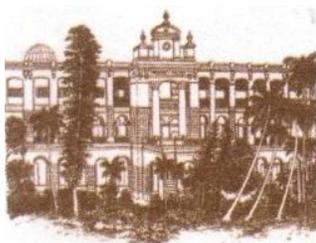


**Structure and Detailed Syllabus**  
**of the Undergraduate Course (B.Sc.) in Biological Science (Hons.) under CBCS**

**Department of Life Sciences**  
**Presidency University**  
(Effective from Academic Year 2021-22)



PRESIDENCY UNIVERSITY  
KOLKATA



**Department of Life Sciences**  
**(Faculty of Natural and Mathematical Sciences)**  
**Presidency University**  
**Hindoo College (1817-1855), Presidency College (1855-2010)**  
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**Department of Life Sciences. Presidency University, Kolkata**

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## **B.Sc. (Hons.) Biological Science**

### **Introduction**

The Biological Science programme at the undergraduate level has been designed to emphasize the importance of interdisciplinary nature underlying the study of all the aspects of structure and function of living organisms, their different constituent biomolecules and their complex inter relationships. Choice-based Credit System (CBCS) offers sound foundations in the form of Core Courses at the same time allowing freedom to students to select elective courses that augment the understanding of the subject at various levels. The elective courses include Discipline Specific Electives (DSE), Skill Enhancement Courses (SEC) and Generic Elective (GE) courses that broaden their learning horizons and widen the scope for higher education and employment avenues. The revised Choice-Based Credit System (CBCS) curriculum to be implemented from the academic session 2021-2022 conforms to Learning Outcome Based Curriculum Framework (LOCF) and aims at imparting concept based learning with emphasis on skill development and research. The overall objective of this programme is to enable students to learn and integrate knowledge in Biophysics, Chemistry and Biology that is relevant to study and understand the complex biological processes and thus prepare them for post-graduate education and careers in academia, research, medicine and industry.

### **Aims and Objectives**

The program aims to:

- Provide students comprehensive knowledge and understanding of major concepts, principles and experimental findings in Biological Science and related interdisciplinary areas.
- Encourage students to employ critical thinking and efficient problem solving skills in different areas related to Biological Science.
- Train students to work effectively in diverse teams in both classroom, laboratory as well as in field-based situations.
- Provide students with the knowledge and skill base that would enable them to undertake further studies in Biological Science and help develop a range of generic skills that are relevant to pursue teaching, research and entrepreneurship.

### **Program Design and Structure:**

The B.Sc. Honours in Biological Science is a three-year degree programme divided into six semesters. Each academic year (July - June) consists of two semesters (ODD and EVEN). The program has been designed to offer a variety of discipline specific and interdisciplinary courses disseminated through class-room, laboratory and out-of-classroom modes of teaching, monitored through a repertoire of assessment methods. The teaching learning process includes theory classes of one hour duration and practical classes of two hour duration for every credit offered. The curriculum is delivered through various methods including classical chalk and talk, power-point presentations, quiz contests, audio and video tools, e-learning and e-content, virtual labs, field trips, seminars by

external experts, symposiums and class discussions. The learning outcome is assessed by direct and indirect methods comprising broadly of Internal Assessment or Continuous Evaluation and End-Semester Examination. The internal assessment includes multiple choice questions, home and class assignments, oral presentations (seminars), group tasks, class discussions and report writing. End-semester assessments include written tests and practical viva examinations. Each course carries 100 marks. For 6-credit Core courses, General Elective courses and Discipline Specific Elective courses, 30 marks is allotted for each practical component and 70 marks is allotted for the theory component. Each practical component includes end semester viva based examination as well as continuous evaluation reflecting the performance of the student throughout the semester. For 4-credit Skill Enhancement Courses carrying 100 marks, the learning outcome is assessed by means of continuous evaluation involving multiple choice questions, home and class assignments, oral presentations (seminars), group tasks, class discussions and survey report submission.

The programme is structured into a variety of courses with different credits, some mandatory while others elective. Broadly, the programme comprises of Core Courses (CC) and elective courses. The core courses are all compulsory courses. The elective courses are of three kinds: Discipline-Specific Elective (DSE), Skill Enhancement Course (SEC) and Generic Elective (GE). The GE courses offered by the Department of Life Sciences are offered to students of other departments. A DLS student will have the option to choose from a range of GE courses offered by other Departments of Presidency University. Courses from Languages, Humanities and Sciences are all available to choose from. The programme also includes two compulsory Ability Enhancement Courses (AECC). The AECC courses are inter-departmental courses and follow a central syllabus.

To successfully complete the program, a student must study fourteen Core Courses, four Discipline-Specific Electives, two Skill Enhancement Courses and two compulsory Ability Enhancement Courses. The Core Courses, Discipline-Specific Electives and Generic Electives are six-credit courses. The Skill Enhancement Courses and Ability Enhancement Courses are four-credit courses. A student has to earn a minimum of 148 credits to get a degree in B.Sc. (Hons.) Biological Science.

### **Graduate Attributes in B.Sc. (Hons.) Biological Science**

A graduate in the Biological Science programme is expected to demonstrate the following attributes:

**Disciplinary knowledge and skills:** Capable of demonstrating (i) comprehensive knowledge and understanding of fundamental concepts in Zoology, Physiology, Botany and interdisciplinary topics like Biotechnology, Molecular Biology, Biochemistry, Cell Biology, Immunology, Microbiology, Evolutionary Biology, Environmental Science, Biostatistics, Bioinformatics and Biophysics (ii) ability to use modern instrumentation/techniques for research spanning from molecules to systems.

**Skilled communicator:** Ability to convey complex information relating to Biological Science in a clear and concise manner both in writing as well as orally, demonstrate the ability to listen carefully, read and write analytically.

**Critical thinker and problem solver:** Ability to employ critical thinking and efficient problem solving skills in different areas related to Biological Science.

**Sense of inquiry:** Capability for raising relevant questions relating to basic understanding and applications in the field of Biological Science.

**Team player/worker:** Capable of working effectively in diverse teams in both classroom, laboratory as well as in field-based situations.

**Digitally literate:** Capable of using computers for bioinformatic work and appropriate biostatistics software for analysis of data, and employing modern library search tools to locate, retrieve, and evaluate biology-related information.

**Ethical awareness/reasoning:** Avoiding unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, and sensitivity towards environmental and sustainability issues.

**Lifelong learners:** Capable of making conscious efforts to achieve self-paced and self directed learning aimed at personal development and for improving knowledge and developing skill.

### **Qualification descriptors for B.Sc. (Hons.) programme in Biological Science:**

- A student should demonstrate (i) systematic and coherent understanding of the field of Biological Science, its applications and links to related disciplinary areas of study; (ii) practical knowledge that enables different types of professions related to Biological Science, including research and development, teaching, entrepreneurship as well as industrial research abilities; (iii) skills in areas pertaining to current developments in the academic field of study, including a critical understanding of the latest developments in the field of Biological Science and an ability to use established techniques of analysis.
- Demonstrate comprehensive knowledge about materials, including current research, scholarly literature, relating to essential and advanced learning areas pertaining to Biological Science, and techniques and skills required for identifying Biological Science-related problems and issues.
- Demonstration of skills in collection of relevant data gathered by reading or experimentation and analysis and interpretation of the data using appropriate methodologies.
- Ability to communicate the results of studies undertaken in an academic field accurately in the form of a paper, oral presentation or report.
- Apply knowledge and skills gained, to new and unfamiliar contexts and to identify and analyze problems and issues and seek solutions to real-life problems.
- Demonstration of the ability to function in an effective manner both independently as well as a member of a team.

### **Programme Outcomes (PO)**

The programme is designed to achieve the following outcomes:

PO-1: To develop an in-depth knowledge and understanding of the discipline.

PO-2: To encourage students to effectively communicate scientific reasoning and data analysis in both written and oral forms.

PO-3: Create an awareness of the impact of biology on the environment, society, and development outside the scientific community.

PO-4: Inculcate the scientific temperament in the students for careers within and outside the scientific community.

## **Programme Specific Outcomes (PSO)**

At the end of the course, the students will be able to

PSO1: Develop an in-depth knowledge and understanding of the fundamental concepts and principles underlying Biological processes.

PSO2: Develop practical knowledge and skills that are required for pursuing a career in clinical diagnosis, drug design, vaccine development, pharmaceutical industry, teaching, research, environmental monitoring.

PSO3: Use various bioinformatics tools for training in the basic theory and application of programs used for database searching, protein and DNA sequence analysis and prediction of protein structures.

PSO4: Effectively communicate scientific reasoning and data analysis in both written and oral forms.

PSO5: Gain knowledge of ethical and good laboratory practices.

