-1 | BTN103G | Biotechnology and Human Welfare | 5+1+0 | 6 |
| II | Core-3 | BTN201C | Mammalian Physiology | 4+0+2 | 6 |
| | Core-4 | BTN202C | Plant Anatomy and Physiology | 4+0+2 | 6 |
| | AECC2 | | English/EVS/MIL communication | 2+0+0 | 2 |
| | GE-2 | BTN203G | Bioethics, Biosafety and IPR | 5+1+0 | 6 |
| III | Core-5 | BTN301C | Genetics | 4+0+2 | 6 |
| | Core-6 | BTN302C | General Microbiology | 4+0+2 | 6 |
| | Core-7 | BTN303C | Plant and Animal Biotechnology | 4+0+2 | 6 |
| | SEC-1 | BTN001S | Bio-Prospection of Indigenous resources | 1+0+1 | 2 |
| | GE-3 | BTN305G | Developmental Biology | 5+0+1 | 6 |
| IV | Core-8 | BTN401C | Molecular Biology | 4+0+2 | 6 |
| | Core-9 | BTN402C | Immunology | 4+0+2 | 6 |
| | Core-10 | BTN403C | Computer application and Bioinformatics | 4+0+2 | 6 |
| | SEC-2 | BTN002S | Molecular Diagnostics | 1+0+1 | 2 |
| | GE-4 | BTN405G | Microbiology and Immunology | 4+0+2 | 6 |
| V | Core-11 | BTN501C | Bioprocess and Food Biotechnology | 4+0+2 | 6 |
| | Core-12 | BTN502C | Recombinant DNA Technology | 4+0+2 | 6 |
| | DSE-1 | BTN503D | Biostatistics | 4+0+2 | 6 |
| | DSE-2 | BTN504D | Environmental Biotechnology | 4+0+2 | 6 |
| VI | Core-13 | BTN601C | Bio Analytical Tools | 4+0+2 | 6 |
| | Core-14 | BTN602C | Genomics and Proteomics | 4+0+2 | 6 |
| | DSE-3 | BTN603D | Biodiversity and Conservation Genetics | 5+1+0 | 6 |
| | DSE-4 | BTN604D | Dissertation | 0+0+6 | 6 |

Core: Core Course, **GE:** Generic Elective, **AECC:** Ability Enhancement Compulsory Course, **SEC:** Skill Enhancement Course, **DSE:** Discipline Specific Elective

| Course Detail | Number | Total Credit |
|--------------------|--------|--------------|
| Core | 14 | 84 |
| AECC | 2 | 4 |
| GE | 4 | 24 |
| SEC | 2 | 4 |
| DSE | 4 | 24 |
| Grand Total | | 140 |

Mapping of POs and the Course Learning Outcomes of B.Sc. in Biotechnology (Hons) Programme

| Programme Outcomes | | Biochemistry and Metabolism (BTN101C) | Cell Biology (BTN102C) | English/EVS/MIL communication | Biotechnology and Human Welfare (BTN103G) | Mammalian Physiology (BTN201C) | Plant Anatomy and Physiology (BTN202C) | English/EVS/MIL communication | Bioethics, Biosafety and IPR (BTN203G) | Genetics (BTN301C) | General Microbiology (BTN302C) | Plant and Animal Biotechnology (BTN303C) | Bio-Prospection of Indigenous resources (BTN001S) | Developmental Biology (BTN305G) |
|--------------------|----------------------------------|---------------------------------------|------------------------|-------------------------------|---|--------------------------------|--|-------------------------------|--|--------------------|--------------------------------|--|---|---------------------------------|
| | | Core-1 | Core-2 | AECC1 | GE-1 | Core-3 | Core-4 | AECC2 | GE-2 | Core-5 | Core-6 | Core-7 | SEC-1 | GE-3 |
| PO1 | In depth knowledge | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO2 | Specialised knowledge and skills | ✓ | ✓ | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO3 | Analytical and critical thinking | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO4 | Research and Innovation | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| | | | | | | | | | | | | | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PO5 | Interdisciplinary Perspective | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO6 | Communication Competence | | | ✓ | | | | ✓ | | | | | ✓ | ✓ |
| PO7 | Career development | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO8 | Team work | ✓ | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO9 | Commitment to the society and to the Nation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| | |
|---|---------------|
| ✓ | Compliant |
| | Non-compliant |

Mapping of POs and the Course Learning Outcomes of B.Sc. in Biotechnology (Hons) Programme

Table 2: B.Sc. Biotechnology COURSES

| Programme Outcomes | | Core-8 | Core-9 | Core-10 | SEC-2 | GE-4 | Core-11 | Core-12 | DSE-1 | DSE-2 | Core-13 | Core-14 | DSE-3 | DSE-4 |
|--------------------|----------------------------------|--------|--------|---------|-------|------|---------|---------|-------|-------|---------|---------|-------|-------|
| PO1 | In depth knowledge | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO2 | Specialised knowledge and skills | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO3 | Analytical and critical thinking | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO4 | Research and Innovation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| | | | | | | | | | | | | | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PO5 | Interdisciplinary Perspective | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO6 | Communication Competence | | | | | | | | | | | | | ✓ |
| PO7 | Career development | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO8 | Team work | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO9 | Commitment to the society and to the Nation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| | |
|---|---------------|
| ✓ | Compliant |
| | Non-compliant |

SEMESTER-I
PAPER: CORE-1
PAPER CODE: BTN101C
BIOCHEMISTRY AND METABOLISM
CREDITS: 4+0+2

Course Outcome:

CO1: Learn in detail the structures, functions and classification of biological molecules (protein, carbohydrate, lipid, nucleic acids).

CO2: Learn the basic concept of enzyme function and action, Inhibition of enzyme activity.

CO3: Comprehend the vital metabolic pathways of living organisms and the interconversion of metabolic fuels.

THEORY:

| Unit | Carbohydrates and Lipids | No. of Lectures |
|------|--|-----------------|
| I | Monosaccharides - structure of aldoses and ketoses; Ring structure of sugars, mutarotation, anomers, epimers and enantiomers; Formation of disaccharides, reducing and non-reducing disaccharides; Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Lipids: Structure and functions. Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, Sphingolipids, Glycolipids | 15 |
| Unit | Proteins and Nucleic acids | No. of Lectures |
| II | Amino acids and Proteins: Structure, properties, classification; forces stabilizing protein structure and shape of protein, Sequencing technique - Edman degradation. Nucleotides - structure and properties; Nucleic acid structure – Watson-Crick model of DNA; Structure of major species of RNA - mRNA, tRNA and rRNA; Denaturation and renaturation of DNA | 15 |
| Unit | Enzymes Catalysis | No. of Lectures |
| III | Introduction to enzymes, active sites, co factors; classification of enzymes; Mechanism of enzyme action: Michaelis-Menten kinetics; concept of activation energy, transition state; Kinetics of enzyme catalysed reaction, Enzyme specificity: Types and theories, Enzyme inhibition: reversible and irreversible; regulation of enzyme activity | 15 |
| Unit | Metabolic pathways | No. of Lectures |
| IV | Glycolysis, Fate of pyruvate under aerobic and anaerobic conditions TCA cycle, Electron Transport Chain, Oxidative phosphorylation, Pentose phosphate pathway and its significance, Gluconeogenesis, β -oxidation of fatty acids. | 15 |

PRACTICAL:

1. Qualitative and Quantitative tests for carbohydrates
2. Qualitative tests for amino acids and proteins.
3. Quantitative tests for amino acids and proteins.
4. Study the effect of salivary amylase on starch

Recommended Textbooks and References:

1. Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.

