

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



**Four Year Undergraduate Syllabus: B.Sc. in Biotechnology
(Honours/Research)**

2023

Name of the Academic Program: Four Year BSc Biotechnology (Hons/Research)

Preamble

The four year undergraduate course in B.Sc. in Biotechnology is a eight semester programme, which encompasses theory and practical in different areas of biotechnology and allied disciplines of life-sciences. The syllabus has been framed in line with the NEP 2020, which facilitates multiple entry and exits. It also contains research component during seventh and eight semesters for students who have a CGPA of 7.5 or more. The programme has 23 Core papers (Theory & Practical), 8 Minors, 3 multi-disciplinary electives (MDE), 4 Ability enhancing courses (AEC), 3 Skill Enhancement Course (SEC) and 2 Value added courses (VAC).

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.
2. To provide the newest 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, entrepreneurship and employment generation.
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 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:

Disciplinary knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines.

Research-related skills: A sense of inquiry and capability for asking relevant/appropriate questions, problematizing, synthesizing and articulating.

Analytical reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others.

Critical thinking: Capability to apply analytic thought to a body of knowledge.

Problem solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems.

Communication Skills: Ability to express thoughts and ideas effectively in writing and orally.

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.

Self-directed learning: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.

Cooperation/Team work: Ability to work effectively and respectfully with diverse teams.

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.

Reflective thinking: Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.

Multicultural competence: Possess knowledge of the values and beliefs of multiple cultures and a global perspective.

Moral and ethical awareness/reasoning: Ability to embrace moral/ethical values in conducting one's life, formulates a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work.

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.

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/re-skilling.

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)

| Program Specific Learning Outcomes | Description of the Program Learning Outcomes of Graduates |
|---|---|
| PLO1 | Demonstrate a holistic understanding and comprehension of the core, interdisciplinary and allied fields of biotechnology |
| PLO2 | Demonstrate aptitude for critical thinking and analytical reasoning to address real-time research problems. |
| PLO3 | Understand the need and impact of biotechnological solutions for addressing endemic societal and environment problems and attempt solutions for sustainable glocal development. Acquire hands on training on entrepreneurial ventures for sustainable livelihood. |
| PLO4 | Develop competencies for effective communication (oral/written/ICT) at various levels, capacities and situations. |
| PLO5 | Demonstrate the ability to comprehend/ identify moral, ethical and professional values and be responsible for the same |
| PLO6 | 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 |

Mapping of POs and the Course Learning Outcomes of B.Sc. In the Four-year Biotechnology (Honours/Research) Programme

Table 1: FYDP in Biotechnology COURSES

| Programme Outcomes | Table 1: FYDP in Biotechnology COURSES | | | | | | | | | | | | | | | | | | |
|---|--|-----------------------------------|---|----------------------------------|--|--|--|--|---|--------------------------------|--------------------------------|--|-------------------------------------|--|---|--------------------------------------|--------------------------------|-------------------------------------|---|
| | Core-1 BTN23C101 Biology-I | Minor-1 BTN23M101 Biology-I | Modern Biology I BTN23MDE101 Modern Biology I | English communication-I AEC-1 | SEC-1 BTN23SEC001 Indigenous Knowledge System based utilization of | VAC-1/ VAC-2 Offered by University | Core-2 BTN23C201 Advanced Biology-II | Minor-2 BTN23M201 Advanced Biology-II (Minor) | Modern Biology II BTN23MDE201 Modern Biology II | AEC-2 Offered by University | SEC-2 Offered by University | VAC-3/ VAC-4 Offered by University | Core-3 BTN23C301 Cell biology | Minor-3 BTN23M301 Advanced Biology-III (Cell Biology) | Modern Biology III BTN23MDE301 Modern Biology III (Cell Biology) | AEC-3 English communication-II | SEC-3 Offered by University | Core-4 BTN23C302 Microbiology | |
| PO1 In depth knowledge | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO2 Specialised knowledge and skills | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO3 Analytical and critical thinking | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| PO4 Research and Innovation | X | X | X | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO5 Interdisciplinary Perspective | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO6 Communication Competence | X | X | X | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO7 Career development | X | X | X | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO8 Team work | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PO9 Commitment to the society and to the Nation | X | X | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| Table 2: FYDP in Biotechnology COURSES | | | | | | | | | | | | | | |
|--|--|------------------------------------|------------------|-------------------|--------|------------|----------|-------------------|-----------------------|-----------------------|-----------------------------------|------------|---------------------|------------------------------|
| Programme Outcomes | Table 2: FYDP in Biotechnology COURSES | | | | | | | | | | | | | |
| | Biochemistry | Advanced Biology-IV (Biochemistry) | Plant Physiology | Animal Physiology | MIL-II | Internship | Genetics | Molecular Biology | Developmental Biology | Analytical Techniques | Advanced Biology-V (Microbiology) | Immunology | Genetic Engineering | Bioethics, Biosafety and IPR |
| PO1 | Core-5 | Minor-4 | Core-6 | Core-7 | AEC-4 | Internship | Core-8 | Core-9 | Core-10 | Core-11 | Minor-5 | Core-12 | Core-13 | Core-14 |
| PO2 | Core-5 | Minor-4 | Core-6 | Core-7 | AEC-4 | Internship | Core-8 | Core-9 | Core-10 | Core-11 | Minor-5 | Core-12 | Core-13 | Core-14 |
| PO3 | Core-5 | Minor-4 | Core-6 | Core-7 | AEC-4 | Internship | Core-8 | Core-9 | Core-10 | Core-11 | Minor-5 | Core-12 | Core-13 | Core-14 |
| PO4 | Core-5 | Minor-4 | Core-6 | Core-7 | AEC-4 | Internship | Core-8 | Core-9 | Core-10 | Core-11 | Minor-5 | Core-12 | Core-13 | Core-14 |
| PO5 | Core-5 | Minor-4 | Core-6 | Core-7 | AEC-4 | Internship | Core-8 | Core-9 | Core-10 | Core-11 | Minor-5 | Core-12 | Core-13 | Core-14 |
| PO6 | Core-5 | Minor-4 | Core-6 | Core-7 | AEC-4 | Internship | Core-8 | Core-9 | Core-10 | Core-11 | Minor-5 | Core-12 | Core-13 | Core-14 |
| PO7 | Core-5 | Minor-4 | Core-6 | Core-7 | AEC-4 | Internship | Core-8 | Core-9 | Core-10 | Core-11 | Minor-5 | Core-12 | Core-13 | Core-14 |
| PO8 | Core-5 | Minor-4 | Core-6 | Core-7 | AEC-4 | Internship | Core-8 | Core-9 | Core-10 | Core-11 | Minor-5 | Core-12 | Core-13 | Core-14 |
| PO9 | Core-5 | Minor-4 | Core-6 | Core-7 | AEC-4 | Internship | Core-8 | Core-9 | Core-10 | Core-11 | Minor-5 | Core-12 | Core-13 | Core-14 |
| | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | ✓ | ✓ | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | ✓ | ✓ | ✓ | ✓ | X | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | ✓ | ✓ | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | ✓ | ✓ | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | X | X | X | X | ✓ | ✓ | X | X | X | X | X | X | X | X |
| | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | ✓ | ✓ | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | ✓ | ✓ | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| Table 3: FYDP in Biotechnology COURSES | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--------------------|----------------------------------|----------------------------------|-------------------------|-------------------------------|--------------------------|--------------------|-----------|---|--------------------------------------|---|--------------------------------------|---|---|--|----------------------------|----------------|---|---------------------------------|----------------------------|--|---|----------------|---|
| Programme Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | Core -15 | Minor-6 | Core -16 | Core -17 | Core -18 | Minor-7 | Lab Course -I | Dissertation 1 | Core -19 | Core -20 | Core -22 | Core -23 | Minor-8 | Dissertation 2 | |
| | | | | | | | | | | BTN23C604 Cell and Tissue Culture | BTN23M601 Advanced Biology-VI (Animal Physiology) | BTN23C701 Genomics and Proteomics | BTN23C702 Applied Microbiology and Bioprocess Engineering | BTN23C703 Computer Application and Bioinformatics | BTN23M701 Advanced Biology-VII (Molecular Biology) | BTN23C704 Lab Course -I | Dissertation 1 | BTN23C801 Climate Smart Agrobiotechnology | BTN23C802 Molecular Genetics | BTN23C803 Lab Course-II | BTN23C804 Immunotherapy and Immunology | BTN23M801 Advanced Biology-VIII (Cell and Tissue Culture) | Dissertation 2 | |
| | | | | | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | In depth knowledge | Specialised knowledge and skills | Analytical and critical thinking | Research and Innovation | Interdisciplinary Perspective | Communication Competence | Career development | Team work | Commitment to the society and to the Nation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