## **Teaching-Learning Processes**

The programme of B.Sc. in Biological Science is designed to encourage the acquisition of disciplinary/subject knowledge, understanding the skills and achieve academic and professional skills required for biology -based professions and jobs. Learning experiences are designed and implemented to foster active/participative learning. Development of practical skills will constitute an important aspect of the teaching-learning process. A variety of approaches to the teaching-learning process, including lectures (online/offline, chalk and board method, powerpoint presentation), oral discussion sessions in the class, seminars, tutorials, short group project-based learning, field-based learning, visit to Zoo/Museum/Botanical garden, substantial laboratory-based practical experiments and surveys will be adopted to achieve this. Problem-solving skills, analytical reasoning skills will be encouraged through adopting appropriate teaching strategies.

## **Assessment Methods**

The assessment of students' achievement in Biological Science will be aligned with the course/programme learning outcomes and the academic and professional skills that the programme is designed to develop. A variety of assessment methods that are appropriate will be used including formative and summative assessment modes. Progress towards achievement of learning outcomes will be assessed using the following: time-constrained examinations; closed-book and open-book tests; problem based assignments; practical assignment laboratory reports; individual/ group project reports (survey reports); oral presentations, including seminar presentation; viva voce; peer and self-assessment methods. Any other pedagogic approaches may be adopted as per the context.

**Semester-wise Modules of the Undergraduate Course in Biological Science (Hons.)/Major under CBCS**  
**Department of Life Sciences, Presidency University, Kolkata**

Semester	Course Type			
	Core Course	Department Specific Elective	Generic Elective	Skill Enhancement Course
First	BIOS01C1: Chemistry		BIOS01GE1: World of Animals	
	BIOS01C2: Light and Life			
Second	BIOS02C3: Biophysics		BIOS02GE2: Economic applications of plant and microbial biotechnology	
	BIOS02C4: Biodiversity			
Third	BIOS03C5: Proteins and Enzymes		BIOS03GE3: Modern Lifestyle, Behaviors and Ailments	BIOS03SEC1: A or B
	BIOS03C6: Cell Biology			
	BIOS03C7: Ecology			
Fourth	BIOS04C8: Systems Physiology		BIOS04GE4: Macromolecules of Life	BIOS04SEC2: A or B
	BIOS04C9: Molecular Biology			
	BIOS04C10: Metabolism and Integration			
Fifth	BIOS05C11: Growth and Reproduction	BIOS05DSE1: A or B		
	BIOS05C12: Genetics	BIOS05DSE2: A or B		
Sixth	BIOS06C13: Defense Mechanisms	BIOS06DSE3: A or B		
	BIOS06C14: Evolutionary Biology	BIOS06DSE4: A or B		

**Academic Session:** Each Semester shall contain at least 16 Teaching Weeks

Odd Semesters: Semesters One, Three and Five - July to December

Even Semesters: Semesters Two, Four and Six- January to June

**Credit Allocation and Marks Distribution for the Undergraduate Course in Biological Science (Hons.)/Major under CBCS**

**Department of Life Sciences, Presidency University, Kolkata**

Semester	Course Type	Paper Code	Course Name	Credits				Marks			
				Theory	Practical	Tutorial	Total	Theory	Practical	Tutorial	Total
First	Core Course	BIOS01C1	Chemistry	4	2		6	70	30		100
First	Core Course	BIOS01C2	Light and Life	4	2		6	70	30		100
First	Generic Elective	BIOS01GE1	World of Animals	4	2		6	70	30		100
First	Ability Enhancement Course		ENVS/ English Commination	4			4	100			100
Second	Core Course	BIOS02C3	Biophysics	4	2		6	70	30		100
Second	Core Course	BIOS02C4	Biodiversity	4	2		6	70	30		100
Second	Generic Elective	BIOS02GE2	Economic applications of plant and microbial biotechnology	4	2		6	70	30		100
Second	Ability Enhancement Course		ENVS/ English Commination	4			4	100			100
Third	Core Course	BIOS03C5	Proteins and Enzymes	4	2		6	70	30		100
Third	Core Course	BIOS03C6	Cell Biology	4	2		6	70	30		100
Third	Core Course	BIOS03C7	Ecology	4	2		6	70	30		100
Third	Generic Elective	BIOS03GE3	Modern Lifestyle, Behaviors and Ailments	4	2		6	70	30		100
Third	Skill Enhancement Course	BIOS03SEC1	A or B	4			4	100			100
Fourth	Core Course	BIOS04C8	Systems Physiology	4	2		6	70	30		100
Fourth	Core Course	BIOS04C9	Molecular Biology	4	2		6	70	30		100
Fourth	Core Course	BIOS04C10	Metabolism and Integration	4	2		6	70	30		100
Fourth	Generic Elective	BIOS04GE4	Macromolecules of Life	4	2		6	70	30		100
Fourth	Skill Enhancement Course	BIOS04SEC2	A or B	4			4	100			100
Fifth	Core Course	BIOS05C11	Growth and Reproduction	4	2		6	70	30		100
Fifth	Core Course	BIOS05C12	Genetics	4	2		6	70	30		100
Fifth	Department Specific Elective	BIOS05DSE1	A or B	4	2		6	70	30		100
Fifth	Department Specific Elective	BIOS05DSE2	A or B	4	2		6	70	30		100
Sixth	Core Course	BIOS06C13	Defense Mechanisms	4	2		6	70	30		100
Sixth	Core Course	BIOS06C14	Evolutionary Biology	4	2		6	70	30		100
Sixth	Department Specific Elective	BIOS06DSE3	A or B	4	2		6	70	30		100
Sixth	Department Specific Elective	BIOS06DSE4	A or B	4	2		6	70	30		100
				<b>Total Credit</b>			<b>148</b>	<b>Total Marks</b>			<b>2600</b>

## **CORE COURSES**

### **Semester I:**

#### **BIOS01C-1: CHEMISTRY**

**Credits - 6: (Theory- 04, Practical- 02)**

#### **Theory**

Credit : 4

Contact Hours per Week : 4

#### ***Unit 1 Chemical Thermodynamics and kinetics***

Qualitative idea of thermodynamics. First Law of Thermodynamics: Calculation of work (w), heat (q), changes in internal energy ( $\Delta E$ ) and enthalpy ( $\Delta H$ ) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of w, q,  $\Delta E$ , and  $\Delta H$  for processes involving changes in physical states. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formation, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature Kirchhoff's Equation. Second law of thermodynamics, concept of entropy, Gibbs free energy and Helmholtz free energy. Calculations of entropy change and free energy change for reversible and irreversible processes under isothermal and adiabatic conditions. Criteria of spontaneity, Gibbs Helmholtz equation. Maxwell's relations. Activation energy and transition-state theory; Different orders of chemical reactions, free energy and chemical reaction.

#### ***Unit 2 Chemical Bonding and Molecular Structure Ionic Bonding***

Lattice energy and solvation energy. Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, Covalent Bonding: VB Approach, Lewis theory, VSEPR theory to explain the shapes of molecules, salient features of the Valence bond (VB) theory and the concept of hybridization, MO Approach: limitations of the VB approach, salient features of the MO theory. Rules for the LCAO method, bonding and anti-bonding MOs and their characteristics for s-s-, s-p and p-p combinations of atomic orbitals, nonbonding combinations of orbitals.

#### ***Unit 3 Fundamentals of Organic Chemistry***

Hybridization in organic compounds, cleavage of covalent bond, homolysis and heterolysis, Electronic effects: Electronic effects and their applications – inductive, resonance and hyperconjugation effects. Structure and relative stability of reactive carbon species – carbocations, carbanions, free radicals and carbenes, Molecular Forces : types of intermolecular and intramolecular forces and their characteristics: dipole-dipole, Dipole Induced dipole and dispersion (London) forces. Hydrogen bond (both intramolecular and intermolecular, Aromaticity).

### **Unit 4 Stereochemistry**

Stereochemistry and its importance. Geometrical isomerism, cis-trans and E/Z nomenclature. Optical isomerism – optical activity, plane polarized light, enantiomerism, chirality, specific molar rotation, Stereoisomerism with two chiral centers: Diastereomers, mesoisomers, Resolution of racemic modification. Projection diagrams of stereoisomers: Fischer, Newman and Sawhorse projections. Relative Configuration: D/L designation. Absolute Configuration: R/S designation of chiral centres.

#### **Practical**

Credit : 2  
Contact Hours per Week : 4

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture
2. Estimation of oxalic acid by titrating it with  $\text{KMnO}_4$ .
3. Estimation of Fe (II) ions by titrating it with  $\text{K}_2\text{Cr}_2\text{O}_7$  using internal indicator
4. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide
5. Separation of the components of a given mixture of two amino acids by paper chromatography.
6. Separation of sugars present in the given mixture by paper chromatography.

#### **Course Outcomes:**

##### **After successfully completing this course, the students will be able to:**

1. Revise their understanding of basic chemistry and will also learn various aspects of general chemistry that are fundamental and essential to understand almost every biological event or process such as- Solubility, pH, buffers, bonding and interactions between atoms, transition between work and heat, processes, equilibrium, entropy, feasibility of any process to happen, kinetics of any reaction, how stereochemistry of reactants determine the reaction mechanism and product specificity etc.
2. Learn to apply the acquired knowledge in basic chemistry to various biological events of life
3. Gain Hands on training in basic chemistry will enable the students to learn conducting an experiment alone and in a group, with rationale, and outcome.