2. D L Nelson and M M Cox, Lehninger Principles of Biochemistry, 7th edition, Macmillan 2017.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.
4. Thomas M Devlin(2010) Text of Biochemistry with Clinical Correlations, Wiley-Liss

SEMESTER-I
PAPER: CORE-2
PAPER CODE: BTN102C
CELL BIOLOGY
CREDITS: 4+0+2

Course Outcome:

CO1: Ability to understand basics of cell structure and function.

CO2: Ability to understand cell signalling and cellular transport of macromolecules.

THEORY:

| Unit | Cell Membrane -Structure and Function | No. of Lectures |
|------|--|-----------------|
| I | Structure of cell membrane, Membrane Theories, Cell Membrane and permeability: membrane as a dynamic entity, membrane transport. | 10 |
| Unit | Interaction of the cell with its environment | No. of Lectures |
| II | General principles of cell communication: cell-cell communications, cell-environment communications. Role of different adhesion molecules: Desmosomes, Hemi-desmosomes, Gap junctions, Tight Junctions, Plasmodesmata | 15 |
| Unit | Cell Organelles | No. of Lectures |
| III | Structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; endoplasmic reticulum and Golgi apparatus, lysosomes, cellular cytoskeleton, mitochondria, and chloroplasts. Nucleus, nucleolus and chromosomes. Organelle Interconnectivity and communication of Mitochondria with the endomembrane system. | 20 |
| Unit | Cellular signalling pathways | No. of Lectures |
| IV | Signalling in normal cells: G-protein mediated signalling, RTK signalling, Ca ⁺⁺ signalling, Insulin Signalling, Ras-MAPK signalling, Wnt signalling. Hedgehog signalling, Toll-like receptor signalling pathways in Apoptosis and Cancer. | 15 |

PRACTICAL:

1. Study of prokaryotic and eukaryotic cell
2. Cell division in onion root tip
3. Demonstration of Dialysis
4. Study of plasmolysis and de-plasmolysis
5. Study of morphological variations in cell nuclei

Recommended Textbooks and References:

1. Karp G., Cell and Molecular Biology: Concepts and Experiments, 7th Edition (John Wiley & Sons, Inc., 2013).
2. Scott, M. P. et al, Molecular Cell Biology, 6th Edition (W. H. Freeman, 2007).
3. Alberts, B. et al., Molecular Biology of the Cell, 5th Edition (Garland Publishing, 2008).
4. Pecorino, Lauren. Molecular biology of cancer: mechanisms, targets, and therapeutics. 4th Edition (Oxford university press, 2012.)

SEMESTER-I
PAPER: GE-1
PAPER CODE: BTN103G
BIOTECHNOLOGY AND HUMAN WELFARE
CREDITS: 5+1+0

Course Outcome:

CO1: Ability to understand basics application of biotechnology in industry, medicine and therapeutics,

CO2: Ability to understand basics application of biotechnology in agriculture and environment.

THEORY

| Unit | Historical timeline of Biotechnology | No. of Lectures |
|------|---|-----------------|
| I | Emergence of fermentation; chromosome structure and discovery of double-helical structure of DNA; era of microbial genetics; era of gene manipulation, emergence of tools and techniques of genetic engineering; Genetically Modified Organisms, Human Genome Project. | 20 |
| Unit | Industrial Biotechnology | No. of Lectures |
| II | Screening for new microbial products, strain improvement, application of industrial microbiology- alcohol, organic acids, antibiotics, yeast, enzymes. Fermented foods- advantages; cheese, wine, fermented fish, bamboo shoot. SCP- advantages, types. Biopesticides: Introduction and application in organic farming for plant disease management. | 20 |
| Unit | Animal & Medical Biotechnology | No. of Lectures |
| III | Introduction to animal cell culture –scope of animal tissue and cell culture, monolayer culture, suspension culture, organ culture, continuous cell lines; subculture; culture media -natural media, serum containing and serum free media. Transgenic animals- objectives, transfection methods. Red biotechnology; biotechnology in medicine: production of monoclonal antibodies, antibiotics and vaccines. Stem cell therapy. | 20 |
| Unit | Agricultural and Environmental Biotechnology | No. of Lectures |
| IV | Introduction to plant tissue culture techniques and its application; biotechnology for improvement of crop yield and quality. Introduction to biodiversity; concept of DNA banks; cryopreservation for biodiversity conservation. | 15 |

Recommended Textbooks and References:

1. Frontiers in Microbial Technology- Bisen, P.S. *CBS Publishers*; 1994.
2. Food Microbiology- Adam, M.R. and Moss, M.O. *New Age International Pvt. Ltd*; 1995.
3. Industrial Microbiology- Prescott, S.C. and Dunn C.G. *Agrobios (India), Jodhpur/ CBS Publishers & Distributors*; 2005.
4. Human Molecular Genetics- Strachan, T. and Andrew, P. *John Wiley-New York*; 2001.
5. Plant Biotechnology- Hammond, J.H., Mcgarvey, P. and Yusibov, V. *Springer Verlag, Heidelberg*; 2000.

SEMESTER-I
PAPER: AECC1
PAPER CODE: N/A
ENGLISH/EVS/MIL COMMUNICATION
CREDITS: 2+0+0

[The detail syllabus for this paper is available with the concerned departments]

SEMESTER-II
PAPER: CORE-3
PAPER CODE: BTN201C
MAMMALIAN PHYSIOLOGY
CREDITS: 4+0+2

Course Outcome:

CO1: Ability to identify different physiological process in mammals.

CO2: Ability to understand the mechanism of digestive, circulatory, respiratory and nervous system in mammals.

THEORY:

| Unit | Digestion and Respiration | No. of Lectures |
|------|---|-----------------|
| I | Digestion: Mechanism of digestion and absorption of carbohydrates, proteins, lipids and nucleic acids. Composition of bile, saliva, pancreatic, gastric and intestinal juice. Respiration: Exchange of gases, Transport of O ₂ and CO ₂ , Oxygen dissociation curve, Chloride shift | 15 |
| Unit | Blood Circulation | No. of Lectures |
| II | Composition of blood, Plasma proteins and their role, blood cells, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin and conduction of heart beat. | 15 |
| Unit | Muscle physiology and osmoregulation | No. of Lectures |
| III | Structure of cardiac, smooth and skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical and electrical events of mechanism of muscle contraction. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation. | 15 |
| Unit | Nervous and endocrine coordination | No. of Lectures |
| IV | Mechanism of generation and propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters, Mechanism of action of hormones (insulin and steroids); Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo and hypersecretions. | 15 |

PRACTICAL:

1. Determination of blood coagulation time.
2. Determination of blood groups.
3. Counting of mammalian RBCs.
4. Estimation of blood glucose.

Recommended Textbooks and References:

1. Textbook of Medical Physiology (XI edition)- Guyton, A.C. and Hall, J.E. *Hercourt Asia PTE Ltd. /W.B. Saunders Company*; 2006.
2. Principles of Anatomy & Physiology (XI edition)- Tortora, G.J. and Grabowski, S. *John Wiley & Sons Inc.*; 2006.

SEMESTER-II
PAPER: CORE-4
PAPER CODE: BTN202C
PLANT ANATOMY AND PHYSIOLOGY
CREDITS: 4+0+2

Course Outcome:

CO1: Understand the root and shoot anatomy of monocot and dicot plants.