COURSE STRUCTURE: Four Year B.Sc. Biotechnology Programme (Hons/Research)

| Semester | Courses | Paper Code | Course Names | Credits | Credit | Total Credits |
|------------|------------|-------------|---|---------|--------|---------------|
| | | | | (L+T+P) | | |
| I | Core 1 | BTN23C101 | Biology-I | 3+0+1 | 4 | 20 |
| | Minor 1 | BTN23M101 | Biology-I | 3+0+1 | 4 | |
| | MDE 1 | BTN23MDE101 | Modern Biology I | 3+0+0 | 3 | |
| | AEC 1 | | AEC 1 English Communication I - To be offered by the University | - | 2 | |
| | SEC 1 | BTN23SEC001 | SEC -1- Indigenous Knowledge System based utilization of bioresources | - | 3 | |
| | VAC 1 | | VAC-1- To be offered by the University | - | 2 | |
| | VAC 2 | | VAC-2- To be offered by the University | - | 2 | |
| II | Core 2 | BTN23C201 | Advanced Biology-II | 3+0+1 | 4 | 20 |
| | Minor 1 | BTN23M201 | Advanced Biology-II | 3+0+1 | 4 | |
| | MDE 2 | BTN23MDE201 | Modern Biology II | 3+0+0 | 3 | |
| | AEC 2 | | MIL-I - To be offered by the University | - | 2 | |
| | SEC 2 | | SEC -2 - To be offered by the University | - | 3 | |
| | VAC 3 | | VAC-3 - To be offered by the University | - | 2 | |
| | VAC 4 | | VAC-4 - To be offered by the University | - | 2 | |
| III | Core 3 | BTN23C301 | Cell Biology | 3+0+1 | 4 | 20 |
| | Core 4 | BTN23C302 | Microbiology | 3+0+1 | 4 | |
| | Minor 3 | BTN23M301 | Advanced Biology-III (Cell Biology) | 3+0+1 | 4 | |
| | MDE 3 | BTN23MDE301 | Modern Biology III (Cell Biology) | 3+0+0 | 3 | |
| | AEC 3 | | English Communication II To be offered by the University | - | 2 | |
| | SEC3 | | To be offered by the University | - | 3 | |
| IV | Core 5 | BTN23C401 | Biochemistry | 3+0+1 | 4 | 20 |
| | Core 6 | BTN23C402 | Plant Physiology | 4+0+0 | 4 | |
| | Core 7 | BTN23C403 | Animal Physiology | 4+0+0 | 4 | |
| | Minor 4 | BTN23M401 | Advanced Biology-IV (Biochemistry) | 3+0+1 | 4 | |
| | AEC 4 | | MIL-II -To be offered by the University | - | 2 | |
| | Internship | BTN23I406 | Internship | 0+0+2 | 2 | |

| | | | | | | |
|------|----------|-----------|---|-------|---|----|
| V | Core 8 | BTN23C501 | Genetics | 3+0+1 | 4 | 20 |
| | Core 9 | BTN23C502 | Molecular Biology | 3+0+1 | 4 | |
| | Core 10 | BTN23C503 | Developmental Biology | 4+0+0 | 4 | |
| | Core 11 | BTN23C504 | Analytical Techniques | 3+0+1 | 4 | |
| | Minor 5 | BTN23M501 | Advanced Biology-V (Microbiology) | 3+0+1 | 4 | |
| VI | Core 12 | BTN23C601 | Immunology | 3+0+1 | 4 | 20 |
| | Core 13 | BTN23C602 | Genetic Engineering | 3+0+1 | 4 | |
| | Core 14 | BTN23C603 | Bioethics, Biosafety and IPR | 4+0+0 | 4 | |
| | Core 15 | BTN23C604 | Cell and Tissue Culture | 3+0+1 | 4 | |
| | Minor 6 | BTN23M601 | Advanced Biology-VI (Animal Physiology) | 4+0+0 | 4 | |
| VII | Core 16 | BTN23C701 | Genomics and Proteomics | 3+0+1 | 4 | 20 |
| | Core 17 | BTN23C702 | Applied Microbiology and Bioprocess Engineering | 3+0+1 | 4 | |
| | Core 18 | BTN23C703 | Computer Application and Bioinformatics | 3+0+1 | 4 | |
| | *Core 21 | BTN23C704 | Lab Course-I | 0+0+4 | 4 | |
| | Minor 7 | BTN23M701 | Advanced Biology-VII (Molecular Biology) | 3+0+1 | 4 | |
| | DPW-1 | | Dissertation of 12 Credits over Semesters VII and VIII, for Honours with Research Degree, only if CGPA \geq 7.5 upto Semester VI. Portion of the work equivalent to 4 Credits shall be evaluated during this semester. * Other students must take Core 21 in this semester. | 0+0+4 | 4 | |
| VIII | Core 19 | BTN23C801 | Climate Smart Agrobiotechnology | 4+0+0 | 4 | 20 |
| | Core 20 | BTN23C802 | Molecular Genetics | 4+0+0 | 4 | |
| | *Core 22 | BTN23C803 | Lab Course-II | 0+0+4 | 4 | |
| | *Core 23 | BTN23C804 | Immunotechnology and Immunotherapy | 4+0+0 | 4 | |
| | Minor 8 | BTN23M801 | Advanced Biology-VIII (Cell and Tissue Culture) | 3+0+1 | 4 | |
| | DPW-2 | | Dissertation Project Evaluation of the remaining 8 credits during this semester * Students not having dissertation/project must take Core 22 and Core 23 in this semester. | 0+0+8 | 8 | |

SEMESTER-I
PAPER: CORE-1
PAPER CODE: BTN23C101
BIOLOGY-I (Major-1)
CREDITS: 3+0+1

Learning Outcome:

LO 1: Ability to understand different life forms.

LO 2: Ability to identify bacteria, viruses, algae, fungi, bryophytes, pteridophytes, Gymnosperms.

THEORY:

| | |
|-------------|---|
| Unit | Introduction to the living world |
| I | Introduction to living organisms: plant, animal, microbes. Eukaryotes and Prokaryotes. Description and comparison of differences among unicellular, colonial and multicellular organisms and their living behaviours. |
| Unit | Microorganisms |
| II | Basic structural and physiological characteristics of archaea, eubacteria, green algae, blue-green algae, red algae, lichen, microalgae, diatom, amoeba, protozoa, fungus, bacteria and viruses-viroids and prions. |
| Unit | Plant Kingdom |
| III | Description on lower and higher groups of plants; characteristics of Thallophytes, Bryophyta, Pteridophytes, Gymnosperms and Angiosperms. |
| Unit | Animal Kingdom |
| IV | Non-chordates and chordates-description and classification with examples. |
| Unit | Introductory genetics |
| V | Fundamentals of genetics, Mendelian and non-Mendelian inheritance, Chromosome types, chromosome theory of inheritance and mutation. |
| Unit | Conservation biology and Forestry |
| VI | Presence of biodiversity; biodiversity scenario and hot spots, sub-tropical, temperate and tropical biodiversity, economics of biodiversity, threatened and endangered species, conservation of wild life both plant and animal types. Sustainable forest management. |

PRACTICAL:

1. Microscopic identification of microalgae, diatom, amoeba, protozoa, fungus, bacteria.
2. Identification of Chordates and non-chordates.
3. Observation of tissue organization in root and shoot apices using permanent slides.