**SEMESTER – I**

**BIOS01C-2: LIGHT AND LIFE**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

**Unit 1**

Nature of light, spectrum of light which is useful/ harmful (ionizing radiation) for various biological processes in life of plants and animals. Unit of light energy (Photon, quantum), Measurement of light (Lux). Introduction to pigments/receptors of light: chlorophylls, carotenoids, phycobiliproteins, bacteriochlorophylls, phytochromes Photoreception in animals, evolution of eye and visual processing in vertebrate retina.

**Unit 2**

Photosynthetic equation, Light and dark reactions, mechanism of photolysis of water and oxygen evolution, O<sub>2</sub> evolving complex; C<sub>3</sub>, C<sub>4</sub>, CAM plants, structure of chloroplast and quantasome, Anoxygenic and oxygenic photosynthesis, reaction centers. Bacterial Photosynthesis.

**Unit 3**

Concept of bioluminescence: definition, diversity of organisms (plants and animals), General account of effect of light on morphology and physiology (stomatal opening and closing, transpiration, seed germination), Concepts of photoperiodism: LDP, SDP, DNP plants, vernalization. Light as an ecological factor affecting distribution of plants and animals (Phytoand Zoo geography), in terrestrial and aquatic ecosystems: Morphological, Anatomical, Physiological and Behavioural adaptations to extreme light conditions by organisms.

**Unit 4**

Behavioural aspects of ecology and physiology: circadian rhythms, jet lag, SAD, hormonal rhythms, melanocytes and skin colour, chromatophores and colour changes in animals, SCN and Pineal gland, Light as an inducer for biosynthesis of enzymes, hormones and other biomolecules.

**Practical**

Credit : 2

Contact Hours per Week : 4

1. Demonstration of
  - a. Light and CO<sub>2</sub> are essential for photosynthesis (Moll's half leaf experiment) and measure oxygen evolution during photosynthesis
  - b. Oxygen liberation during photosynthesis using Hydrilla, Measurement of light using Lux meter

- c. Berlese funnel experiment to demonstrate the effect of light on soil fauna
- d. Animal migration in aquatic ecosystems during day and night (pictures only)
2. To study the estrous cycle of rat
3. Chemical separation of chloroplast pigments/Chromatographic separation of chloroplast pigments.
4. Demonstration of Blackman's law of limiting factors (using Hydrilla).
5. Study of the effect of red and blue light on seed germination
6. Photographs/slides/specimens of photoautotrophic and photosynthetic bacteria, chloroplast, quantasome, bioluminescent organisms (plants and animals)
7. To study the effect of light and darkness on the chromatophores of fish
8. To study the phototactic behavior of different larval instars of Spodoptera
9. To study the effect of light/darkness on development of insect (Spodoptera)
10. To test / survey for colour blindness using Ishihara charts
11. To study Diurnal variations in human body temperature

**Course Outcomes:**

**After successfully completing this course, the students will be able to understand:**

1. Physics of light, units and measurement of light energy and light intensity, pigments and receptors which are sensitive to light in bacteria, plants and animals.
2. Photosynthesis in plants and bacteria under different conditions - the reaction mechanisms and the reaction centres involved.
3. The concept of bioluminescence, diversity of plants and animals exhibiting bioluminescence; effect of light on the morphological and physiological processes of plants, effect of light as an ecological factor.
4. Concept of circadian rhythms, and maintaining biological rhythms.
5. Gain practical training on effects of different factors on photosynthesis and seed germination, effect of light on animal migration in aquatic ecosystems; cyclic activity such as estrous cycle in rats and diurnal variation of body temperature of humans.

**SEMESTER - II**

**BIOS02C-3: BIOPHYSICS**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Mechanics***

Galilean invariance and Newton's Laws of motion. Dynamics of a system of particles, Conservation of momentum and energy, work energy theorem. Conservation of angular momentum, torque, Motion of a particle in central force field. Kepler's Laws, Satellite in circular orbit and applications (Synchronous satellite, GPS, Artificial gravity, apparent

weightlessness), Physiological effects of acceleration and angular motion. Special Theory of Relativity: Constancy of speed of light, postulate of Special theory of relativity, length contraction, time dilation, relativistic velocity addition, Mass-energy momentum relations.

### **Unit 2: Waves and Oscillations**

Simple harmonic motion, damped and driven harmonic oscillator, coupled oscillator, energy relation and energy transfer, normal modes, Wave equation, Travelling waves, superposition principle, pulses, Doppler effect, effects of vibrations in humans, physics of hearing, heartbeat. Modern optics: Two slit Interference, Diffraction, Resolving power, Resolution of the eye, Laser characteristics, Principle, Population inversion, Application of laser in medical science, Polarization of EM wave.

### **Unit 3: Biological membranes and Channel Proteins**

Colloidal solution, Micelles, reverse micelles, bilayers, liposomes, phase transitions active, passive and facilitated transport of solutes and ions, Fick's Laws, Nernst Planck Equations, Diffusion, Osmosis, Donnan effect, permeability coefficient. Ionophores, membrane potential, water potential in context to ion-channels and aquaporins; gating mechanism.

### **Unit 4: Spectroscopic techniques**

Basic principles of electromagnetic radiation, energy, wavelength, wave numbers and frequency. Review of electronic structure of molecules (Molecular Orbital theory), absorption and emission spectra. Beer-Lambert law, light absorption and its transmittance. UV and visible spectrophotometry-principles, instrumentation and applications. Fluorescence spectroscopy, static & dynamic quenching, energy transfer, fluorescent probes in the study of protein, nucleic acids, Infra-red spectroscopy, light scattering in biology, circular dichroism.

#### **Practical**

Credit : 2  
Contact Hours per Week : 4

1. Verification of Beer-Lambert Law
2. Determination of Molar Extinction coefficient
3. Determination of concentration of nucleic acids through UV-Vis spectroscopy
4. Determination of concentration of proteins through UV-Vis spectroscopy
5. Effect of different solvents on UV absorption spectra of proteins.
6. Determination of CMC for a detergent
7. Osmosis experiment using potato.

#### **Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Learn basic concepts of physics and apply them to study the physicochemical properties of biomolecules.

2. Learn to investigate the light absorption properties of biomolecules through spectrophotometry, for qualitative and quantitative analysis of biomolecules.
3. Learn the concepts related to mechanics of solids and liquids to understand the basic mechanisms of cell biology especially cell adhesion, migration and mechanotransduction.
4. Learn about the mechanism of transport of various ions/molecules across cell membranes and their significance in several biological processes.

**SEMESTER – II**

**BIOS02C-4: BIODIVERSITY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Defining Biodiversity***

Components of Biodiversity. Biodiversity crisis and biodiversity loss. Importance of biodiversity in daily life. Biodiversity and climate change. Types of Ecosystems: India as a megadiverse country. Hotspots and biodiversity in India. Biodiversity and Ecosystem functioning. Types of Biodiversity, microbial classification and diversity.

***Unit 2: Modern Tools in the study of Biodiversity***

Endemism, endemic plants and animals; Assessment of mapping of biodiversity; GIS/Remote sensing; Biotechnology and Conservation, IUCN; Germplasm banks, National Parks, Botanical Gardens; Wildlife Sanctuaries, Bio resources.

***Unit 3: Crop Diversity***

Wild relatives of cultivated plants; Domesticated diversity; Spice diversity; Forest diversity and wildlife.

***Unit 4: Bio-prospecting***

Representative type (one each) studies from Cryptogams, Phanerogams, Non-chordates and Chordates; Sacred flora and fauna. Bio-prospecting– Micro-organisms as a source of novel enzymes, antibiotics, antiviral agents; Immunosuppressive agents and other therapeutic agents. Botanicals for Biocontrol, Health and biodiversity.