CO2: Knowledge on the various aspects of plant water relations.

CO3: Comprehend the vital physiological and metabolic processes for the growth and developments of plants.

| Unit | Plant Anatomy | No. of Lectures |
|------|---|-----------------|
| I | Structure and Development of Plant Body: Tissues and tissue system, Theories of structural organization of root apex and shoot apex (SAM, RAM) and their developmental stages, Secondary and anomalous secondary growth in monocot and dicot stems. | 15 |
| Unit | Plant water relations, Mineral nutrition and Transport | No. of Lectures |
| II | Plant water relations, Water Potential, water absorption by roots, pathways of water movement, aquaporins, Ascent of sap: Cohesion-Tension theory, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration. | 15 |
| Unit | Leaf ontogeny and Photosynthesis | No. of Lectures |
| III | Photosynthesis, Photosynthetic pigments, concept of two photo systems, photophosphorylation, C3, C4 Cycle and CAM plants, Factors affecting rate of photosynthesis; photorespiration. Leaf Ontogeny | 15 |
| Unit | Plant Hormones | No. of Lectures |
| IV | Plant growth hormones: auxin, gibberellin, cytokinin, abscisic acid and ethylene: Physiological role and mode of action. Influence on seed dormancy, seed germination and light signalling | 15 |

PRACTICAL:

1. Preparation of stained mounts of anatomy of monocot and dicot's root.
2. Preparation of stained mounts of anatomy of monocot and dicot's stem and leaf.
3. To study the Effect of carbon dioxide on the rate of photosynthesis.
4. Extraction and estimation of chlorophyll from plants.

Recommended Textbooks and References:

1. Integrative Plant Anatomy- Dickinson, W.C. *Harcourt Academic Press, USA*; 2000.
2. Anatomy of Seed Plants- Esau, K. *Wiley Publishers*; 1997.
3. Plant Anatomy- Fahn, A. *Pergmon Press, USA and UK*; 1974.
4. Introduction to Plant Physiology- Hopkins, W.G. and Huner, P.A. *John Wiley and Sons*; 2008.
5. Plant Anatomy- Mauseth, J.D. *The Benjamin/Cummings Publisher, USA*; 1998.
6. Plant Physiology- Salisbury, F.B. and Ross, C.W. *Wadsworth Publishing Co. Ltd.*; 1991.
8. Plant Physiology- Taiz, L. and Zeiger, E. *Sinauer Associates Inc. MA, USA*; 2002.

SEMESTER-II
PAPER: AECC2
PAPER CODE: N/A
ENGLISH/EVS/MIL COMMUNICATION
CREDITS: 2+0+0

[The detail syllabus for this paper is available with the concerned department]

SEMESTER-II
PAPER: GE-2
PAPER CODE: BTN203G
BIOETHICS, BIOSAFETY AND IPR
CREDITS: 5+1+0

Course Outcome:

- CO1: Ability** to perceive the intellectual property rights of products derived from biotechnology research
CO2: Ability to perceive and practice the ethical code in research as outlined by statutory bodies
CO3: Ability to assess the risk of products derived from recombinant DNA research.

THEORY:

| Unit | Bioethics for biomedical and health research | No. of Lectures |
|------|--|-----------------|
| I | Historical evolution and Fundamentals of bioethics; Animal rights, ethics and environment, social experimentation and role of ethics, Ethical committee's role. Clinical ethics, Gene therapy product development and clinical trials, stem cell research, assisted reproductive technologies-regulatory arrangements, surrogacy, designer babies. Ethical implication of cloning. | 20 |
| Unit | Introduction to Biosafety | No. of Lectures |
| II | Definition, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region and country, bio-safety in laboratory, Institutional Biosafety committee, Classification and description of biosafety levels; Biosafety cabinets; Biosafety regulations to protect nature; Potential risk from Genetically modified organisms. | 20 |
| Unit | Intellectual Property Rights | No. of Lectures |
| III | General overview of Intellectual Properties, Industrial Design and trademark; Trade secret; Traditional knowledge, new plant varieties and geographical indication; Patents structure and classification; Patenting procedures; Patenting in Biotechnology. | 20 |
| Unit | Bioethics in practice | No. of Lectures |
| IV | Public understanding of science; Bioethics in the laboratory- the Mertonian norms; scientific integrity-truthfulness, diligence, objectivity, collegiality; respect for subject of study- human and non-human; professional duties, educational responsibilities. | 15 |

Recommended Textbooks and References:

- Bioethics- an introduction for biosciences- Mephram, B., *Oxford University Press Inc., New York*; 2008.
- Bioethics and Biosafety- Sateesh, M.K.I. K. *International Pvt. Ltd.*; 2009.
- IPR, Biosafety and Bioethics- Goel and Parashar, *Pearson Education. Delhi, Chennai*; 2013.

SEMESTER III
PAPER: CORE-5
PAPER CODE: BTN301C
GENETICS
CREDITS: 4+0+2

Course Outcome:

- CO1: To understand** the laws governing the inheritance of characters in biological system
CO2: Knowledge on the chromosomal and genomic organization of prokaryotes and eukaryotes.
CO3: Delineating the cell division abnormalities and agents underlying gene mutation.
CO4: Ability to understand the genetic basis of variation, to do gene mapping and find the relation between genotype and phenotype.

THEORY:

| Unit | Mendelian genetics | No. of Lectures |
|------|--|-----------------|
| I | Historical developments in the field of genetics Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Law of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance. Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, pleiotropy, multiple allele, lethal genes, penetrance and expressivity. Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes. | 20 |
| Unit | Genome organization | No. of Lectures |
| II | Eukaryotic nuclear genome composition—unique & repetitive DNA, satellite DNA. Noncoding DNA sequences, Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, Genome organization in prokaryotes. | 10 |
| Unit | Genetic Mutations and Chromosomal aberrations | No. of Lectures |
| III | Gene mutations: Definition and types of mutations, Spontaneous and Induced mutation: Causes and effects, Ames test for mutagenic agents. Structural changes in chromosome: variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression. Numerical changes in chromosome: Aneuploidy and Euploidy | 15 |
| Unit | Linkage, Sex determination and Population genetics | No. of Lectures |
| IV | Linkage and Recombination of genes in a chromosome crossing over- Models and Mechanisms. Sex determination and sex linkage: Mechanisms of sex determination, Barr bodies, dosage compensation, sex linked inheritance. In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating. | 15 |

PRACTICAL:

1. Studies on Mendel's law of segregation
2. Studies on Mendel's law of independent assortment

3. Demonstration of Barr body.
4. Karyotype analysis in human.
5. Pedigree charts of some common characters like blood group, color blindness and PTC testing.

Recommended Textbooks and References:

1. Principles of Genetics (VIII edition) -Gardner, E.J., Simmons, M.J. and Snustad, D.P. John Wiley and Sons; 1991.
2. Principles of Genetics (V edition) -Snustad, D.P. and Simmons, M.J. John Wiley & Sons; 2008.
3. Concepts of Genetics (IX edition)- Klug, W.S., Cummings, M.R., Spencer, C.A., Pallino, M.A. and Killian, D. Pearson; 2009.
4. Genetics- A Molecular Approach (III edition)- Russell P.J. Benjamin Cummings; 2009.
5. Introduction to Genetic Analysis (IX edition)- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.W. H. Freeman & Company; 2007.