Suggested Books:

1. BIOLOGY by Raven, Johnson, Losos, & Singer (2013), 10th Edition, McGraw-Hill Education.
2. Principles of Genetics by Robert H. Tamarin. TATA McGRAW-HILL Edition
3. Conservation biology for all. By Sodhi, N. S., & Ehrlich, P. R. (Eds.). (2010). Oxford University Press.

SEMESTER-I
PAPER: MINOR-I
PAPER CODE: BTN23M101
BIOLOGY-I
CREDITS: 3+0+1

Learning Outcome:

LO 1: Ability to understand different life forms.

LO 2: Ability to identify bacteria, viruses, algae, fungi, bryophytes, pteridophytes, Gymnosperms.

THEORY:

| | |
|-------------|---|
| Unit | Introduction to the living world |
| I | Introduction to living organisms: plant, animal, microbes. Eukaryotes and Prokaryotes. Description and comparison of differences among unicellular, colonial and multicellular organisms and their living behaviours. |
| Unit | Microorganisms |
| II | Basic structural and physiological characteristics of archaea, eubacteria, green algae, blue-green algae, red algae, lichen, microalgae, diatom, amoeba, protozoa, fungus, bacteria and viruses-viroids and prions. |
| Unit | Plant Kingdom |
| III | Description on lower and higher groups of plants; characteristics of Thallophytes, Bryophyta, Pteridophytes, Gymnosperms and Angiosperms. |
| Unit | Animal Kingdom |
| IV | Non-chordates and chordates-description and classification with examples. |
| Unit | Introductory genetics |
| V | Fundamentals of genetics, Mendelian and non-Mendelian inheritance, Chromosome types, chromosome theory of inheritance and mutation. |
| Unit | Conservation biology and Forestry |
| VI | Presence of biodiversity; biodiversity scenario and hot spots, sub-tropical, temperate and tropical biodiversity, economics of biodiversity, threatened and endangered species, conservation of wild life both plant and animal types. Sustainable forest management. |

PRACTICAL:

1. Microscopic identification of microalgae, diatom, amoeba, protozoa, fungus, bacteria.
2. Identification of Chordates and non-chordates.
3. Observation of tissue organization in root and shoot apices using permanent slides.

Suggested Books:

1. BIOLOGY by Raven, Johnson, Losos, & Singer (2013), 10th Edition, McGraw-Hill Education.
2. Principles of Genetics by Robert H. Tamarin. TATA McGRW-HILL Edition
3. Conservation biology for all. By Sodhi, N. S., & Ehrlich, P. R. (Eds.) (2010). Oxford University Press.

SEMESTER-I
PAPER: MDE-1
PAPER CODE: BTN23MDE101
MODERN BIOLOGY I
CREDITS: 3+0+0

Learning Outcome:

LO 1: Ability to understand different life forms.

LO 2: Ability to identify bacteria, viruses, algae, fungi, bryophytes, pteridophytes, Gymnosperms.

THEORY:

| | |
|-------------|---|
| Unit | The living world |
| I | Introduction to living organisms: plant, animal, microbes. Description and comparison of differences among unicellular, colonial and multicellular organisms and their living behaviours. |
| Unit | Microbial World |
| II | Characteristics of archaea, eubacteria, green algae, blue-green algae, red algae, lichen, microalgae, diatom, amoeba, protozoa, fungus, bacteria and viruses-viroids and prions. |
| Unit | Plant Kingdom |
| III | Description on lower and higher groups of plants; characteristics of Thallophytes, Bryophyta, Pteridophytes, Gymnosperms, and Angiosperms. |
| Unit | Animal Kingdom |
| IV | Non-chordates and chordates-description and classification with examples. |
| Unit | Introduction to Genetics |
| V | Fundamentals of genetics, Mendelian and non-Mendelian inheritance, Chromosome types, chromosome theory of inheritance and mutation. |
| Unit | Biodiversity & Conservation |
| VI | Presence of biodiversity; biodiversity scenario and hot spots, sub-tropical, temperate and tropical biodiversity, economics of biodiversity, threatened and endangered species, conservation of wild life both plant and animal types. Sustainable forest management. |

Suggested Books:

1. BIOLOGY by Raven, Johnson, Losos, & Singer (2013), 10thEdition, McGraw-Hill Education.
2. Principles of Genetics by Robert H. Tamarin. TATA McGRAW-HILL Edition.
3. Conservation biology for all. By Sodhi, N. S., & Ehrlich, P. R. (Eds.). (2010). Oxford University Press.

SEMESTER-I
PAPER: AEC 1
 To be offered by the University

SEMESTER-I
PAPER: SEC 1
PAPER CODE: BTN23SEC001
Indigenous Knowledge System Based Utilization Of Bioresources
CREDITS: 1+1+1

Course Outcome:

CO 1: Study of the selected indigenous fermented foods of NE India having high economic potential.

CO 2: Skill development on production of selected indigenous fermented foods of NE India.

CO 3: Skill development on production of selected commercial/indigenous mushrooms of NE India.

THEORY:

| Unit | Fermented food and its scope |
|------|---|
| I | Indigenous fermented foods of NE region- types, nutritional and medicinal profile; Fermented functional foods, value addition to fermented food, and bioentrepreneurship. |
| Unit | Mushroom cultivation |
| II | Mushroom biology, Edible and poisonous mushroom; nutritional value, Cultivation Techniques (Spawn and Mushroom). |

TUTORIAL (DEMONSTRATION):

1. Demonstration on preparation of fermented plant/Dairy food products.
2. Demonstration of mushroom Spawn production and cultivation.

PRACTICAL (HANDS ON TRAINING):

1. Pure culture-based preparation of fermented plant/Dairy food products.
2. Mushroom 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. Handbook of Plant- Based fermented food and beverage technology-Hui Y.H and ÖzgülEvranoz, E, 2nd Edition, CRC Press; 2012.
5. Mushroom Biotechnology: Developments and Applications- Petre, M. Acad. Press; 2015.

SEMESTER-I

PAPER: VAC 1

To be offered by the University

SEMESTER-I

PAPER: VAC 2

To be offered by the University

SEMESTER-II
PAPER: CORE-2
PAPER CODE: BTN23C201
ADVANCED BIOLOGY-II (Major-2)
CREDITS: 3+0+1

Learning Outcome:

LO 1: Ability to understand function of different biomolecules in life forms.

LO 2: Ability to understand the basics of vital biochemical, physiological and defensive processes.

THEORY:

| | |
|-------------|---|
| Unit | Chemical basis of life |
| I | Origin of life, role of water molecule, introduction to buffers, chemistry of life. |
| Unit | Elements of Biochemistry |
| II | Structure and functions of carbohydrates, protein, lipids and nucleic acids; thermodynamics of biological system. |
| Unit | Basics of Cell and Molecular Biology |
| III | Cell as functional unit of life, structure and function of cells. Cell division and cell cycle, Cell death, autophagy, apoptosis. Central dogma of molecular biology— transcription, splicing, translation and regulation of gene expression. |
| Unit | Plant and Animal Physiology |
| IV | Absorption and transpiration in plants, photosynthesis, secondary metabolism. Digestive system, vascular, respiratory, excretory systems in animals. |
| Unit | Introductory Immunology |
| V | Introduction to immunology and immune system. Types of immunity, Immune response. Antigens and antibodies. Immunoglobulins – types, structure and functions. Immunization approaches. |
| Unit | Human welfare |
| VI | Introduction to Recombinant DNA technology, Genetic Engineering, Microbial Biotechnology, Transgenic plants and animals. Stem cell biology. |

PRACTICAL:

1. Preparation of buffers routinely used in biological experiments.
2. Microscopic observation of permanent slides of monocot / dicot root and shoot tissues.
3. Microscopic observation of permanent slides of tissues (digestive, respiratory and excretory systems).

Suggested books

1. Biochemistry by J. M. Berg, J. L. Tymoczko, & Lubert Stryer (2011), 7th Edition, Palgrave MacMillan.
2. BIOLOGY by Raven, Johnson, Losos, & Singer (2013), 10th Edition, McGraw-Hill Education.
3. ESSENTIAL GENETICS: A Genomics Perspective by D. L. Hartl & E. W. Jones (2012), 6th Edition, Jones & Bartlett Learning.
4. Molecular and Cell Biology (Schaum's Outlines series special Indian edition) by W. D. Stansfield, J. S.C. Colome, R. J. Cano and R. N. Sharan (2010), McGraw Hill Education.