**Practical**

Credit : 2

Contact Hours per Week : 4

1. Study of following specimens: Euglena, Noctiluca, Paramecium, Sycon, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, Hermit Crab, Daphnia, Millipede, Centipede, Beetle, Pila, Chiton, Dentalium, Octopus, Asterias, and Antedon.
2. Dissections/ Virtual demonstration: Digestive and nervous system of Cockroach; Mouth parts, salivary apparatus and ovary of cockroach; Unstained mount of Placoid scales.
3. Study of following specimens: Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Ichthyophis/Uraeotyphlus, Salamander, Rhacophorus, Draco, Uromastyx, Naja, Viper, any three common birds, Squirrel and Bat.
4. Study of a few endangered species of amphibians, reptiles, birds and mammals of India
5. To study the faunal composition (insects and mites) of soil samples. (Berley's funnel)
6. To study faunal composition of water samples (Lucky drop method)
7. Report on visit to National Park/Wildlife sanctuary/Botanical garden/ Zoological Garden. FLORA
8. Study through specimens/photographs/slides of (a) Keystone species (b) Ecads, Ecotypes, Ecophenes (c) Source of immunosuppressive and other therapeutic agents (d) Botanicals for biocontrol (e) Sacred flora (havan materials etc.)
9. Study through permanent slides and specimens (vegetative and reproductive structures) of Coleacheate, Vaucheria, Polysiphonia, Fucus (Fucus permanent slides only); Rhizopus, Penicillium and Agaricus; Riccia, Anthoceros, Funaria; Psilotum, Selaginella, Pteris; Cycas, Pinus, Gnetum

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Understand different components of biodiversity
2. Gain knowledge about modern tools in biodiversity assessment
3. Understand Crop biodiversity
4. Understand Bioprospecting
5. Perform identification of different model invertebrates and vertebrates animals
6. Perform dissection/virtual demonstration of different body parts of invertebrates.
7. Gain comprehensive knowledge about the faunal community from water and soil by means of a Study tour

**SEMESTER – III**

**BIOS03C-5: PROTEINS AND ENZYMES**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Biomolecules- Diversity and distribution***

Lipids: Role of lipids in cellular architecture and functions. Definition and classification of lipids. Structure and function of fatty acids, triacylglycerols, phospholipids and sterols. Lipid chemistry: Classification and properties of lipids with emphasis on saponification number, iodine number, acetyl number, Reichert-Meissel number, hydrogenation and rancidity of fats. Carbohydrates: Biological roles of carbohydrates, Classification and properties of carbohydrates with emphasis on stereoisomerism, optical isomerism, epimerization, mutarotation and reducing action of sugars, monosaccharides- Hexoses and pentoses. Disaccharides-Sucrose, lactose, maltose. Storage and structural polysaccharides-Glycogen, starch and cellulose. Nucleic acid chemistry: elementary concept of nucleoside, nucleotide, polynucleotide; elementary concept of RNA. Nucleic acids: Role of nucleic acids in living system. Composition of nucleic acids-the purine and pyrimidine bases. Bonding interactions and factors stabilizing nucleic acid structures.

***Unit 2: Proteins***

Classification of proteins on the basis of composition, conformation and function-functional diversity of proteins. The amino acid building blocks-classification, structure and physical properties of the standard amino acids. Proteinaceous and non-proteinaceous, essential and non-essential amino acids. Primary, secondary, tertiary and quaternary structure of proteins. Properties of proteins with emphasis on isoelectric pH, salting in and out, biuret test and heat coagulation. Structure of myoglobin and hemoglobin. Molecular physiology of myoglobin and hemoglobin, Bohr effect, Hill's coefficient. Concerted and sequential models for allosteric proteins.

***Unit 3: Enzymes***

Enzymes as biological catalysts. Enzyme classification and nomenclature. Chemical nature of enzymes, ribozymes. Concept of active site, specificity. Coenzymes, cofactors and prosthetic groups. Kinetics of enzyme catalyzed reactions –Michaelis Menten equation. Determination of  $K_m$  and  $V_{max}$ . Factors influencing the rate of enzyme catalyzed reactions. Enzyme inhibitions- competitive, non-competitive and uncompetitive inhibition. Catalytic mechanism of lysozyme or chymotrypsin. Regulation of enzyme activity allosteric enzymes, feedback inhibition with ATPase as an example.

***Unit 4: Isolation and purification of enzymes***

Methods of enzyme isolation and purification. Introduction to enzyme immobilization.

**Unit 5: Role of Metal ions in Biology**

Metalloprotein, Metalloenzymes, metal base drug interaction and inhibition; metalloporphyrins, Fe-S cluster - the multipurpose redox cofactors.

**Practical**

Credit : 2

Contact Hours per Week : 4

1. Preparation of buffers
2. Determination of PKa value for acetic acid
3. Identification of substances of biological importance by biochemical tests.
4. Estimation of proteins by Biuret method
5. Estimation of proteins by Lowry's method
6. Estimation of glucose / sucrose / lactose in milk by Benedict's method
7. Separation of sugars by Thin Layer chromatography
8. Effect of pH on the activity of an enzyme
9. Determination of Michaelis Menten parameters of an enzyme

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Learn the basic concepts regarding the building blocks of biological system
2. Understand the basic concepts related to enzymes which are the major players of our biological system: kinetics, inhibition, regulations, mechanism of its action, its purification from cells
3. Learn the involvement of metal ions in biology
4. Gain hands-on training on biochemical analysis of biological important components.

**SEMESTER – III**

**BIOS03C-6: CELL BIOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

**Unit 1: An Overview of Cells**

History, Cell theory, Overview of Prokaryotic and Eukaryotic Cells, Plant and Animal cells, exceptions to cell theory, Phages, Virioids, Mycoplasmas, Viruses, Prions, hierarchy in cell structure and cell molecules (inorganic elements,

building blocks, macromolecules, supramacromolecules, cell organelles, cells, tissues, organs, organisms etc.), Cell cycle and its regulation.

***Unit 2: Tools and techniques in cell biology***

Microscopy: Light microscopy, Phase contrast microscopy, Confocal microscopy, Electron microscopy (SEM, TEM, STEM), fluorescence microscopy, principles and applications. Basics and uses of flow cytometry, fluorescent probes, Spectrophotometry, Mass spectrometry, X-ray diffraction, Chromatography: Paper, TLC, gel-filtration, ion-exchange, affinity and HPLC.

***Unit 3: Cell wall, extracellular matrix and cell interactions***

Cell wall, distribution, chemical composition, functions and variations in prokaryotic and eukaryotic cells (primary and secondary wall), Glycocalyx, Cell-cell interactions/ Junctions, pit connections in plants and animals.

***Unit 4: Cell membrane***

Structure and functions, active and passive transport, proton pumps associated (Na-K, Ca-calmodulin etc. and their distribution), phagocytosis, pinocytosis, exocytosis, endocytosis.

***Unit 5: Nucleus***

Nuclear envelope, structure of nuclear pore complex, nuclear lamina, transport across nuclear membrane, Nucleolus, rRNA processing.

***Unit 6: Mitochondria, Chloroplasts, Lysosomes, Glyoxysomes and Peroxisomes***

Structural organization, function, marker enzymes of the above organelles, biogenesis of mitochondria and chloroplasts, brief account of transport in mitochondria and chloroplasts (Tim/Tom; Tic/Toc) and semiautonomous nature of mitochondria and chloroplast, lysosomes and quality control in the cell.

***Unit 7: Cytoskeleton***

Structure and organization of actin, myosin and intermediate filaments, microtubules, and their role in cellular traffic and cell cycle.

***Unit 8: Protein sorting and Transport***

Structure and functions of Endoplasmic reticulum and Golgi apparatus, GERL.

### **Unit 9: Cell signaling**

Signaling molecules and their receptors, functions; intracellular signal transduction pathways (with special reference to some selected pathways); signaling networks and cross talk; bacterial signal transduction (two component system).

### **Unit 10: Cancer**

Programmed Cell Death; Biology and elementary knowledge of development and causes of cancer; Tumor viruses, Oncogenes and suppressor genes, Cancer treatment-Molecular approach, Stem cells and therapeutic cloning.

### **Practical**

Credit : 2

Contact Hours per Week : 4

1. Separation of nucleic acid bases by paper chromatography.
2. Study of different stages of meiosis by temporary preparation/ permanent slides of onion flower buds.
3. Study of different stages of mitosis by temporary preparation/ permanent slides of onion root tips.
4. Demonstration of ciliary movements and staining of fresh tissues like epithelial, connective, muscular and nervous tissues.
5. Staining of fixed tissue sections by hematoxylin - eosin method.
6. Preparation of temporary slides of the following (Onion epidermal peel/ root tips or any other suitable available material like Crinum, Wheat caryopsis etc.): Cytochemical staining of DNA by Feulgen, Cytochemical staining of RNA by Methyl Green, PyroninCytochemical staining of polysaccharides by PAS.
7. Cytochemical staining of proteins by Bromophenol blue, Cytochemical staining of histones by fast green
8. Vital staining of mitochondria by Janus green B in cheek epithelial cells; bacterial staining
9. Identification and study of types of cancer, cancer cells by permanent slides/ photographs.
10. Study of the following microscopic techniques by photographs: Fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching, shadow casting
11. Study of ultrastructure of cell ( Cell wall, Primary and secondary pits, Plasmodesmata, Gap junctions, Tight junctions, Plasma membrane, Nucleus, Nuclear Pore Complex, Chloroplast, Mitochondrion, Golgi bodies, Lysosomes, SER and RER), Prokaryotic and Eukaryotic cell, Plant and Animal Cell, Phages: TMV and Bacteriophage, Viroids and Prions (Mad Cow's / Kuri/ PSV disease), Mycoplasmas through electron micrographs/photographs.

### **Course Outcomes:**

#### **After successfully completing this course, the students will be able to learn**

1. How the world inside the cell operates.
2. How wonderfully all the workloads of a cell are distributed in various compartments and how all these organelles cooperate with each other inside the cell for its survival.
3. How beautifully the cell organizes its survival and death machinery and also increases its number with proper segregation of its genetic materials.