SEMESTER-III

PAPER: CORE-6

PAPER CODE: BTN302C

GENERAL MICROBIOLOGY

CREDITS: 4+0+2

Course Outcome:

CO1: Follow the historical discoveries made in the field of microbiology and the evolution of microbiology.

CO2: Comprehend the diversity of bacteria, classification and identification with knowledge of general characters of various bacterial phyla.

CO3: Understand basic concepts of microbial nutrition, growth and genetics

THEORY:

| Unit | Introduction to Microbiology | No. of Lectures |
|------|---|-----------------|
| I | Milestones in the history of Microbiology, Structure and activities of Microbial cells Morphology and cell structure of bacteria, Microorganisms and the Biosphere | 15 |
| Unit | Microbial taxonomy | No. of Lectures |
| II | Principle and its types; Classical and modern approach; Taxonomic Hierarchy, Bergey's Manual of Systematic/Determinative Bacteriology. | 15 |
| Unit | Cultivation, maintenance and application of microorganisms | No. of Lectures |
| III | Koch' Postulates, growth and culturing of microbes; Microbiological media, composition and types; growth curve, nutritional groups of bacteria; Methods of isolation, purification and preservation of microorganisms. Use of microorganism in food, industrial, agricultural and environmental sectors | 20 |
| Unit | Genetics of microbes and viruses | No. of Lectures |
| IV | DNA transfer in bacteria: transformation, conjugation, transduction. Viral replication; introductory idea of viroids, virusoid and prions. | 10 |

PRACTICAL:

1. Preparation of culture media and sterilization methods.
2. Isolation of microorganisms from different sources.
3. Techniques for maintaining pure culture in microorganisms.
4. Staining methods: simple staining, Gram staining, spore staining, negative staining.

Recommended Textbooks and References:

1. Brock Biology of Microorganisms (12th edition)- Madigan, M.T., Martinko, J.M. and Parker, J. *Pearson/Benjamin Cummings*; 2009.
2. General Microbiology (5th edition)- Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. *McMillan*; 2005.
3. Microbiology: An Introduction (9th edition)- Tortora, G.J., Funke, B.R. and Case, C.L. *Pearson Education*; 2008.
4. Prescott, Harley and Klein's Microbiology (7th edition)- Willey, J.M., Sherwood, L.M., Woolverton, C.J. and Prescott, L.M. *McGraw Hill Higher Education*; 2008.

SEMESTER-III
PAPER: CORE-7
PAPER CODE: BTN303C
PLANT AND ANIMAL BIOTECHNOLOGY
CREDITS: 4+0+2

Course Outcome:

CO 1: Comprehend the basics and methodology of plant and animal tissue culture.

CO 2: Understand the applications of plant and animal cell culture in basic/applied research.

THEORY:

| Unit | Plant Cell and tissue culture | No. of Lectures |
|------|--|-----------------|
| I | Introduction to plant tissue culture: Cellular totipotency, Culture media and plant growth regulators, callus culture, cell suspension culture, ovary and embryo culture, root and shoot tip culture, Somatic embryogenesis, Somaclonal variation, Protoplast isolation and Culture | 15 |
| Unit | Application of plant tissue culture | No. of Lectures |
| II | Micropropagation, secondary metabolite production, production of virus free plants, methods of cryopreservation and germplasm conservation, Genetic transformation and crop improvement. | 15 |
| Unit | Animal cell culture techniques | No. of Lectures |
| III | Design and layout of animal cell culture laboratory; basic techniques of cell culture- primary culture, organ culture, embryo culture, monolayer culture, suspension culture, transformed animal cells and continuous cell line, Culture media-natural media- serum containing and serum free media; semi synthetic and synthetic media, Maintenance of cell culture: subculture, contamination, preservation | 15 |
| Unit | Applications of animal cell culture technology | No. of Lectures |
| IV | Cell products-antibodies and immuno-regulators, recombinant products; gene therapy, cell and tissue therapy, somatic cell fusion. Stem cells: properties, types, niche, culture of stem cells, embryonic stem cell transfer, applications. Transgenic animals: Sheep, Mice and Fish. Bio-piracy, ethical aspects of ART; therapeutic cloning- saviour siblings, designer babies; animal welfare and animal rights. | 15 |

PRACTICAL:

1. To learn about washing glasswares, wet and dry sterilization technique.
2. Preparation of different plant tissue culture media.
3. Sterilization of plant explant for inoculation.
4. To dissect and culture Embryo
5. Visit to an animal cell culture laboratory.

Recommended Textbooks and References:

1. Plant Biotechnology- Hammond, J. H., Mcgarvey, P. and Yusibov, V. *Springer, Heidelberg*; 2000.
2. Biochemistry and Molecular Biology of Plants- Buchanan, B. B., W. Gruissen and Jones R. L. *Rockville, American Society of Plant Biologist, USA*; 2000.
3. Plant Tissue Culture- Razdan, M.K., *Oxford /IBH Pub. Co. Pvt. Ltd.*; 2000.
4. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications-Freshney, R.I. *Wiley-Blackwell*; 2015.

SEMESTER-III**PAPER: SEC-I****PAPER CODE: BTN001S****BIO-PROSPECTION OF INDIGENOUS RESOURCES****CREDITS: 1+0+1****Course Outcome:**

CO1: Identify the different fermented foods of NE, and their medical/ nutritional value

CO2: Identify the fruiting stages of mushroom (Edible/Poisonous) and the culture requirements of mushrooms for mushroom cultivation

THEORY:

| Unit | Fermented food and its scope | No. of Lectures |
|------|--|-----------------|
| I | Indigenous fermented food of NE region- types, nutritional and medicinal values; value addition to fermented food. | 8 |
| Unit | Mushroom cultivation | No. of Lectures |
| II | Edible and poisonous mushroom; nutritional value, Cultivation Techniques (Spawn and Mushroom). | 7 |

PRACTICAL:

1. Analysis of fermented food- sensory and microbial.
2. Demonstration of Mushroom spawns production and cultivation.

Recommended Textbooks and References:

1. Food Microbiology (Paperback) - Adams, M.R., Moss, M.O. New Age International Private Ltd.; 2018.
2. Food Microbiology- Adams, M.R., Moss, M.O. and McClure, P. Royal Society of Chemistry; 2015.
3. Food Microbiology- Frazier, W.C., Westoff, D.C. and Vanitha, K.N. McGraw Hill Education; 2017.
4. Mushroom Biotechnology: Developments and Applications- Petre, M. Acad. Press; 2015

SEMESTER-III
PAPER: GE-3
PAPER CODE: BTN305G
DEVELOPMENTAL BIOLOGY
CREDIT: 5+0+1

Course Outcome:

CO1: Ability to understand the molecular basis of development in animals and plants.
CO2: Ability to understand how multicellular organism develops from a single cell through differentiation and development in animal and plants.