SEMESTER-II
PAPER: MINOR-2
PAPER CODE: BTN23M201
ADVANCED BIOLOGY-II
CREDITS: 3+0+1

Learning Outcome:

LO 1: Ability to understand function of different biomolecules in life forms.

LO 2: Ability to understand the basics of vital biochemical, physiological and defensive processes.

THEORY:

| | |
|-------------|---|
| Unit | Chemical basis of life |
| I | Origin of life, role of water molecule, introduction to buffers, chemistry of life. |
| Unit | Elements of Biochemistry |
| II | Structure and functions of carbohydrates, protein, lipids and nucleic acids; thermodynamics of biological system. |
| Unit | Basics of Cell and Molecular Biology |
| III | Cell as functional unit of life, structure and function of cells. Cell division and cell cycle, Cell death, autophagy, apoptosis. Central dogma of molecular biology— transcription, splicing, translation and regulation of gene expression. |
| Unit | Plant and Animal Physiology |
| IV | Absorption and transpiration in plants, photosynthesis, secondary metabolism. Digestive system, vascular, respiratory, excretory systems in animals. |
| Unit | Introductory Immunology |
| V | Introduction to immunology and immune system. Types of immunity, Immune response. Antigens and antibodies. Immunoglobulins – types structure and functions. Immunization approaches. |
| Unit | Human welfare |
| VI | Introduction to Recombinant DNA technology, Genetic Engineering, Microbial Biotechnology, Transgenic plants and animals. Stem cell biology. |

PRACTICAL:

1. Preparation of buffers routinely used in biological experiments.
2. Microscopic observation of permanent slides of monocot / dicot root and shoot tissues.
3. Microscopic observation of permanent slides of animal tissues (digestive, respiratory and excretory systems).

Suggested Books:

1. Biochemistry by J. M. Berg, J. L. Tymoczko, & Lubert Stryer (2011), 7th Edition, Palgrave MacMillan.
2. BIOLOGY by Raven, Johnson, Losos, & Singer (2013), 10th Edition, McGraw-Hill Education.
3. ESSENTIAL GENETICS: : A Genomics Perspective by D. L. Hartl & E. W. Jones (2012), 6th Edition, Jones & Bartlett Learning.
4. Molecular and Cell Biology (Schaum's Outlines series special Indian edition) by W. D. Stansfield, J. S.C. Colome, R. J. Cano and R. N. Sharan (2010), McGraw Hill Education.

SEMESTER-II
PAPER: MDE -2
PAPER CODE: BTN23MDE201
MODERN BIOLOGY II
CREDITS: 3+0+0

Learning Outcome:

LO 1: Ability to understand function of different biomolecules in life forms.

LO 2: Ability to understand the basics of vital biochemical, physiological and defensive processes.

THEORY:

| | |
|-------------|--|
| Unit | Chemistry of life |
| I | Origin of life, role of water molecule, introduction to buffers, chemistry of life. |
| Unit | Basics of Biochemistry |
| II | Structure and functions of carbohydrates, protein, lipids and nucleic acids; thermodynamics of biological system. |
| Unit | Elementary Cell and Molecular Biology |
| III | Cell division and cell cycle, apoptosis. Central dogma of molecular biology. |
| Unit | Elementary Plant and Animal Physiology |
| IV | Absorption and transpiration in plants, photosynthesis. Digestive system, vascular, respiratory, excretory systems in animals. |
| Unit | Elementary Immunology |
| V | Introduction to immunology and immune system. Types of immunity, Immune response. Structure and functions of antigens and antibodies. Immunization approaches. |
| Unit | Applications of Biotechnology |
| VI | Introduction to Genetic Engineering, Microbial Biotechnology, Transgenic plants and animals. Stem cell biology. |

Suggested Books:

1. Biochemistry by J. M. Berg, J. L. Tymoczko, & Lubert Stryer (2011), 7th Edition, Palgrave MacMillan.
2. BIOLOGY by Raven, Johnson, Losos, & Singer (2013), 10th Edition, McGraw-Hill Education.
3. ESSENTIAL GENETICS: : A Genomics Perspective by D. L. Hartl & E. W. Jones (2012), 6th Edition, Jones & Bartlett Learning.
4. Molecular and Cell Biology (Schaum's Outlines series special Indian edition) by W. D. Stansfield, J. S.C. Colome, R. J. Cano and R. N. Sharan (2010), McGraw Hill Education.

SEMESTER-II
PAPER: AEC 2
PAPER CODE:

To be offered by the University

SEMESTER-II
PAPER: SEC 2
PAPER CODE

To be offered by the University

SEMESTER-II**PAPER: VAC 3**

To be offered by the University

SEMESTER-II**PAPER: VAC 4**

To be offered by the University

SEMESTER-III**PAPER: CORE-3****PAPER CODE: BTN23C301****CELL BIOLOGY****CREDITS: 3+0+1****Learning Outcome:***LO 1: Ability to understand basics of cell structure and function.**LO 2: Ability to understand cell signalling and cellular transport of macromolecules.***THEORY:**

| Unit | Cell Membrane -Structure and Function |
|-------------|--|
| I | Structure of cell membrane, Membrane Theories, Cell Membrane and permeability: membrane as a dynamic entity, membrane transport. Cell-division Cycle. |
| Unit | Interaction of the cell with its environment |
| 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. |
| Unit | Cell Organelles |
| 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. |
| Unit | Cellular signalling pathways |
| IV | Signalling molecules, ligands, agonists and antagonists, Signalling in normal cells: G-protein mediated signalling, RTK signalling, Ca ⁺⁺ signalling, Insulin Signalling, Ras-MAPK signalling, Wnt signalling. Hedgehog signalling, Signalling pathways in Apoptosis and Cancer. |

PRACTICAL:

1. Cell division in onion root tip.
2. Study of morphological variations in cell nuclei.
3. Study of plasmolysis and de-plasmolysis .

Suggested Books:

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. Becker, W. M. et al., The World of Cell, 8th Edition (Benjamin Cummings, 2011).

SEMESTER-III
PAPER: CORE-4
PAPER CODE: BTN23C302
MICROBIOLOGY
CREDITS: 3+0+1

Learning Outcome:

LO 1: Follow the historical discoveries made in the field of microbiology and the evolution of microbiology.

LO 2: Comprehend the diversity of bacteria, classification and identification with knowledge of general characters of various bacterial phyla.

LO 3: Understand basic concepts of microbial nutrition, growth and genetics.

THEORY:

| | |
|-------------|--|
| Unit | Introduction to Microbiology |
| I | Milestones in the history of Microbiology, Structure and activities of Microbial cells Morphology and cell structure of bacteria, Koch's postulate, host-microbial interactions. |
| Unit | Microbial taxonomy |
| II | Basis of classification; Classical and modern approach; Taxonomic Hierarchy, Bergey's Manual of Systematic/Determinative Bacteriology. |
| Unit | Cultivation, maintenance and application of microorganisms |
| III | Microbiological media, composition and types; growth curve, nutritional groups of bacteria; Methods of isolation, purification and preservation of microorganisms. Microbial growth and nutrition; Aerobic and anaerobic respiration; Nitrogen fixation. |
| Unit | Genetics of microbes and viruses |
| IV | DNA transfer in bacteria: transformation, conjugation, transduction. Viruses- structure and classification. |

PRACTICAL:

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

Suggested Books:

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: MINOR -3
PAPER CODE: BTN23M301
ADVANCED BIOLOGY-III (CELL BIOLOGY)
CREDITS: 3+0+1

Learning Outcome:

LO 1: Ability to understand basics of cell structure and function.

LO 2: Ability to understand cell signalling and cellular transport of macromolecules.