4. How the cell on the one hand compartmentalizes itself from its surroundings and on the other hand constantly maintains connections to the outside world and responds instantly to the stimuli.
5. Learn different staining procedures and understand cellular diversity, cell measurement methods, cell division through different laboratory exercises.

**SEMESTER – III**

**BIOS03C-7: ECOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Introduction to Ecology***

Relevance of studying ecology, History of ecology, Autecology and synecology, levels of organization, major biomes (role of temperature and precipitation). Laws of limiting factors (Leibigs law of minimum, Shelfords law of tolerance), ecological range (Eury, Steno). Ecological factors (abiotic and biotic): detailed study of temperature and light as physical factors. Soil- characteristics and horizons.

***Unit 2: Population Ecology***

Population : Unitary and Modular populations, metapopulation : Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; carrying capacity, population dynamics (exponential and logistic growth equation and patterns), r and K selection, density-dependent and independent population regulation; Competition, Niche concept, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation – Introduction. Phenotypic and genotypic plasticity, Species interactions.

***Unit 3: Ecosystem and Community Ecology***

Concept, components, types of ecosystem with one example Pond ecosystem in detail (abiotic and biotic components, BOD, eutrophication). Energy flow (Grazing and Detritus food chain), linear and Y-shaped energy flow model, food web. Ecological pyramids and Ecological efficiencies. Nutrient cycle with one example of Nitrogen cycle. Community ecology: Community structure: Dominance, diversity, species richness, abundance, stratification; Diversity indices; Ecotone and edge effect; Community dynamics (succession): Viewpoint of succession, Primary and secondary succession, Hydrarch and xerarch succession. Climax: monocl意思 and polyclimax concepts (preclimax, postclimax, disclimax etc.). Concept of keystone, indicator, umbrella and flagship species.

**Unit 4: Behavioral ecology**

Social, reproductive & territorial behavior, kin selection. Evolution of optimal life history, trade-offs, semelparity and iteroparity, reproductive structure and mating system. Four questions of Niko Tinbergen, Communication: pheromone and bee-dance.

**Practical**

Credit : 2

Contact Hours per Week : 4

1. Study through specimens/photographs/slides of Parasitic angiosperms, Saprophytic angiosperms, VAM fungi, Root nodules, Coralloid roots, Mycorrhizal roots, Velamen roots, Different types of lichen.
2. Principle and function of Sechi disc, Atmometer, Anemometer, Hygrometer, Hair hygrometer, Luxmeter, Rain gauge, Soil thermometer, Min-Max thermometer
3. To determine a minimal quadrat area for sampling in the given simulation sheet
4. To determine density/frequency/abundance of the vegetation by quadrat method in the field or on given simulation sheet
5. To determine soil texture, soil density, bulk density, particle density and pore space.
6. To determine water holding capacity and percolation rate of soil.
7. To determine pH, Cl, SO<sub>4</sub>, NO<sub>3</sub>, base deficiency, organic matter, cation exchange capacity in the soil.
8. Plotting of survivorship curves from hypothetical life table data.
9. To estimate dissolved oxygen content of given water sample using Winkler's method and free CO<sub>2</sub>
10. Study of animal behavior in natural habitat (Forest/ aquatic ecosystem).

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Understand about conservation of the ecosystem, prevent extinction of species, understand the interrelationships among organisms and habitats, reduce pollution, inculcate thoughtfulness towards the environment among the future generations.
2. Learn about employment of scientific methodology via lab and field studies to understand how the different organisms grow, populate, how they interact with other organisms either as parasites, predators, how the organisms die out as well as how they evolve or adapt to changing climatic and environmental situations.
3. Using the principles of ecology, students learn to predict, counteract and prevent potentially adverse effects we might have on the earth due to our undying greed for more, and thus safeguarding our wellbeing and survival on this planet.

**SEMESTER - IV**

**BIOS04C-8: SYSTEMS PHYSIOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Movements and Bulk Transport***

Cellular movements, ciliary and flagellar structure and function; Introduction to musculo-skeletal system; Terrestrial, aquatic and aerial locomotion; Locomotory cost; Long distance transport of water and nutrients in plants (xylem and phloem transport) ; General plan and physiology of circulatory system in vertebrates and invertebrates; Blood and body fluids - composition, haemopoiesis, haemoglobin, hemostasis, blood transfusion, anaemia; circulation in humans. Cardiovascular system -cardiac cycle, cardiac output, electrocardiography and arrhythmias.

***Unit 2: Gas exchange in animals & humans***

Role of respiratory pigments, significance of different lung volumes and capacities ; Generation and utilization of energy, Exchange in unicellular organisms and plants; Respiratory organs in aquatic and terrestrial systems ; Physiology of aquatic breathing and aerial breathing; Feeding patterns, physiology of human digestive system, regulation of digestion and absorption of foods.

***Unit 3: Regulatory Physiology***

Mechanism of opening and closing of stomata. Regulation of water and solutes in aquatic and terrestrial animals; Osmoregulatory organs Renal regulation of osmolarity,. Transpiration in plants; Excretion of nitrogenous wastes in animals and humans; Countercurrent multiplier and exchanger, Patterns of Thermoregulation: Ectotherms, Endotherms and homeotherms and their mechanism; Concept of Q10, Structural and functional adaptation to stress.

***Unit 4: Integrative Physiology***

An overview of the nervous system, Neurone -structure, types, properties and propagation of nerve impulse; Sensory physiology - receptors- types and potentials. Reflex action- types and properties. Endocrine systems in animals and humans and their physiological effects; Plant hormones and their physiological effects; Regulation of metabolism and response to environmental cues.

**Practical**

Credit : 2

Contact Hours per Week : 4

1. Effect of isotonic, hypotonic and hypertonic salines on erythrocytes
2. Identification of different histological sections. Identification of blood cells and differential counts.

3. Estimation of total count of WBC & RBC using haemocytometer.
4. Identification of megakaryocytes from bone marrow and measurement of its diameter.
5. Pneumographic recording of respiratory movements under different experimental conditions.
6. Studies on the movements of the heart and intestine.
7. Study of the effect of various environmental factors on transpiration in an excised twig/ leaf.
8. Calculation of the stomatal index, stomatal frequency and percentage of leaf area open through stomata in mesophytes and xerophytes.
9. Study of the mechanism of stomatal opening and closing.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Get a comprehensive overview of the workings of bulk transport in human, animal and plant systems
2. Understand the unique role of various organs and organ systems in performing various vital functions.
3. Understand gas exchange, temperature and salt balance, appreciate the importance of homeostasis in different systems
4. Understand sensory systems and regulation by hormones in plants and animals including humans.
5. Learn to apply critical thinking and integrate scientific knowledge to understand the basic physiological principles which led to diverse evolutionary adaptations.

**SEMESTER - IV**

**BIOS04C-9: MOLECULAR BIOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Genes and genomic organization***

Definition of a gene, organization of genes in viruses, bacteria and eukaryotes. Complexity of eukaryotic genes and chromosomes, Cot Curve analysis, supercoiling of DNA and its importance, linking number, topoisomerases, inhibitors of topoisomerases and their application in medicine, Nucleosome structure and packaging of DNA into higher order structures.

***Unit 2: Replication of DNA***

Features of DNA Replication, chemistry of DNA synthesis, the replication fork, origin of replication, stages of DNA replication, enzymes and proteins involved in DNA replication, *E coli* DNA polymerases, replication in eukaryotes,

telomeres and telomerase. Comparison of replication in prokaryotes and eukaryotes. Regulation of DNA replication in prokaryotes and eukaryotes

**Unit 3: DNA repair**

Mutations and cancer, mismatch repair, base excision repair, nucleotide excision repair, direct repair, recombination repair, Non-homologous end joining (NHEJ), error-prone translesion DNA synthesis, SOS repair in bacteria

**Unit 4: DNA-dependent synthesis of RNA**

Types of RNAs, DNA-dependent RNA polymerase, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, the three stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Transcription in eukaryotes, inhibitors of transcription and applications as antibiotics.

**Unit 5: RNA processing**

Modification of eukaryotic mRNA at the 5' and the 3' end, splicing introns, differential RNA processing, processing of rRNAs and tRNAs, special function RNAs, RNA as enzyme.

**Unit 6: Proteins Synthesis**

The genetic code, cracking the genetic code, degeneracy, wobble hypothesis, features of the genetic code, translational frameshifting and RNA editing, the ribosome as a supramolecular machine, structure of tRNAs, the five stages of protein biosynthesis, aminoacyl-tRNA synthetases, initiation in prokaryotes and in eukaryotes, elongation, termination, folding and processing, inhibitors of protein synthesis and their application in medicine.