THEORY:

| Unit | Developmental biology and Genetics | No. of Lectures |
|------|---|-----------------|
| I | Historical perspective and different techniques in developmental biology, Model Organisms: An overview of model organisms Criterion of model organism. Developmental events and genetics: Genes in early development, control of gene expression and cell signalling, Early embryonic development: Gametogenesis, Fertilization, Cleavage I, Cleavage II, Gastrulation I, Gastrulation II. | 20 |
| Unit | Patterning of body plan in Vertebrates and Invertebrate | No. of Lectures |
| II | Early embryogenesis: morula and blastula formation, early cell differentiation, Cell lineages and developmental controls, formation of germ layers, gastrulation, Axis formation and anterior/posterior patterning and dorsal/ventral patterning in zebra fish/mouse/human. Early pattern formation and laying of body axis planes in invertebrates, Axis formation and anterior/posterior patterning and dorsal/ventral patterning in <i>Drosophila/C.elegans</i> (maternal effect genes, segmentation, zygotic genes). | 20 |
| Unit | Plant Embryonic Development and Patterning | No. of Lectures |
| III | Embryogenesis in plant: Development of Male and Female Gametophyte. Embryogenesis. Axial and Radial patterning in plants. Developmental control genes in a model plant (<i>Arabidopsis</i>). Regulation/Organization of Shoot Apical Meristem (SAM) and Root Apical Meristems (RAM) and Floral meristems (ABC Model). | 20 |
| Unit | Factors influencing Plant Development | No. of Lectures |
| IV | Photomorphogenesis and Skotomorphogenesis. Role of Micro RNAs. Recent advances in apomixes and Self-incompatibility. | 15 |

PRACTICAL:

1. Study of developmental stages in frog/chicken - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula.
2. Study of the different types of placenta- histological sections through permanent slides/ photomicrographs.
3. Examination of RAM and SAM under microscope.
4. Flower formula and flower diagram

Recommended Textbooks and References:

1. Developmental Biology (VIII edition)- Gilbert, S. F. *Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA*; 2006.
2. An introduction to Embryology- Balinsky, B.I. *International Thomson Computer Press*; 2008.
3. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015).
4. Plant physiology and development (Ed. 6). Sinauer Associates Incorporated.

SEMESTER-IV
PAPER: CORE-8
PAPER CODE: BTN401C
MOLECULAR BIOLOGY
CREDITS: 4+0+2

Course Outcome:

CO1: Ability to understand the molecular basis of various biological processes.

CO2: Ability to understand three fundamental aspects in biological phenomenon: The central dogma

CO3: Ability to understand the molecular basis of life.

THEORY:

| Unit | DNA replication and Chromosomal Organization | No. of Lectures |
|------|--|-----------------|
| I | Replication of DNA in prokaryotes and eukaryotes: Modes of DNA replication, Bi-directional and unidirectional replication, DNA polymerases; The replication complex: pre-priming proteins, primosome, replisome; Rolling circle replication. Chromosome Organization: Structure and characteristics of bacterial and eukaryotic chromosome, packaging of DNA molecule into chromosomes | 15 |
| Unit | DNA damage, repair and homologous recombination | No. of Lectures |
| II | DNA damage and repair, causes and types of DNA damage, mechanism of DNA repair: base excision repair, nucleotide excision repair, mismatch repair, recombinational repair, nonhomologous end joining. Homologous recombination models and mechanisms. | 15 |
| Unit | Transcription and RNA processing | No. of Lectures |
| III | Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, elongation; pre mRNA processing: 5' cap formation, 3' polyadenylation, Splicing, Editing | 15 |
| Unit | Genetic code and regulation of gene expression | No. of Lectures |
| IV | Genetic code-properties of universal genetic code, Wobble hypothesis, mitochondrial genetic code. Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides. Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system): Lac and Trp operon. | 15 |

PRACTICAL:

1. Isolation of chromosomal DNA from prokaryotic cells.
2. Isolation of genomic DNA from eukaryotic cells.
3. Agarose gel electrophoresis of genomic DNA.
4. Estimation of DNA by spectrophotometry.

Recommended Textbooks and References:

1. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). Lewin's genes XII. Jones & Bartlett Learning.
2. The World of the Cell (VII edition)- Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. Pearson Benjamin Cummings Publishing, San Francisco; 2009.
4. Alberts, Bruce, et al. "Molecular biology of the cell. Garland Pub." Inc., London (2002).

SEMESTER-IV
PAPER: CORE-9
PAPER CODE: BTN402C
IMMUNOLOGY
CREDITS: 4+0+2

Course Outcome:

CO 1: Ability to understand the basis of immunology.

CO 2: Ability to design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out the kind of immune responses in the setting of infection (viral or bacterial) by looking at cytokine profile

THEORY:

| Unit | Overview of the immune system | No. of Lectures |
|------|---|-----------------|
| I | Concept of immune system; Types of immunity: innate and adaptive, humoral and cell mediated immunity, primary and secondary immune responses. Development of the immune system: haematopoiesis; Components of the innate and adaptive immunity; Cells and organ of the immune system: B Lymphocytes, T lymphocytes, NK cells, Mononuclear phagocytes, Granulocytic cells, Primary lymphoid organs, secondary lymphoid organs. | 15 |
| Unit | Immune responses generated by B and T lymphocytes | No. of Lectures |
| II | Antigens: general properties, antigenicity and immunogenicity; antigen processing and presentation- endogenous antigens, exogenous antigens. Major Histocompatibility Complex: structures and function of CLASS I, CLASS II and CLASS III MHCs. Immunoglobulins: basic structure and function of immunoglobulins. Organization and expression of immunoglobulin genes Cell-mediated immune responses. | 15 |
| Unit | Immunodiagnosics, Immunotherapy and Vaccinology | No. of Lectures |
| III | Precipitation and agglutination reactions, Introduction to immunodiagnosics- RIA, ELISA, Western Blotting Concept of Active and passive immunization; Whole organism Vaccines, Purified macromolecules as vaccines, Recombinant vector vaccines, DNA vaccines, Subunit vaccines. Monoclonal antibodies and their therapeutic uses | 20 |
| Unit | Hypersensitivity, Immunodeficiency and Autoimmunity | No. of Lectures |
| IV | Introduction to hypersensitivity, types of hypersensitivity, introduction to primary and secondary immunodeficiency disorders, types of autoimmune diseases. | 10 |

PRACTICAL:

1. Radial Immunodiffusion Assay
2. Haemagglutination Assay
3. Blood smear identification of leucocytes
4. Effect of anticoagulant in blood clotting.
5. Determination of antibody titre by ELISA.

Recommended Textbooks and References:

1. 2. Roitt's Essential Immunology (11th edition)- Delves, P., Martin, S., Burton, D. and Roitt, I.M. Wiley-Blackwell Scientific Publication, Oxford; 2006.
2. Kubly's Immunology (6th edition)- Goldsby, R.A., Kindt, T.J. and Osborne, B.A.W.H. Freeman and Company, New York; 2007.

4. Janeway's Immunobiology (7th edition)- Murphy, K., Travers, P. and Walport, M. Garland Science Publishers, New York; 2008.

SEMESTER-IV
PAPER: CORE-10
PAPER CODE: BTN403C
COMPUTER APPLICATION AND BIOINFORMATICS
CREDITS: 4+0+2

Course Outcome:

CO1: Ability to generate data, data management concepts, data mining strategies and their effective utilization using computational tools.

CO2: Ability to comprehend the aspects of sequence data integration, management, mining and analysis for defined applications

THEORY:

| Unit | Introduction to Computers and Bioinformatics | No. of Lectures |
|------|---|-----------------|
| I | Operating Systems, Networks, Computers in biology. Bioinformatics- History, Scope, Applications | 15 |
| Unit | Introduction to Biological Databases | No. of Lectures |
| II | Databases- Types of Biological Databases, Pitfalls, Information Retrieval from Biological Databases | 15 |
| Unit | Sequence Alignment | No. of Lectures |
| III | Pairwise Sequence alignment; Sequence Homology, Sequence Similarity, Sequence Identity; Scoring Matrices , Statistical Significance of Sequence Alignment, Multiple Sequence Alignment, Scoring Function. | 15 |
| Unit | Phylogenetic Analysis | No. of Lectures |
| IV | Molecular Evolution and Molecular Phylogenetics, Distance-Based Methods, Character-Based Methods, Phylogenetic Tree Evaluation, Phylogenetic Programs | 15 |

PRACTICAL:

1. Various resources at NCBI.
2. Biological databases- Search and information retrievals, sequence retrieval.
3. Tools for database search: sequence alignment, BLAST
4. Phylogenetic analysis.