THEORY:

| | |
|-------------|--|
| Unit | Cell Membrane -Structure and Function |
| I | Structure of cell membrane, Membrane Theories, Cell Membrane and permeability: membrane as a dynamic entity, membrane transport. Cell-division Cycle. |
| Unit | Interaction of the cell with its environment |
| 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. |
| Unit | Cell Organelles |
| 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. |
| Unit | Cellular signalling pathways |
| IV | Signalling molecules, ligands, agonists and antagonists, Signalling in normal cells: G-protein mediated signalling, RTK signalling, Ca ⁺⁺ signalling, Insulin Signalling, Ras-MAPK signalling, Wnt signalling. Hedgehog signalling, Signalling pathways in Apoptosis and Cancer. |

PRACTICAL:

1. Cell division in onion root tip.
2. Study of morphological variations in cell nuclei.
3. Study of plasmolysis and de-plasmolysis.

Suggested Books:

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. Becker, W. M. et al., The World of Cell, 8th Edition (Benjamin Cummings, 2011).

SEMESTER-III
PAPER: MDE-3
PAPER CODE: BTN23MDE301
MODERN BIOLOGY III (CELL BIOLOGY)
CREDITS: 3+0+0

Learning Outcome:

LO 1: Ability to understand basics of cell structure and function.

LO 2: Ability to understand cell signalling and cellular transport of macromolecules.

THEORY:

| | |
|-------------|--|
| Unit | Cell Membrane -Structure and Function |
| I | Structure of cell membrane, Membrane Theories, Cell Membrane and permeability: membrane as a dynamic entity, membrane transport. Cell Cycle. |
| Unit | Interaction of the cell with its environment |
| 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. |
| Unit | Cell Organelles |
| 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. |
| Unit | Cellular signalling pathways |
| IV | Signalling in normal cells: G-protein mediated signalling, RTK signalling, Ca ⁺⁺ signalling, Insulin Signalling, Ras-MAPK signalling, Apoptosis and Cancer. |

Suggested Books:

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. Becker, W. M. et al., The World of Cell, 8th Edition (Benjamin Cummings, 2011).

SEMESTER-III
PAPER: AEC 3
PAPER CODE:

SEMESTER-III
PAPER: SEC 3

To be offered by the University

SEMESTER-IV
PAPER: CORE-5
PAPER CODE: BTN23C401
BIOCHEMISTRY
CREDITS: 3+0+1

Learning Outcome:

LO 1: Learn in detail the structures, functions and classification of biological molecules (protein, carbohydrate, lipid, nucleic acids).

LO 2: Learn the basic concept of enzyme function and action, Inhibition of enzyme activity.

LO 3: Comprehend the vital metabolic pathways of living organisms and the interconversion of metabolic fuels.

THEORY:

| Unit | Carbohydrates and Lipids |
|------------|---|
| 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. |
| Unit | Proteins and Nucleic acids |
| 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; micro-RNAs and other RNA species; Denaturation and renaturation of DNA. |
| Unit | Enzymes Catalysis |
| 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. |
| Unit | Metabolic pathways |
| 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 , Fatty acid synthesis. |

PRACTICAL:

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

Suggested Books:

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-IV
PAPER: CORE-6
PAPER CODE: BTN23C402
PLANT PHYSIOLOGY
CREDITS: 4+0+0

Learning Outcome:

LO 1: Understand the root and shoot anatomy of monocot and dicot plants.

LO 2: Knowledge on the various aspects of plant water relations.

LO 3: Comprehend the vital physiological and metabolic processes for the growth and developments of plants.

THEORY:

| Unit | Plant Anatomy |
|------|---|
| I | Structure and Development of Plant Body: Tissues and tissue system, Theories of structural organization of root apex and shoot apex (SAM, RAM), Secondary and anomalous secondary growth in monocot and dicot stems. |
| Unit | Plant water relations, Mineral nutrition and Transport |
| 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. |
| Unit | Leaf ontogeny and Photosynthesis |
| III | Photosynthesis, Photosynthetic pigments, concept of two photo systems, photophosphorylation, C3, C4 Cycle and CAM plants, Factors affecting rate of photosynthesis; photorespiration. Leaf Ontogeny. |
| Unit | Plant Hormones |
| IV | Plant growth hormones: auxin, gibberellin, cytokinin, abscisic acid and ethylene: Physiological role and mode of action. |

Suggested Books:

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 Benjammin/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-IV
PAPER: CORE-7
PAPER CODE: BTN23C403
ANIMAL PHYSIOLOGY
CREDITS: 4+0+0

Learning Outcome:

LO 1: Ability to identify different physiological process in animals.

LO 2: Ability to understand the mechanism of digestive, circulatory, respiratory and nervous system in animals.

THEORY:

| | |
|-------------|---|
| Unit | Digestion and Respiration |
| 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. |
| Unit | Blood Circulation |
| II | Composition of blood, Plasma proteins and their role, blood cells, Mechanism of coagulation of blood. Heart and vessels anatomy, Mechanism of working of heart: Cardiac output, cardiac cycle, Origin and conduction of heart beat. |
| Unit | Muscle physiology and osmoregulation |
| 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. |
| Unit | Nervous and endocrine coordination |
| 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. |

Suggested Books:

1. Textbook of Medical Physiology (XI edition)- Guyton, A.C. and Hall, J.E. *Harcourt 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-IV
PAPER: MINOR-4
PAPER CODE: BTN23M401
ADVANCED BIOLOGY-IV (BIOCHEMISTRY)
CREDITS: 3+0+1

Learning Outcome:

LO 1: Learn in detail the structures, functions and classification of biological molecules (protein, carbohydrate, lipid, nucleic acids).

LO 2: Learn the basic concept of enzyme function and action, Inhibition of enzyme activity.

LO 3: Comprehend the vital metabolic pathways of living organisms and the interconversion of metabolic fuels.

THEORY:

| Unit | Carbohydrates and Lipids |
|------|--|
| 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. |
| Unit | Proteins and Nucleic acids |
| 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; micro-RNAs and other RNA species; Denaturation and renaturation of DNA. |
| Unit | Enzymes Catalysis |
| 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. |
| Unit | Metabolic pathways |
| 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 acid, Fatty acid synthesis. |

PRACTICAL:

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

Suggested Books:

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-IV

PAPER: AEC 4 (MIL -II)
To be offered by the University

SEMESTER-IV
PAPER CODE: BTN23I406
INTERNSHIP
CREDITS: 0+0+2

SEMESTER V
PAPER: CORE-8
PAPER CODE: BTN23C501
GENETICS
CREDITS: 3+0+1

Learning Outcome:

LO 1: To understand the laws governing the inheritance of characters in biological system.

LO 2: Knowledge on the chromosomal and genomic organization of prokaryotes and eukaryotes.

THEORY:

| Unit | Mendelian genetics |
|-------------|--|
| 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. |
| Unit | Genome organization |
| 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. |
| Unit | Genetic Mutations and Chromosomal aberrations |
| 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. |
| Unit | Linkage, Sex determination and Population genetics |
| 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, allelic and genotype frequencies, changes in allelic frequencies. |

PRACTICAL:

1. Studies on Mendel's law of segregation.
2. Studies on Mendel's law of independent assortment.
3. Demonstration of Barr body.

Suggested Books:

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., Palldino, M.A. and Killian, D. *Pearson*; 2009.
4. Genetics- A Molecular Approach (III edition)- Russell P.J. *Benjamin Cummings*; 2009.

SEMESTER-V
PAPER: CORE-9
PAPER CODE: BTN23C502
MOLECULAR BIOLOGY
CREDITS: 3+0+1

Learning Outcome:

LO 1: Ability to understand the molecular basis of various biological processes.

LO 2: Ability to understand three fundamental aspects in biological phenomenon: The central dogma and molecular basis of life.

THEORY:

| Unit | DNA replication and Chromosomal Organization |
|-------------|--|
| 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. |
| Unit | DNA damage, repair and homologous recombination |
| 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. |
| Unit | Transcription and RNA processing |
| 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, RNA interference. Post-transcriptional modifications. |
| Unit | Genetic code and regulation of gene expression |
| 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. |

PRACTICAL:

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

Suggested Books:

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.
3. Alberts, Bruce, et al. "Molecular biology of the cell. Garland Pub." Inc., London (2002).

SEMESTER-V
PAPER: CORE-10
PAPER CODE: BTN23C503
DEVELOPMENTAL BIOLOGY
CREDITS: 4+0+0

Learning Outcome:

LO 1: Ability to understand the molecular basis of development in animals and plants.