**Unit 7: Regulation of gene expression**

Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains. Regulation of gene expression in bacteria, lac operon and trp operon, induction of SOS response, synthesis of ribosomal proteins, riboswitches. Overview of regulation of gene expression in eukaryotes, heterochromatin, euchromatin, chromatin remodeling, DNA binding activators and co-activators, regulation of galactose metabolism genes in yeast, post-transcriptional gene-silencing by RNA interference.

**Practical**

Credit : 2  
Contact Hours per Week : 4

1. Estimation of DNA by DPA method.
2. Estimation of RNA by Orcinol method.

3. Separation of nucleotide bases by paper chromatography/Plasmid DNA isolation.
4. Extraction of total nucleic acids from plant tissue/animal cells/ yeast.
5. Isolation of RNA from plant tissue/animal cells/ yeast.
6. Isolation of chromosomal DNA from *E. coli* / yeast/ animal cells.
7. Measure Purity of isolated DNA by A260/A280 Ratio.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Learn about the structure of DNA, about genome organization in various life forms
2. Learn about the mechanism of DNA replication along with regulation in prokaryotes and eukaryotes.
3. Learn about the process of transcription, RNA processing and translation in prokaryotes and eukaryotes.
4. Learn about the various ways in which the DNA can be damaged leading to mutations and lesions and different ways to repair DNA damage.
5. Learn about the various ways in which these biological processes are regulated and its significance

**SEMESTER – IV**

**BIOS04C-10: METABOLISM AND INTEGRATION**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Concept of Metabolism***

Principles of bioenergetics-Standard free energy change, metabolic roles of ATP-Phosphoryl group transfer, nucleotidyl group transfer. Experimental approaches to study of metabolism; Primary and secondary metabolism Energetics.

***Unit 2: Metabolic Pathways***

Carbohydrate metabolism - Glycolysis, alcoholic and lactic acid fermentation, Pasteur Effect, gluconeogenesis, Cori cycle, glucose-alanine cycle, futile cycle. TCA cycle, HMP shunt, glycogenolysis & glycogen synthesis. Disorders associated with defects in carbohydrate metabolism- a brief account on fructose intolerance, lactose intolerance, lactic acidosis, disorders related to glycogen metabolism, genetic deficiency of Glucose-6- phosphate dehydrogenase, Galactosemia, Diabetes Mellitus (NIDDM and IDDM). Lipid metabolism - Mobilization of triglycerides, metabolism of glycerol,  $\beta$ -oxidation of saturated, monounsaturated and poly-unsaturated fatty acids, even and odd chain fatty acids. Ketogenesis and significance, Biosynthesis of Nutritional disorder-PEM (Kwashiorkor and Marasmus), Obesity. Metabolic disorders-saturated and unsaturated fatty acids, synthesis of triglycerides and cholesterol, lipoproteins-

synthesis, transport and its disorders. Diabetes. Inborn errors of metabolism- i) Protein-PKU, Alkaptonuria and Maple syrup and Gaucher's disease. Protein catabolism - Transamination and deamination, Urea cycle, glucogenic and ketogenic amino acids, biosynthesis and catabolism of amino acids (glycine, phenylalanine, glutamic acid) Nucleotide metabolism: Biosynthesis and catabolism of purines and pyrimidines (Adenine and cytosine). Porphyrin metabolism: Biosynthesis and degradation of porphyrins, biosynthesis of bile pigments.

### **Unit 3: Metabolic Integration**

Metabolic changes during starve-feed cycle, exercise, diabetes and alcohol abuse.

### **Unit 4: Oxidative phosphorylation**

Components, properties and function of electron transport system, chemiosmotic hypothesis, inhibitors and uncouplers of the electron transport system, Shuttle systems.

### **Unit 5: Microbes and Metabolism**

Role of microbes in metabolic tasks- alternate metabolic cycles. Carbon metabolism of intracellular bacterial pathogens, environmental cleansing, metabolic handling of xenobiotics and drug resistance, photo and lithotrophic metabolic capabilities; Myporia.

### **Practical**

Credit : 2  
Contact Hours per Week : 4

1. Estimation of blood glucose – Glucose Oxidase method
2. Estimation of Cholesterol
3. Estimation of SGPT and SGOT
4. Estimation of Bilirubin
5. Estimation of creatinine
6. Estimation of serum protein, serum albumin, serum A: G ratio.
7. Identification of organelles by marker enzymes – SDH, LDH and acid phosphatase.

### **Course Outcomes:**

#### **After successfully completing this course, the students will be able to understand:**

1. The basic concept of metabolism and the experimental techniques used to study metabolic pathways.
2. The principles of bioenergetics and the molecules involved in energy transfer in metabolic reactions.
3. The different metabolic pathways of carbohydrate, protein, fat, nucleic acid and porphyrin metabolism.
4. Different disorders associated with defects in carbohydrate, protein, fat and nucleic acid metabolism.
5. Metabolism during starve-feed cycle, diabetes exercise, obesity and alcohol abuse.
6. Oxidative phosphorylation - components ,reactions couplers and uncouplers of the electron transport chain,

7. Alternate metabolic pathways in bacteria, role of microbes in environmental cleansing; xenobiotic metabolism and drug resistance.
8. Gain hands-on training on estimation of different blood components of clinical importance such as glucose, proteins, cholesterol, SGOT, SGPT, etc.

## **SEMESTER – V**

### **BIOS05C-11: GROWTH AND REPRODUCTION**

**Credits - 6: (Theory- 04, Practical- 02)**

#### **Theory**

Credit : 4

Contact Hours per Week : 4

#### ***Unit 1: Introduction***

General growth patterns in animals and plants. The role of cell wall in cell growth; extension growth of multicellular organs in plants. Primary meristem: concept of stem cell; shoot apical meristem- dynamics of shoot apical meristem; homeobox genes and meristem identity; root apical meristem as an organized structure; Post - embryonic meristems in plants with special reference to Arabidopsis embryogenesis. Analysis of plant growth: kinetics and kinematics. Senescence, ageing, abscission and programmed cell death: a general account, with special reference to hyperplasia and hypertrophy in animals and tumours in plants. Factors regulating growth in animals with emphasis on hormones).

#### ***Unit 2: Pre Fertilization Changes***

Alternation of generations and reproductive patterns in animals and plants; Asexual and sexual reproduction- an overview (regeneration, archegonium, heterospory, siphonogamy, apogamy, apospory, apomixis etc.). Pre-fertilization events- gametogenesis- (spermatogenesis, oogenesis) and folliculogenesis, types of eggs in animals, menstrual cycle, hormonal changes during adolescence.

#### ***Unit 3: Post Fertilization Changes and Early Development***

Post Fertilization Events; Types of Cleavages; Blastula; Fate Maps, Morphogenetic movements during gastrulation; Gastrulation in frog and chick and humans; Fate of Germ layers; Neural tube formation, brief account on embryonic induction, Extra Embryonic membranes in chick and mammal, Placenta: Functions and types. Sex determination, changes during pregnancy, parturition and lactation. Plant development biology-embryogenesis, organogenesis, plant regulation, protoplast technology.

#### ***Unit 4: Differentiation***

Organogenesis: Formation of CNS, Organogenesis of secondary girth.

**Practical**

Credit : 2  
Contact Hours per Week : 4

1. Study of whole mounts of chick- early developmental stages
2. Study of chick development from live eggs (window viewing)
3. Study of section of chick embryo through selective developmental stages
4. Videos showing selective embryonic events like cleavage; gastrulation
5. Measurement of animal/plant cell size using ocular and stage micrometer.
6. Micro and mega sporogenesis in higher plants-slides only
7. Pollen germination in vivo and in vitro
8. Embryo development in flowering plant-slides only; dissection of endosperm and embryo
9. Survey of dispersal mechanisms of seeds
10. Fixing and staining of different stages of rat embryo (post implantation stages).

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Learn the mechanisms of growth and the factors regulating growth including nutrition, hormones etc.
2. Get a comprehensive knowledge regarding basic male and female reproductive organs, their histopathological architecture, molecular mechanisms involved in production of male and female germ cells,
3. Understand the mechanism of union of germ cells and development of a next progeny.
4. Visualize and appreciate concepts learnt in theory and apply experimental approaches to understand these developmental events in the laboratory.

**SEMESTER – V**

**BIOS05C-12: GENETICS**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4  
Contact Hours per Week : 4

**Unit 1: Mendelian Genetics and Extensions**

Model organisms in genetic analysis, Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. Principles of Inheritance, Chromosome theory of inheritance, Laws of probability, Pedigree analysis, Incomplete dominance, co-dominance, Overdominance, Multiple alleles, pseudoallele, Lethal alleles, Penetrance & expressivity, Epistasis, Pleiotropy, Phenocopy, gene transfer in bacteria, Benzer's cis-trans complementation experiment

**Unit 2: Linkage, Crossing over and Chromosomal Mapping**

Linkage and Crossing over, cytological basis of crossing over, Molecular mechanism of crossing over. Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and Coincidence, Chromosome Mapping in Prokaryotes & Eukaryotes.