Recommended Textbooks and References:

1. Discovering Genomics, Proteomics and Bioinformatics- Campbell, A.M. and Heyer, L.J. Benjamin Cummings; 2006.
2. Developing Bioinformatics Computer Skill- Gibas, C. and Jambeck, P. O'Reilly Publication; 2001.
3. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGrawHill, 6th Edition, 2011.
4. Date C.J, "An Introduction to Database", Addison-Wesley Pub Co, 7th Edition, 2001.
5. Essential Bioinformatics- Xiong, J. Cambridge University Press; 2006.

SEMESTER-IV
PAPER: SEC-2
PAPER CODE: BTN002S
MOLECULAR DIAGNOSTICS
CREDITS: 1+0+1

Course Outcome:

CO1: Learn the skills and techniques associated with engineering of biochemical and clinical aspects of medical biotechnology

CO2: Learn the skills and techniques associated with disease diagnostics and therapeutics relevant to placement in the biotechnology/biomedical industry

THEORY:

| Unit | Enzyme Immunoassays | No. of Lectures |
|------|--|-----------------|
| I | Enzyme immunoassays after immunoblotting. Enzyme Immunohistochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immunoassays. | 5 |
| Unit | Molecular methods in clinical microbiology | No. of Lectures |
| II | Applications of PCR and RT-PCR; Susceptibility tests: Tests for bactericidal activity | 4 |
| Unit | Molecular diagnostics of disease pathogenesis | No. of Lectures |
| III | Detection genetic polymorphism, SNP, application of PCR-RFLP; Immunodiagnostic tests: Immunofluorescence, radioimmunoassay. | 4 |
| Unit | Flow Cytometry | No. of Lectures |
| IV | Flow cytometry and cell sorting. Electron microscopy. | 3 |

PRACTICAL:

1. Perform/demonstrate RFLP and its analysis.
2. Perform PCR for detection of viral infection.
3. Demonstration of immunohistochemistry.

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

Recommended Textbooks and References:

1. Practical Biochemistry, Principles and Techniques- Wilson, K. and Walker, J. Cambridge University Press; 2000.
2. Bioinstrumentation- Webster, J.G. John Wiley & Sons; 2008.
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes- Van Impe, J.F., Vanrolleghem, P.A. and Iserentant, D.M. Springer; 1998.
4. Jawetz, Melnick and Adelberg's Medical Microbiology (24th edition)- Brooks, G.F., Carroll, K.C., Butel, J.S. and Morse, S.A. McGraw- Hill Publication; 2007.
5. Mims' Medical Microbiology (4th edition)- Goering, R., Dockrell, H., Zuckerman, M. and Wakelin, D. Elsevier; 2007.

SEMESTER-IV
PAPER: GE-4
PAPER CODE: BTN405G
MICROBIOLOGY AND IMMUNOLOGY
CREDITS: 4+0+2

Course Outcome:

CO1: Obtain knowledge about various microbes including cell structure, cell cycles, reproduction in bacteria and aspects of bacterial growth and a firm grasp of the basics of microscopy and the principles.

CO2: Comprehend the concept of immunity, components of the immune system and the basics of immunotechnology

THEORY:

| Unit | History and evolution of microbiology | No. of Lectures |
|------|--|-----------------|
| I | Diversity of microorganisms- archaea and bacteria, eukarya- Microscopy: Light microscopy, phase contrast microscopy: basic working principles and applications | 15 |
| Unit | Microbial Nutrition and Growth | No. of Lectures |
| II | Concept of Microbial Nutrition and Growth. Major pathogenic microorganisms in humans and plants -infection modes | 15 |
| Unit | Concept of immunity | No. of Lectures |
| III | Acquired, innate, cell mediated and humoral immunity. Cells and organs of the immune system | 15 |
| Unit | Antigens and Antibody | No. of Lectures |
| IV | Concept of antigens and antibody-basic structure, types. Antigen-Antibody interactions- Agglutination and precipitation, RIA, ELISA | 15 |

PRACTICAL:

1. Aseptic techniques: Glassware sterilization, preparation and sterilization of media.
2. Gram's staining of bacteria.
3. Preparation of blood smear and observation of blood cells.
4. Haemagglutination Assay

Recommended Textbooks and References:

1. Microbiology- Prescott, Harley and Klein; McGraw- Hill Education; 2008.
2. Principles of Microbiology-Atlas, R. M., McMillan Publishing House; 1998.
3. Microbiology: An introduction- Tortora, G.J., Funke, B.R. and Case, C.L., Pearson Pub; 2018.
4. Kuby Immunology- Kindt, T.J., Goldsby, R.A., Osborne, B.A. and Kuby, J.W.H. Freeman, New York; 2007.
5. Essential Immunology- Delves, P.J., Martin, S.J., Burton, D.R. and Roitt, I.M. Blackwell Publishing company; 2004.

SEMESTER-V
PAPER: CORE-11
PAPER CODE: BTN501C
BIOPROCESS AND FOOD BIOTECHNOLOGY
CREDITS: 4+ 0+ 2

Course Outcome:

CO1. Understand the important aspects of microbial cultures: kinetics of growth and death, types of microbial culture, basic principles of fermentation technology.

CO2. Comprehend and apply the working principle and different types of bioreactors, their application in designing production processes.

THEORY:

| Unit | Introduction to bioprocess technology and food biotechnology | No. of Lectures |
|------|--|-----------------|
| I | Range of bioprocess technology. Basic principle components of fermentation technology, solid state and submerged fermentation, concept of starter culture; fermented foods. Types of microbial culture– batch, fed-batch and continuous culture. | 15 |
| Unit | Design of bioprocess vessels | No. of Lectures |
| II | Significance of Impeller, Baffles, Sparger; types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. | 15 |
| Unit | Downstream processing | No. of Lectures |
| III | Introduction to downstream processing, product recovery and purification. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins | 15 |
| Unit | Food biotechnology | No. of Lectures |
| IV | Basic food chemistry, food additives; enzymes in food industry; GM foods; food safety; food preservation – physical, chemical and biological methods. | 15 |

PRACTICAL:

1. Study of bacterial growth curve.
2. Production and analysis of ethanol.
3. Production and analysis of lactic acid.
4. Screening of extracellular enzyme producing bacteria from food.

Recommended Textbooks and References:

1. Industrial Microbiology (1st edition)- Casida, L.E. Wiley Eastern Limited; 1991.
2. Biotechnology: A textbook of Industrial Microbiology (2nd edition)- Crueger, W. and Crueger, A. Panima Publishing Co., New Delhi; 2000.
3. Industrial Microbiology (1st edition)- Patel, A.H. Macmillan India Limited; 1996.
4. Principles of Fermentation Technology (2nd edition)- Stanbury, P.F., Whitaker, A. and Hall, S.J. Elsevier Science Ltd.; 2006.
5. Microbial Biotechnology- Glazer, A.N. and Nikaïdo, H. W.H. Freeman & Co.; 1995.
6. Frontiers in Microbial Technology- Bisen, P.S. CBS Publishers; 1994.