LO 2: 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 |
| 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. |
| Unit | Patterning of body plan in Vertebrates and Invertebrate |
| 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). |
| Unit | Plant Embryonic Development and Patterning |
| 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). |
| Unit | Factors influencing Plant Development |
| IV | Light Signalling: Photomorphogenesis and Skotomorphogenesis. Role of Micro RNAs. |

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.

Suggested Books:

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). *Plant physiology and development* (Ed. 6). Sinauer Associates Incorporated.

SEMESTER-V
PAPER: CORE-11
PAPER CODE: BTN23C504
ANALYTICAL TECHNIQUES
CREDITS: 3+ 0+ 1

Learning Outcome:

LO 1: Understand the basics of biochemical analytical techniques and interpret the effect on sample analysis

LO 2: Acquire advanced understanding of microscopy, spectroscopy and chromatography techniques for designing experiments and analysing data

THEORY:

| | |
|-------------|---|
| Unit | Basic laboratory techniques and Centrifugation |
| 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. |
| Unit | Microscopy and Micrometry |
| II | Microscopy: Dark field microscope; phase contrast microscope, DIC, fluorescence microscope, Confocal, FRAP, electron microscopy- principle, instrumentation and application of SEM and TEM, Micrometry and measurement of microscopic elements. |
| Unit | Chromatography |
| III | Chromatography: Introduction to chromatography, general principle and application of paper chromatography, TLC, gel filtration chromatography, ion exchange chromatography, LPLC, FPLC and HPLC, Gas chromatography. Electrophoresis: General principle and application; Agarose gel electrophoresis, SDS-PAGE, Microarray. |
| Unit | Spectroscopy and Radioactivity |
| IV | Absorption spectroscopy: Instrumentation and application of UV and visible spectroscopy, IR spectroscopy (FTIR), Radiation- nonionizing and ionizing, radioactivity- types of decay; autoradiography, carbon dating. |

PRACTICAL:

1. Calibration of pH meter.
2. Demonstration of HPLC/GC-MS.
3. Chlorophyll estimation.

Suggested Books:

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-V
PAPER: MINOR-5
PAPER CODE: BTN23M501
ADVANCED BIOLOGY-V (MICROBIOLOGY)
CREDITS: 3+0+1

Learning Outcome:

LO 1: Follow the historical discoveries made in the field of microbiology and the evolution of microbiology.

LO 2: Comprehend the diversity of bacteria, classification and identification with knowledge of general characters of microbes, microbial nutrition, growth and genetics.

THEORY:

| | |
|-------------|--|
| Unit | Introduction to Microbiology |
| I | Milestones in the history of Microbiology, Structure and activities of Microbial cells Morphology and cell structure of bacteria, Koch's postulate, host-microbial interactions. |
| Unit | Microbial taxonomy |
| II | Basis of classification; Classical and modern approach; Taxonomic Hierarchy, Bergey's Manual of Systematic/Determinative Bacteriology. |
| Unit | Cultivation, maintenance and application of microorganisms |
| III | Microbiological media, composition and types; growth curve, nutritional groups of bacteria; Methods of isolation, purification and preservation of microorganisms. Microbial growth and nutrition; Aerobic and anaerobic respiration; Nitrogen fixation. |
| Unit | Genetics of microbes and viruses |
| IV | DNA transfer in bacteria: transformation, conjugation, transduction. Viruses- structure and classification. |

PRACTICAL:

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

Suggested Books:

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-VI
PAPER: CORE-12
PAPER CODE: BTN23C601
IMMUNOLOGY
CREDITS: 3+0+1

Learning Outcome:

LO 1: Ability to understand the basis of immunology.

LO 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 |
|------|--|
| I | Concept of immune system; Basic features of immunity: Memory, specificity and recognition of self. 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. |
| Unit | Cell and tissues of the Immune system |
| II | Cells and organ of the immune system: B Lymphocytes, T lymphocytes, NK cells, Mononuclear phagocytes, Granulocytic cells, Primary lymphoid organs, secondary lymphoid organs. |
| | Immune responses generated by B and T lymphocytes |
| III | Antigens: general properties, antigenicity and immunogenicity. 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 Humoral and Cell-mediated immune responses. |
| Unit | Hypersensitivity, Immunodeficiency and Autoimmunity |
| IV | Introduction to hypersensitivity, types of hypersensitivity, introduction to primary and secondary immunodeficiency disorders, Autoimmunity and types of autoimmune diseases. Immune tolerance; Graft versus host reaction. |

PRACTICAL:

1. Radial Immunodiffusion Assay.
2. Haemagglutination Assay.
3. Determination of antibody titre by ELISA.

Suggested Books:

1. Roitt's Essential Immunology (11th edition)- Delves, P., Martin, S., Burton, D. and Roitt, I.M. Wiley-Blackwell Scientific Publication, Oxford; 2006.
2. Kuby's Immunology (6th edition)- Goldsby, R.A., Kindt, T.J. and Osborne, B.A.W.H. Freeman and Company, New York; 2007.
3. Janeway's Immunobiology (7th edition)- Murphy, K., Travers, P. and Walport, M. Garland Science Publishers, New York; 2008.

SEMESTER-VI
PAPER: CORE-13
PAPER CODE: BTN23C602
GENETIC ENGINEERING
CREDITS: 3+0+1

Learning Outcome:

LO 1: To be able to understand molecular cloning and design cloning strategies.

LO 2: To understand the methods of gene delivery in plants and animals.

THEORY:

| | |
|-------------|--|
| Unit | Molecular tools and applications |
| I | Restriction enzymes, ligases, Nucleases, polymerases, alkaline phosphatase, Reverse Transcriptase. Cloning vectors -Plasmids, Bacteriophage-derived, Cosmid vectors, yeast and bacterial artificial chromosomes, viral vectors, Molecular cloning. |
| Unit | Nucleic acid amplification and analysis techniques |
| 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. Transposons and gene targeting; DNA labelling. |
| Unit | Gene transfer in mammalian systems |
| III | Gene transfer to animal cells: major strategies for gene transfer, selectable markers and reporter for animal cells, production of transgenic mice. Site-directed mutagenesis; Gene therapy |
| Unit | Gene transfer in plants |
| 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. |

PRACTICAL:

1. Qualitative and quantitative analysis of DNA using spectrophotometer.
2. Restriction digestion of DNA.
3. PCR amplification of gene.

Suggested Books:

1. Gene Cloning and DNA Analysis- Brown, T.A. Blackwell Publishing, Oxford, UK; 2006.
2. Biotechnology-Appling 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-VI
PAPER: CORE-14
PAPER CODE: BTN23C603
BIOETHICS, BIOSAFETY AND IPR
CREDITS: 4+0+0

Learning Outcome:

LO 1: Ability to perceive the intellectual property rights of products derived from biotechnology research.

LO 2: Ability to perceive and practice the ethical code in research as outlined by statutory bodies.

THEORY:

| | |
|-------------|--|
| Unit | Bioethics for biomedical and health research |
| 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. |
| Unit | Introduction to Biosafety |
| 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. |
| Unit | Intellectual Property Rights |
| 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. |
| Unit | Bioethics in practice |
| 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. Terminator Technology. |

Suggested Books:

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

SEMESTER-VI
PAPER: CORE-15
PAPER CODE: BTN23C604
CELL AND TISSUE CULTURE
CREDITS: 3+0+1

Learning Outcome:

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

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

THEORY:

| Unit | Plant Cell and tissue culture |
|-------------|--|
| 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. |
| Unit | Application of plant tissue culture |
| II | Micropropagation, secondary metabolite production, production of virus free plants, methods of cryopreservation and germplasm conservation, Genetic transformation and crop improvement. Methods of gene transfer in plants. Achievements and recent developments of genetic engineering in agriculture. Development of transgenics for biotic & abiotic stress tolerance. |
| Unit | Animal cell culture techniques |
| 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. Anchorage and non-anchorage dependent cell culture; Kinetics of cell growth; Hybridoma technology and monoclonal antibody production. |
| Unit | Applications of animal cell culture technology |
| IV | Virus isolation and identification, production of vaccines. Cell products-antibodies and immunoregulators, 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. |

PRACTICAL:

1. Preparation of different plant tissue culture media.
2. Sterilization of plant explant for inoculation.
3. Visit/demonstration of an animal cell culture laboratory.