**Unit 3: Mutations**

Chromosomal mutations, Structural (Deletion, Duplication, Inversion, Translocation) and numerical aberration (Aneuploidy and Polyploidy) of chromosomes and associated disorders in Human; Gene mutations: Induced v/s Spontaneous, Back v/s Suppressor mutations. Molecular basis of mutations in relation to UV light and chemical mutagens, Detection of mutations: CIB method, Attached X-method, DNA repair mechanisms.

**Unit 4: Extra chromosomal Inheritance**

Chloroplast mutation/Variation in four 'o clock plant and Chlamydomonas, Mitochondrial mutations in Neurospora and yeast, Maternal effects, Pattern of shell coiling in snail, Infective heredity-Kappa particles in Paramecium.

**Unit 5: Genome Dynamics-Transposable Genetic Elements**

Sex determination and dosage compensation in Drosophila and human. Prokaryotic transposable elements-IS elements, Composite transposons, Tn-3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P-elements in *Drosophila*; Uses of transposons.

**Unit 6: Genomics, Bioinformatics and Proteomics**

Genomes of bacteria, Drosophila and Humans; Human genome project; Introduction to Bioinformatics, Gene and Protein databases, sequence similarity and alignment, Gene feature identification. Gene Annotation and analysis of transcription and translation; Posttranslational analysis-Protein interaction.

**Unit 7: Population and Evolutionary Genetics**

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, Genetic drift. Speciation.

**Practical**

Credit : 2  
Contact Hours per Week : 4

1. Study of Linkage, recombination, gene mapping using marker based data from *Drosophila*.
2. Study of Phlox/ Allium Karyotype (normal and abnormal).
3. PTC testing in a population and calculation of allele and genotype frequencies.

4. Study of abnormal human karyotype and pedigrees (dry lab).
5. Isolation of plasmid DNA from *E.coli* and restriction enzyme digestion of plasmid DNA.
6. Estimation of size of a DNA fragment after electrophoresis using DNA markers.
7. Construction of Restriction digestion maps from data provided.
8. Demonstration of DNA fingerprinting.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Understand the concept of genotype and phenotype, describe the basic principles of Mendelian genetics and appreciate the various factors that confer genotypic and phenotypic variability.
2. Understand the inter relationship between environment versus inheritance in determining the conversion of genotype to phenotype.
3. Learn to use the concepts of bacterial and viral genetics to understand resistance patterns and to create linkage and genetic maps.
4. Learn to describe population structure by genetic variation, pedigree analysis and develop broad and balanced knowledge and understanding of key biological concepts, principles and theories related to evolution, genetic change and speciation.
5. Learn to apply the principles of transmission and inheritance in real life situations.

**SEMESTER – VI**

**BIOS06C-13: DEFENSE MECHANISMS**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1 Introduction***

Overview of defense mechanisms in plants and animals; Hematopoiesis, cells and organs of the immune system, primary and secondary lymphoid organs and tissues.

***Unit 2: Innate immunity in plants and animals***

Plants - Chemical and morphological defense in plants; elicitors, receptors, Basal resistance and innate biochemical host defenses  
Animals - Anatomical barriers, cell types of innate immunity, Pattern Recognition Receptor (PRR), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response. Complement activation by classical, and alternate pathway, biological consequences of complement activation.

**Unit 3: Adaptive Immunity in Plants and Animals**

Plants - Biotic- interactions with symbionts, pathogens. Biochemical host defenses, Basal resistance and basic compatibility; Gene for gene concept; interaction in host-pathogen systems, receptor-elicitor model, plant gene-gene interaction. Cytological protection and induced resistance. Passive and active defenses. Animals - Antigens and haptens, Factors that dictate immunogenicity, B and T cell epitopes. Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family. Generation of antibody Diversity. Monoclonal antibodies; Immunological methods- Antigen-antibody interactions; Histocompatibility antigens - MHC, HLA and Disease; T and B cell - Maturation, activation and effector response, Positive and Negative selection, APC and Antigen Presentation, Cytokines and Chemokines.

**Unit 4: Immune dysfunction and applications**

Immunological tolerance; Immunological disorders – Hypersensitivity and Autoimmune diseases. Immunodeficiencies; Transplantation Immunology; Immune response against major classes of pathogens. Applications in agriculture, pharmaceuticals, and biopest control.

**Practical**

Credit : 2

Contact Hours per Week : 4

1. Survey of structural plants defenses: viz. cuticle, wax, lignin, bark, thorns, prickles, trichomes.
2. Immunodiffusion – SRID. Rocket IEP
3. Spleen cell isolation and counting.
4. ABO and Rh blood grouping
5. Latex agglutination assay
6. Quantitative immunoprecipitation assay

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Get an overview of the immune system and learn about the various cells, organs and tissues of the immune system.
2. Learn the basic defense mechanisms of the human body, learn how our body differentiate self from non self and thus successfully eliminate any danger from outside
3. Understand the cellular and molecular pathways of humoral and cell-mediated immune responses and appreciate the importance of immune system in health and disease.
4. Learn about the various preexisting structural and induced defenses in plants and how pathogens can cause disease in plants, and understand the genetic basis of plant-pathogen interaction.
5. Learn how immunodeficiency makes us vulnerable and how vaccine is essential to protect us from infectious diseases.

**SEMESTER – VI**

**BIOS06C-14: EVOLUTIONARY BIOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Historical Review of Evolutionary Concept***

Pre-Darwinian ideas – List of contributors influencing Darwin indicated as a timeline. Lamarckism – Merits and demerits. Darwinism – Merits and demerits, Post-Darwinian era – Modern synthetic theory; biomathematics and the theory of population genetics leading to Neo-Darwinism

***Unit 2: Life's Beginnings***

Chemogeny – An overview of pre-biotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres). Origin of photosynthesis – Evolution of oxygen and ozone buildup. Endosymbiotic theory – Evolution of Eukaryotes from Prokaryotes.

***Unit 3: Evidences of Evolution***

Paleobiological– Concept of Stratigraphy and geological timescale; fossil study (types, formation and dating methods). Anatomical– Vestigial organs; Homologous and Analogous organs (concept of parallelism and convergence in evolution). Taxonomic– Transitional forms/evolutionary intermediates; living fossils. Phylogenetic – a) Fossil based – Phylogeny of horse as a model. b) Molecule based – Protein model (Cytochrome C); gene model (Globin gene family)

***Unit 4: Sources of Evolution – Variations as Raw Materials of Change***

Types of variations – Continuous and discontinuous; heritable and non-heritable. Causes, classification and contribution to evolution – Gene mutation; chromosomal aberrations; recombination and random assortment (basis of sexual reproduction); gene regulation. Concept of micro- and macro-evolution – A brief comparison.

***Unit 5: Forces of Evolution – Qualitative Studies Based on Field Observations***

Natural selection as a guiding force – Its attributes and action Basic characteristics of natural selection. Colouration, camouflage and mimicry, Co-adaptation and co-evolution, Man-made causes of change – Industrial melanism; brief mention of drug, pesticide, antibiotic and herbicide resistance in various organisms. Modes of selection, Polymorphism, Heterosis and Balanced lethal systems. Genetic Drift (Sewall Wright effect) as a stochastic/random force – Its attributes and action. Basic characteristics of drift; selection vs. drift, Bottleneck effect, Founder principle.

**Unit 6: Forces of Evolution –Quantitative Studies Based on Biomathematics**

Quantitative Studies Based on Biomathematics, Population genetics – Gene pool; gene/allele frequency; genotypic frequency; phenotypic frequency (simple problems for calculation). Conservation of gene frequencies (when selection does not operate) – Hardy-Weinberg’s Law of Genetic Equilibrium. Alterations in gene frequency (when selection operates) – Calculation based on Selection Coefficient and Fitness). Fluctuations in gene frequency (when drift operates) – Calculation based on standard deviation.

**Unit 7: Product of Evolution – Speciation**

Concept of species as a real entity, Mechanisms of speciation – Allopatric; sympatric; peripatric, Patterns of speciation– Anagenesis and Cladogenesis; Phyletic Gradualism and Punctuated Equilibrium (Quantum Evolution), Basis of speciation – Isolating mechanisms.

**Unit 8: End of Evolution – Extinction**

Periodic extinctions, Mass-scale extinctions – Causes and events

**Unit 9: Evolution of Plants and Fungi**

Origin of land plants – Terrestrial algae and Bryophytes; alternation of generations. Early vascular plants – Steelar evolution; Sporangium evolution. Angiosperms – Phylogeny of major groups.