SEMESTER-V
PAPER: CORE-12
PAPER CODE: BTN502C
RECOMBINANT DNA TECHNOLOGY
CREDITS: 4+0+2

Course Outcome:

CO 1: To be able to understand molecular cloning and design cloning strategies
CO 2: To understand the methods of gene delivery in plants and animals.

THEORY:

| Unit | Molecular tools and applications | No. of Lectures |
|------|---|-----------------|
| I | Restriction enzymes, ligases, Nucleases, polymerases, alkaline phosphatase, Reverse Transcriptase. Cloning vectors (<i>E.coli</i> based, Bacteriophage-derived, Artificial chromosomes) | 10 |
| Unit | Nucleic acid amplification and analysis techniques | No. of Lectures |
| II | Principle and applications of Polymerase chain reaction (PCR), primer-design. Types of PCR (Reverse transcription, Nested, Multiplex & Real time). Site-directed mutagenesis. Preparation and screening of Genomic and cDNA library. Rapid Amplification of cDNA Ends. Southern and Northern hybridization, Dot Blot, Microarray. | 20 |
| Unit | Gene transfer in mammalian systems | No. of Lectures |
| III | Gene transfer to animal cells: major strategies for gene transfer, selectable markers and reporter for animal cells, production of transgenic mice | 15 |
| Unit | Gene transfer in plants | No. of Lectures |
| IV | Genetic engineering in plants: Use of <i>Agrobacterium tumefaciens</i> and <i>A. rhizogenes</i> , Ti plasmids, Plant transformation markers and reporter genes, Use of plant viruses as episomal expression vectors. | 15 |

PRACTICAL:

1. Isolation of chromosomal DNA from plant tissues/ *E.coli*.
2. Qualitative and quantitative analysis of DNA using spectrophotometer.
3. Restriction digestion of DNA.
4. PCR amplification of gene.

Recommended Textbooks and References:

1. Gene Cloning and DNA Analysis- Brown, T.A. Blackwell Publishing, Oxford, UK; 2006.
2. Biotechnology-Applying the Genetic Revolution- Clark, D.P. and Pazdernik, N.J. Elsevier Academic Press, USA; 2009.
3. Molecular Biotechnology- Principles and Applications of recombinant DNA- Glick, B.R. and Pasternak, J. J.ASM Press, Washington; 2003.
4. Principles of Gene Manipulation and Genomics- Primrose, S.B. and Twyman, R.M. Blackwell Publishing, Oxford, U.K.; 2006.
5. Molecular Cloning-A Laboratory Manual- Sambrook, J., Fritsch, E.F. and Maniatis, T. Cold Spring Harbor Laboratory Press; 2001.

SEMESTER-V
PAPER: DSE-1
PAPER CODE: BTN503D
BIostatISTICS
CREDITS: 4+0+2

Course Outcome:

CO1: Describe various application area of biostatistics and distinguish different types of data and sampling techniques.

CO2: Compute and interpret central tendency, correlation, regression analysis and variability in statistical data

THEORY:

| Unit | Introduction to Biostatistics | No. of Lectures |
|------|--|-----------------|
| I | Introduction, characteristics and limitations of Biostatistics; applications and scope of biostatistics; Statistical terms and symbols, Collection of data; Primary and Secondary data, Classification and Graphical representation of statistical data. | 15 |
| Unit | Central tendency and Dispersion | No. of Lectures |
| II | Measures of central tendency and dispersion. Correlation and Regression. Examples from Biological Sciences. | 15 |
| Unit | Probability | No. of Lectures |
| III | Probability-definition; classical & axiomatic probability, Theorems of probability, Elementary ideas of Binomial, Poisson and Normal distributions. | 15 |
| Unit | Methods of sampling | No. of Lectures |
| IV | Methods of sampling, confidence level, testing of hypothesis, standard error and deviation. Test of significance- t-test, chi-square test for goodness of fit, analysis of variance (ANOVA). | 15 |

PRACTICAL:

1. Based on graphical representation.
2. Based on measures of Central Tendency and Dispersion.
3. Based on Distributions-Binomial, Poisson, Normal.
4. Based on t, f and Chi-square test.

Recommended Textbooks and References:

1. Introductory Biostatistics (1st edition)- Le, C.T. John Wiley, USA; 2003.
2. High Yield TM Biostatistics- Glaser, A.N. Lippincott Williams and Wilkins, USA; 2001.
3. Advanced Biology Statistics- Edmondson, A. and Druce, D. Oxford University Press; 1996.
4. Biostatistics: A foundation for Analysis in Health Sciences- Danial, W. John Wiley and Sons Inc.; 2004.
5. Practical Statistics for Experimental Biologists- Swardlaw, A.C. John Wiley and sons, Inc., New York; 1985.
6. Statistics for Biologists- Campbell, R.C. Cambridge University Press, Cambridge; 1974.

SEMESTER-V
PAPER: DSE-2
PAPER CODE: BTN504D
ENVIRONMENTAL BIOTECHNOLOGY
CREDITS: 4+0+2

Course Outcome:

CO 1. Understand the concepts, structure and function of environment, ecology and ecosystems.

CO 2. Explain the impacts caused to the environment by soil/air/water pollution, green-house gases.

CO 3. Understand and **design** process of bioremediation, bioleaching and microbe-based enrichment

THEORY:

| Unit | Introduction to Environmental Biotechnology | No. of Hrs |
|-------------|--|------------------------|
| I | An introduction to environmental resources- types and their conservation; Conventional fuels and their environmental impact, effects on greenhouse gas emissions; modern fuels and their environmental impact. | 15 |
| Unit | Bioremediation | No. of Lectures |
| II | Bioremediation of soil and water contaminated with oil spills, heavy metals and detergents; Phytoremediation. Degradation of pesticides and other toxic chemicals by microorganisms degradation aromatic and chlorinated hydrocarbons and petroleum products. Treatment of municipal waste and Industrial effluents. | 20 |
| Unit | Biofertilizers | No. of Lectures |
| III | Bio-fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers. Environmental significance of genetically modified microbes, plants and animals. | 10 |
| Unit | Bioleaching and microbe-based enrichment | No. of Lectures |
| IV | Bioleaching. Biosensors: Introduction to the concept of Biosensors, Biosensor types and Application. | 15 |

PRACTICAL:

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. Analysis of water sample by MPN method.

Recommended Textbooks and References:

1. Environmental Biotechnology: Principles and Applications- Rittmann, B.E. and McCarty, P. McGraw-Hill Education; 2001.
2. Waste Water Engineering- Metcalf and Eddy, Tata McGraw Hill Publishing Co. Ltd., New Delhi; 2005.
3. Environmental Microbiology: Methods and Protocols- Spencer, J.F.T. and Spencer, A.L.R. Humana Press; 2004.
4. An Introduction to Environmental Biotechnology- Wright, M. Kluwer Academic Publishers, Boston; 1999.
5. Biodegradation and Bioremediation (2nd edition)- Alexander, M. Acad. Press, 1999.
6. Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants- Prasad, M.N.V. and Strzalka, K. Kluwer Academic Publishers, Dordrecht; 1999.