Suggested Books:

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-VI
PAPER: MINOR-6
PAPER CODE: BTN23M601
ADVANCED BIOLOGY-VI
(ANIMAL PHYSIOLOGY)
CREDITS: 4+0+0

Learning Outcome:

LO 1: Ability to identify different physiological process in animals.

LO 2: Ability to understand the mechanism of digestive, circulatory, respiratory and nervous system in animals.

THEORY:

| | |
|-------------|---|
| Unit | Digestion and Respiration |
| 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. |
| Unit | Blood Circulation |
| II | Composition of blood, Plasma proteins and their role, blood cells, Mechanism of coagulation of blood. Heart and vessels anatomy, Mechanism of working of heart: Cardiac output, cardiac cycle, Origin and conduction of heart beat. |
| Unit | Muscle physiology and osmoregulation |
| 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. |
| Unit | Nervous and endocrine coordination |
| 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. |

Suggested Books:

1. Textbook of Medical Physiology (XI edition)- Guyton, A.C. and Hall, J.E. *Harcourt 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-VII
PAPER: CORE-16
PAPER CODE: BTN23C701
GENOMICS AND PROTEOMICS
CREDITS: 3+0+1

Learning Outcome:

LO 1: Acquire knowledge and understanding of fundamentals of genomics and proteomics.

LO 2: Understand the applications of genomics and proteomics in various applied areas of biology.

THEORY:

| Unit | Genomics and Sequencing technologies |
|-------------|---|
| I | Introduction to Genomics, DNA sequencing methods – manual and automated: Maxam- Gilbert and Sangers method. First, Second and Third Generation Sequencing. |
| Unit | Databases |
| II | Nucleotide Sequence Databases, Protein Sequence Databases: Entrez and Ensemble. |
| Unit | Comparative genomics |
| III | Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; metagenomics; use of genomes to understand evolution of eukaryotes, track emerging diseases and; design new drugs (pharmacogenomics). |
| Unit | Introduction to Proteomics |
| IV | Introduction to Proteomics, Analysis of proteomes- 2D-PAGE. Mass spectrometry-based methods for protein identification, ESI and MALDI-TOF-TOF. Yeast 2- hybrid system. |

PRACTICAL:

1. Using the Entrez database.
2. Using the Ensemble Genome Browser.
3. Demonstration of SDS-PAGE.

Suggested Books:

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.

SEMESTER-VII
PAPER: Core-17
PAPER CODE: BTN23C702
APPLIED MICROBIOLOGY AND BIOPROCESS ENGINEERING
CREDITS: 3+0+1

Learning Outcome:

LO 1: Understand the important aspects of microbial cultures: kinetics of growth and death, types of microbial culture, basic principles of fermentation technology.

LO 2: 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 |
| I | Range of bioprocess technology. Basic 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. |
| Unit | Design of bioprocess vessels |
| II | Significance of Impeller, Baffles, Sparger; types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. |
| Unit | Engineering principle of bioprocessing |
| III | Introduction to upstream and downstream processing, product recovery and purification. Biofuels, Bioplastics, industrial enzymes, antibiotics. |
| Unit | Industrial applications |
| IV | Basic food chemistry, food additives; enzymes in food industry; GM foods; food safety; food preservation – physical, chemical and biological methods. Immobilization of biocatalysts (enzymes and cells) for bioconversion processes. |

PRACTICAL:

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

Suggested Books:

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 NIKaido, H. W.H. Freeman & Co.; 1995.
6. Frontiers in Microbial Technology- Bisen, P.S. CBS Publishers; 1994.

SEMESTER-VII
PAPER: CORE-18
PAPER CODE: BTN23C703
COMPUTER APPLICATION AND BIOINFORMATICS
CREDITS: 3+0+1

Learning Outcome:

LO 1: Ability to generate data, data management concepts, data mining strategies and their effective utilization using computational tools.

LO 2: Ability to comprehend the aspects of sequence data integration, management, mining and analysis for defined applications.

THEORY:

| | |
|-------------|--|
| Unit | Introduction to Computers and Bioinformatics |
| I | Operating Systems, Networks, Computers in biology. Bioinformatics- History, Scope, Applications. |
| Unit | Introduction to Biological Databases |
| II | Databases- Types of Biological Databases, Pitfalls, Information Retrieval from Biological Databases. |
| Unit | Sequence Alignment |
| III | Pairwise Sequence alignment; Sequence Homology, Sequence Similarity, Sequence Identity; Scoring Matrices, Statistical Significance of Sequence Alignment, Multiple Sequence Alignment, Scoring Function. |
| Unit | Phylogenetic Analysis |
| IV | Molecular Evolution and Molecular Phylogenetics, Distance-Based Methods, Character-Based Methods, Phylogenetic Tree Evaluation, Phylogenetic Programs. |

PRACTICAL:

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

Suggested Books:

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-VII
PAPER: *CORE-21
PAPER CODE: BTN23C704
LAB COURSE-I
CREDITS: 0+0+4

Learning Outcome:

LO 1: Ability to understand the fundamentals of biosafety, experimental design and practices.

LO 2: Ability to design and execute basic biochemical and microbiological experiments.

LO 3: Ability to design and execute basic molecular biology and genetic engineering experiments.

LIST OF PRACTICAL:

1. Washing, sterilization techniques, basic safety measures and laboratory note books and record keeping.
2. Handling and safe operation of instruments, housekeeping for sophisticated instrumentation and personal protective equipment (PPE).
3. Study of bacterial growth kinetics
4. Antibiotic sensitivity assay.
5. Carbohydrate estimation by Anthrone method.
6. Protein estimation by Bradford method.
7. Plasmid DNA extraction
8. Restriction digestion of DNA isolated from bacteria/ plant/ animal tissue
9. Amplification of DNA using Polymerase Chain Reaction.

Suggested Books:

1. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). Molecular cloning: a laboratory manual Cold spring harbor laboratory press.
2. Seidman, L. A., Kraus, M. E., Brandner, D. L., & Mowery, J. (2022). Laboratory Manual for Biotechnology and Laboratory Science: The Basics. CRC Press.

*Students not having dissertation/project must enroll for **Core 21** in Semester VII.

SEMESTER-VII
PAPER: MINOR-7
PAPER CODE: BTN23M701
ADVANCED BIOLOGY-VII
(MOLECULAR BIOLOGY)
CREDITS: 3+0+1

Learning Outcome:

LO 1: Ability to understand the molecular basis of various biological processes.

LO 2: Ability to understand three fundamental aspects in biological phenomenon: The central dogma.

LO 3: Ability to understand the molecular basis of life.

THEORY:

| Unit | DNA replication and Chromosomal Organization |
|-------------|--|
| 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. |
| Unit | DNA damage, repair and homologous recombination |
| 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. |
| Unit | Transcription and RNA processing |
| 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, RNA interference, Post-transcriptional modifications. |
| Unit | Genetic code and regulation of gene expression |
| 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. |

PRACTICAL:

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

Suggested Books:

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-VII
PAPER: DPW-1
PAPER CODE:
PROJECT/DISSERTATION
CREDITS: 0+0+4

Dissertation /Project

For Honours with Research Degree, only if CGPA ≥ 7.5 upto Semester VI. Evaluation of the 4 credits during this semester * Students not having dissertation/project must take Core 21 in this semester.

SEMESTER-VIII
PAPER: CORE-19
PAPER CODE: BTN23C801
CLIMATE SMART AGROBIOTECHNOLOGY
CREDITS: 4+0+0

Learning Outcome:

LO 1: To provide an introduction to the origins of climate, climate change phenomena and climate vulnerabilities.

LO 2: To provide an introduction to biotic/abiotic stress arising out of climate change, their possible impacts on agricultural productivity and development of climate smart crops as well as technological interventions for climate change mitigation.

THEORY:

| | |
|-------------|---|
| Unit | Science of Climate Change |
| I | Introduction to earth's climatic system. Science and origins of Climate Change, Green House Gases and Global Warming; Global Climatic Assessment. |
| Unit | Abiotic stress and Climate change mitigation |
| II | Climate change induced crop failures-historical perspective, Crop-water relationship and water management, Soil-crop relationship and management, Effects of elevated CO ₂ and temperature on agricultural productivity, mitigation. |
| Unit | Biotic stress and Climate change mitigation |
| III | Introduction to biotic stresses arising out of climate change-threats from, insects, pests, pathogenic microbes and weeds. Biotechnological and molecular breeding approaches for development of Climate Smart Crops. |
| Unit | Technological interventions for Climate change mitigation |
| IV | Introduction to climate modelling toolbox - MOSAICC. Technological intervention - Agricultural IoT, Smart Farming, Precision Farming and Digital Farming. |

Suggested Books:

1. Venkatramanan, V., Shachi Shah, and Ram Prasad, eds. Global climate change: resilient and smart agriculture. Springer, 2020.
2. AR6 Climate Change 2021: Impacts, Adaptation and Vulnerability [available at <https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/>; accessed on 10.3.2021].
3. Lipper, Leslie, et al. (eds.), Climate smart agriculture: building resilience to climate change. Springer Nature, 2017.
4. Bhattacharyya, Pratap, Himanshu Pathak, and Sharmistha Pal. Climate Smart Agriculture: Concepts, Challenges, and Opportunities. Springer Nature, 2020.
5. Carraro, Carlo, ed. International environmental agreements on climate change. Vol. 13. Springer Science & Business Media, 1999.

SEMESTER-VIII
PAPER: CORE-20
PAPER CODE: BTN23C802
MOLECULAR GENETICS
CREDITS: 4+0+0

Learning outcome:

LO 1: Ability to understand the basis of recombinant DNA technology.

LO 2: Ability to perform PCR, analysis of gene polymorphisms, tools to modify genes.

THEORY:

| | |
|-------------|---|
| Unit | Identification and assessment of genetic variations |
| I | Molecular markers: Mini and Micro-satellites. Restriction fragment length polymorphism (RFLP), Single strand polymorphism (SSCP), Denaturing high performance liquid chromatography (DHPLC), Random amplification of polymorphic DNA (RAPD). |
| Unit | Human, plant and microbial molecular genetics |
| II | Nomenclature of human genes and mutations, Phenotype, Genotype, Pedigree analysis-construction and analysis of monogenic diseases/disorders (Autosomal-dominant and recessive, X linked-dominant and recessive, Mitochondrial, multifactorial inheritance/complex traits, SNPs-Types & application, Y chromosome, Fluorescence In-Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH), Linkage analysis, Genome-wide association studies (GWAS). |
| Unit | Genome editing approaches |
| III | Homologous Recombination, RNAi technique, Site specific nucleases- Cas9-CRISPR, TALENS, Zn-Finger protein. Conditional knockout-Cre-Lox p mechanism, Knock-in, Animal models for human diseases. |
| Unit | Evolution at molecular level in population |
| IV | Gene frequency; Hardy Weinberg law; Factors influencing Hardy Weinberg equilibrium-Mutation, Selection, Migration, Gene flow, Genetic drift; Human genetic diversity, Origin of major human groups. |

Suggested Books:

1. Kothari, M. L., Essentials of Human Genetics, 5th Edition, Orient Black Swan Publisher, 2008. ISBN: 978-8173716478.
2. Strachan, T and Read, A. P, Human molecular genetics, 4th Edition, Garland Publishing, 2010. ISBN-13: 978-0815341499.
3. Tamarin R H. Principles of Genetics, 7th Edition, McGraw Higher Ed Publishers, 2010. ISBN: 9780070486676.

SEMESTER-VIII
PAPER: *CORE-22
PAPER CODE: BTN23C803
LAB COURSE-II
CREDITS: 0+0+4

Learning Outcome:

LO 1: Ability to use computational tools for bioinformatics.

LO 2: Ability to use genetic engineering tools in research, design experiments and use immunotechniques in applied research.

LIST OF PRACTICAL:

1. Procedure for submission of DNA sequences to public database.
2. Phylogenetic tree construction using MEGA.
3. Homology searching using BLAST.
4. PCR primer designing using online tools.
5. Separation of proteins using NATIVE and SDS PAGE.
6. Competent cell preparation and cloning in *E coli*.
7. Experiment on agglutination and radial immunodiffusion for testing the antigen antibody reaction.
8. Demonstration of Enzyme Linked Immunosorbent Assay (ELISA) technique.
9. Web based tools for vaccine design.

Suggested Books:

1. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). Molecular cloning: a laboratory manual Cold spring harbor laboratory press.
2. Seidman, L. A., Kraus, M. E., Brandner, D. L., & Mowery, J. (2022). Laboratory Manual for Biotechnology and Laboratory Science: The Basics. CRC Press.

* Students not having dissertation/project must enroll for *Core 22 and *Core 23 in Semester VIII.

SEMESTER-VIII
PAPER: *CORE-23
PAPER CODE: BTN23C804
IMMUNOTECHNOLOGY AND IMMUNOTHERAPY
CREDITS: 4+0+0

Learning Outcome:

LO 1: Ability to correlate immune response in various cellular functions.

LO 2: Ability to use different immunological techniques in solving problems related to scientific research, health care and diagnosis.

THEORY:

| | |
|-------------|--|
| Unit | Adaptive immune responses |
| I | Antigens: general properties, antigenicity and immunogenicity, epitopes; haptens, adjuvants; 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, classes & subclasses of immunoglobulins. Cell-mediated immune responses. |
| Unit | Immunodiagnosics |
| II | Concept of affinity, avidity, cross reactivity and seroconversion. Precipitation, Agglutination and Neutralization reactions. Immunodiagnosics (ELISA, Western blotting, RIA). |
| Unit | Vaccinology |
| III | Concepts of active and passive immunization; live, killed, attenuated, subunit vaccines; recombinant DNA vaccines, mRNA- and protein -based vaccines, plant-based vaccines, vectored vaccines. Antibody engineering: generation of monoclonal antibodies, catalytic antibodies, idiotypic vaccines and marker vaccines, dendritic cell-based vaccines, cancer vaccine, T cell-based vaccine, edible vaccine and therapeutic vaccine. |
| Unit | Immunopharmacology |
| IV | Concepts of Hypersensitivity, immunodeficiency, immune tolerance and autoimmunity. Types of hypersensitivity, introduction to primary and secondary immunodeficiency disorders, types of autoimmune diseases, treatment of autoimmune diseases; cancer immunotherapeutic drugs, Immunosuppressive therapy, immunomodulatory and immunostimulant drugs, antiallergic drugs. |

Suggested Books:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
4. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press.

*Students not having dissertation/project must take *Core 22 and *Core 23 in this semester.

SEMESTER-VIII
PAPER: MINOR-8
PAPER CODE: BTN23M801
ADVANCED BIOLOGY-VIII
(CELL AND TISSUE CULTURE)
CREDITS: 3+0+1

Learning Outcome:

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

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

THEORY:

| | |
|-------------|---|
| Unit | Plant Cell and tissue culture |
| 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. |
| Unit | Application of plant tissue culture |
| II | Micropropagation, secondary metabolite production, production of virus free plants, methods of cryopreservation and germplasm conservation, Genetic transformation and crop improvement. Methods of gene transfer in plants. Achievements and recent developments of genetic engineering in agriculture. Development of transgenics for biotic & abiotic stress tolerance. |
| Unit | Animal cell culture techniques |
| 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. Anchorage and non-anchorage dependent cell culture; Kinetics of cell growth; Hybridoma technology. |
| Unit | Applications of animal cell culture technology |
| 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. |

PRACTICAL:

1. Preparation of different plant tissue culture media.
2. Sterilization of plant explant for inoculation.
3. Visit/demonstration of an animal cell culture laboratory.

Suggested Books:

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-VIII
PAPER: DPW-2
PAPER CODE:
PROJECT/DISSERTATION
CREDITS: 0+0+8

Dissertation /Project:

Evaluation of the remaining 8 credits during this semester * Students not having dissertation/project must take Core 22 and Core 23 in this semester.