SEMESTER-VI
PAPER: CORE-13
PAPER CODE: BTN601C
BIO ANALYTICAL TOOLS
CREDITS: 4+ 0+ 2

Course Outcome:

CO1: Understand the basics of biochemical analytical techniques and interpret the effect on sample analysis

CO-2: Acquire advanced understanding of microscopy and chromatography techniques for designing experiments and analysing data

CO-3: Comprehend various forms of spectroscopy and design experiments for sample analysis

THEORY:

| Unit | Basic laboratory techniques and Centrifugation | No. of Lectures |
|------|--|-----------------|
| I | pH meter: Principle, reference electrodes, asymmetric potential, application, care and maintenance. Centrifugation: Principles of sedimentation, factors effecting centrifugation, rotor types; ultracentrifuge, analytical centrifugation, differential and density gradient centrifugation. | 10 |
| Unit | Microscopy | No. of Lectures |
| II | Microscopy: Dark field microscope; phase contrast microscope, DIC, fluorescence microscope, Confocal, FRAP, electron microscopy- principle, instrumentation and application of SEM and TEM | 15 |
| Unit | Chromatography | No. of Lectures |
| III | Chromatography: Introduction to chromatography, general principle and application of paper chromatography, TLC, gel filtration chromatography, ion exchange chromatography, LPLC and HPLC, Gas chromatography. Electrophoresis: General principle and application; Agarose gel electrophoresis, SDS-PAGE | 15 |
| Unit | Spectroscopy and Radioactivity | No. of Lectures |
| IV | Absorption spectroscopy: Instrumentation and application of UV and visible spectroscopy, IR spectroscopy (FTIR), mass spectrometry, ESI, MALDI; Radiation- nonionizing and ionizing, radioactivity- types of decay; autoradiography, carbon dating | 20 |

PRACTICAL:

1. Calibration of pH meter.
2. Chromatographic separation of biomolecules.
3. Spectrophotometric estimation of vitamin C.
4. Chlorophyll estimation.

Recommended Textbooks and References:

1. Principles and Techniques of Biochemistry and Molecular Biology (Sixth edition)-Wilson, K. and Walker, J. Cambridge University Press; 2007 (Reprint).
2. Bioseparations (First edition)-Sivasankar, B. PHI Learning Pvt Ltd, New Delhi; 2010.
3. Bialek, William. Biophysics: searching for principles. Princeton University Press, 2012.
4. Cotterill, Rodney. "Biophysics: An Introduction." –Wiley, 2014

SEMESTER-VI
PAPER: CORE-14
PAPER CODE: BTN602C
GENOMICS AND PROTEOMICS
CREDITS: 4+0+2
THEORY

Course Outcome:

CO1: Acquire knowledge and understanding of fundamentals of genomics and proteomics

CO2: Understand the applications of genomics and proteomics in various applied areas of biology

THEORY:

| Unit | Genomics and Sequencing technologies | No. of Lectures |
|------|---|-----------------|
| I | Introduction to Genomics, DNA sequencing methods – manual and automated: Maxam- Gilbert and Sangers method. First, Second and Third Generation Sequencing | 15 |
| Unit | Databases | No. of Lectures |
| II | Nucleotide Sequence Databases, Protein Sequence Databases: Entrez and Ensemble | 10 |
| Unit | Introduction to protein structure | No. of Lectures |
| III | Introduction to protein structure: Primary, secondary, tertiary and quaternary. Chemical bonds in proteins. Ramachandran Plot. | 20 |
| Unit | Introduction to Proteomics | No. of Lectures |
| IV | Introduction to Proteomics, Analysis of proteomes- 2D-PAGE. Mass spectrometry-based methods for protein identification. | 15 |

PRACTICAL:

1. Using the Entrez database .
2. Using the Ensemble Genome Browser.
3. Softwares for Protein localization.
4. Demonstration of SDS-PAGE.

Recommended Textbooks and References:

1. Genes IX- Benjamin, L. Johns and Bartlett Publisher; 2006.
2. Modern Biotechnology (2nd edition)-Primrose, S.B. Blackwell Publishing; 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th edition)- Glick, B.R., Pasternak, J.J. and Patten, C.L. American Society for Microbiology; 2010.
4. Molecular Cloning: A Laboratory Manual (Vol. I to III)- Sambrook, J. and Russell, D. Cold Spring Harbor Laboratory Press, US; 2000.
5. Principles of Gene Manipulation (6th edition)- Primrose, S.B., Twyman, R.M and Old, R.W. Wiley-Blackwell; 2001.

SEMESTER-VI
PAPER: DSE-3
PAPER CODE: BTN603D
BIODIVERSITY AND CONSERVATION GENETICS
CREDITS: 5+1+0
THEORY

Course Outcome:

CO1: Understanding the basics of science of biodiversity in an ecological context

CO2: Learning tools and techniques relevant to monitoring of biological diversity

CO3: Ability to design a field-based project with rationale and appropriate methodology

THEORY:

| Unit | Introduction to Biodiversity and Conservation Genetics | No. of Lectures |
|------|---|-----------------|
| I | Introduction: Levels of biological diversity; importance of genetic diversity and need of biodiversity conservation; <i>Ex-situ</i> and <i>In-situ</i> conservation; Biodiversity hot-spots. Conservation genetics; concept, recognition of genetic factors in conservation biology, Genetic versus demographic and environmental factors in conservation biology. | 20 |
| Unit | Biodiversity Documentation and Assessment | No. of Lectures |
| II | Biodiversity Documentation and Assessment: Morphological and molecular characterization of biodiversity; Introduction to biodiversity databases; Endemism; Red data book; Germplasm conservation and biological repository. | 15 |
| Unit | Genetics and extinction | No. of Lectures |
| III | Genetics and the fate of endangered species, relationship between inbreeding and extinction, Relationship between loss of genetic diversity and extinction. Population Genetics: Evolution in large populations; Importance of mutation, migration and their interactions with selection in conservation, Selective value of mutations, Migration–selection equilibria and clines. Loss of genetic diversity in small populations; Relationship between population size and genetic diversity in wild populations, effective population size Hardy-Weinberg equilibrium, Low genetic diversity and threatened species, Genetic drift, Mutation, Natural selection, Migration and gene flow, Bottleneck and Founder effect. | 25 |
| Unit | Molecular Tools and Techniques for Biodiversity Conservation | No. of Lectures |
| IV | Allozymes; Microsatellites; RFLP; RAPD; AFLP; ISSR; SSR; VNTRs; SNPs; Chloroplast DNA; Mt DNA; DNA barcoding. | 15 |

Recommended Textbooks and References:

1. Biodiversity- Wilson, E.O. National Academy Press, Washington, D.C.; 1988.
2. A primer of Conservation Genetics- Frankham, R., Ballou, J.D. and Briscoe, D.A. Cambridge University Press; 2004.
3. Genetic Analysis: A History of Genetic Thinking- Falk, R. Cambridge University Press; 2011.
4. Population Genetics- Hamilton, M.B. Wiley-Blackwell; 2009.
5. Molecular Evolution and Phylogenetics- Nei, M. and Kumar, S. Oxford University Press; 2000.
6. Principles of Systematic Zoology-Mayr, E. and Ashlock, P.D. Mcgraw-Hill Book Comp;1991.
7. Fundamentals of Plant systematic- Radford, A.E. and Caddell, G.M. Harper & Row; 1986.

**SEMESTER-VI
PAPER: DSE-4
PAPER CODE: BTN604D
DISSERTATION
CREDITS: 0+0+6**

[Dissertation to be assigned to the students by respective supervisor(s) or teacher(s) in charge]

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