**Unit 10: Human Ancestry and Phylogeny**

Primate characteristics and unique Hominin characteristics. Primate phylogeny leading to Hominin line. Human migration – Theories. Brief reference to molecular analysis of human origin – Mitochondrial DNA and Y-chromosome studies

**Practical**

Credit : 2  
Contact Hours per Week : 4

1. Evidences of fossils
  - a. Study of types of fossils ( e.g. trails, casts and moulds and others) and Index fossils of Palaeozoic era
  - b. Connecting links/transitional forms - Eg. Euglena, Neopilina, Balanoglossus, Chimaera, Tiktaalik, Archaeopteryx, Ornithorhynchus
  - c. Living fossils - Eg. Limulus, Peripatus ,Latimeria, Sphenodon
  - d. Vestigial, Analogous and Homologous organs using photographs, models or specimen
2. Variations.
  - a. Sampling of human height, weight and BMI for continuous variation

- b. Sampling for discrete characteristics (dominant vs recessive) for discontinuous variations E.g hitch-hiker's thumb, dexterity, tongue rolling, ear lobe (data categorization into 16 groups based on the combination of 4 traits; assigning each subject to the respective group)
3. Selection Exemplifying Adaptive strategies (Colouration, Mimetic form, Co-adaptation and co-evolution; Adaptations to aquatic, fossorial and arboreal modes of life) using Specimens
4. Neo-Darwinian Studies
  - a. Calculations of genotypic, phenotypic and allelic frequencies from the data provided
  - b. Simulation experiments using coloured beads/playing cards to understand the effects of Selection and Genetic drift on gene frequencies
5. Phylogeny
  - a. Digit reduction in horse phylogeny (study from chart),
  - b. Study of horse skull to illustrate key features in equine evolution
  - c. Study of monkey and human skull - A comparison to illustrate common primate and unique Hominin features

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Learn about the compelling evidences in favour of evolution like fossils, comparative anatomy and molecular homologies.
2. Learn about the processes of evolution by mutation, migration, selection and genetic drift
3. Understand how biodiversity is generated by repeated speciations and lost over time due to mass extinctions.
4. Learn about the Neutral Theory of Molecular Evolution
5. Understand key concepts of Population Genetics in terms of Hardy-Weinberg Law , understand micro-evolutionary changes and speciation

## DISCIPLINE SPECIFIC ELECTIVES (DSE)

### SEMESTER – V

#### **BIOS05DSE-1A: BIOSTATISTICS & BIOINFORMATICS**

**Credits - 6: (Theory- 04, Practical- 02)**

#### **Theory**

Credit : 4

Contact Hours per Week : 4

#### ***Unit1: Biostatistics***

Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Overview of testing of hypothesis, errors of inference and distribution types.

Distribution-free test - Chi-square test, G-test.

Product moment Correlation- assumptions, properties, computations and applications, Spearman's rank correlation coefficient, Point biserial r, Biserial r, contingency coefficient.

Properties and computations of simple linear regression.

#### ***Unit 2: Bioinformatics***

Bioinformatics spectrum: Introduction to Genomic Data and Data Organization; Information from nucleic acid/protein sequences and structures.

Protein and Nucleic Acid Sequence Data Banks – NBRF-PIR, SWISSPORT, GenBank, EMBL.

Structural data bank – PDB, SCOP, CATH, CSD

Sequence Analysis – Analysis tools for sequence data banks, Pair-wise alignment – NEEDLEMAN AND WUNSCH ALGORITHM, SMITH WATERMAN. Multiple alignments – CLUSTAL, BLAST, FASTA algorithm to analyze sequence pattern, motifs and profiles.

Basics of systems biology.

#### **Practical**

Credit : 2

Contact Hours per Week : 4

#### **Bioinformatics Practical:**

1. Sequence Alignment (BLAST/ ClustalW/ FASTA)
2. Primer Designing (IDT tools) and sequencing data analysis
3. Accessing sequence and structure databases and information retrieval
4. Image J
5. Phylogenetic Cluster Analysis
6. Gene Prediction

7. Prediction of protein structure
8. Viewing three dimensional Structures of Macromolecules by Rasmol
9. Protein- Protein Interactions (STRING)

**Biostatistics Practical:**

1. Plotting of graphs.
2. Computation of Mean, median, mode, standard deviation
3. Testing of hypothesis by z and t test.
4. Chi square analysis
5. Computation of correlation statistics
6. Computation of regression equation.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Gain a comprehensive knowledge regarding statistical presentation and evaluation of multiparametric data
2. Recognize the importance of data collection and its role in determining scope of inference.
3. Learn about hypothesis testing.
4. Choose and apply appropriate statistical methods for analyzing one or two variables.
5. Understand the basics of bioinformatics and develop awareness of the interdisciplinary nature of this field.
6. Learn about Biological Databases and the types of databases.
7. understand protein structure using visualization softwares , learn about gene prediction program
8. Understand sequence alignments and analyze phylogeny using alignment tools.

**SEMESTER – V**

**BIOS05DSE-1B: PLANT SCIENCE AND PLANT BIOTECHNOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4  
Contact Hours per Week : 4

***Unit 1: Evolution from Archegoniatae to Angiosperms.***

Transition to land habit and Alternation of generations, Sporangial evolution, Heterospory and seed habit. Botanical nomenclature, concept of taxa, rank and naming, author citation, Type specimens; Herbarium Concept of chemotaxonomy, numerical, molecular taxonomy, Gene bank and DNA Barcoding, Chloroplast and Mitochondrial markers, Clustering and Phylogenetic tree, DNA Bank for conservation strategy.

**Unit 2: Paleobotany; Anatomy and Reproductive morphology of higher plants.**

Geological time scale and emerging plant groups; Fossilization processes; Fossil types and fossil dating, Forensic palynology.

Organization of Root and Shoot apex, wood anatomy (primary and secondary growth); Inflorescence, Floral parts, Male and female gametophytes.

**Unit 3: Plant Metabolism & Plant Cytogenetics.**

Mineral uptake and nutrition, Important elements (macro and micronutrients), mineral deficiency symptom;

Biosynthesis and breakdown of carbon compounds: Sucrose, Starch, Cellulose, Lipids

Nitrogen fixation, Ammonia assimilation and transamination; Sulphur and phosphorus metabolism.

Genomic variation in chromosomes and inheritance in plants: Aneuploidy (monosomics, trisomics, nullisomics) and Polyploidy (autopolyploidy, allopolyploidy, segmental allopolyploidy, autoallopolyploidy); Chromosomal structural aberration: Deletion, Duplication, Translocation and Inversion.

Repetitive DNA sequence, tandem and interspersed, Homoeotic gene in plants (ABCE Quartet model of flowering).

**Unit 4: Plant Breeding, Tissue culture, and Plant Biotechnology**

Domestication, and Selection: Pureline and mass selections, applications. Heterosis or hybrid vigour, Male sterility: concept, types and applications. Apomixis and self-incompatibility and their role in plant breeding. Use of molecular markers.

Marker assisted selection, Dominant and recessive marker, RFLP, RAPD, SCAR, CAPS, AFLP, SSR, ITS, Physical map vs. genetic map

Basics of Plant Tissue Culture: Concept of totipotency, Explants, Various sterilization and explant preparation techniques, Plant tissue culture media composition: macro and micro-nutrients and plant growth regulators used in plant tissue culture media;

Micropropagation and clonal fidelity; Somatic embryogenesis and synthetic seeds,

Protoplast isolation and fusion: Protoplast isolation technique; Different protoplast fusion methods: Chemical fusion, Electrofusion; Cybrids.

Different types of vectors, restriction enzymes, DNA ligase, Plant selection markers, reporter genes.

Different gene delivery methods: particle bombardment, microinjection, *Agrobacterium* mediated transformation, Ti plasmid, Ri plasmid.

**Practical:**

Credit : 2

Contact Hours per Week : 4

1. Work out one Bryophytes (Hepatics/Moss) / one Pteridophytes (Lycopodium /Selaginella /Equisetum /Pteris/) /one gymnosperm (Cycas/Pinus)
2. Work out one dicot and monocot for taxonomic interpretations.
3. Anatomy of specimens (Hydrophytes/Xerophytes leaves)/ secondary growth from stem

4. Spectrophotometric estimation of total phenols by TPC
5. Separation of lipid classes by TLC from Mustard/Groundnut seeds
6. Work out on Mitotic metaphase / anaphase from root tip of Allium / meiosis from
7. Preparation and sterilization of Plant tissue culture media
8. Sterilization of explants
9. Isolation and estimation of genomic DNA
10. PCR with universal primers.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Appreciate the evolution of plants
2. Understand the development of the plant system
3. Understand the specifics of plant metabolism and cytogenetics
4. Appreciate and understand plant biotechnology

**SEMESTER – V**

**BIOS05DSE-2A: ANALYTICAL TECHNIQUES IN IN BIOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Imaging and related techniques***

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; use of fluorochromes: Flow cytometry (FACS), applications of fluorescence microscopy. Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy, sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

***Unit 2: Cell fractionation***

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

***Unit 3: Radioisotopes***

Use in biological research, auto-radiography, pulse chase experiment.

**Unit 4: Spectrophotometry**

Principle and its application in biological research.

**Unit 5: Chromatography**

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

**Unit 6: Characterization of proteins and nucleic acids**

Mass spectrometry; X-ray crystallography, NMR; Characterization of proteins and nucleic acids; Electrophoresis: PAGE, SDS-PAGE

**Practical**

Credit : 2

Contact Hours per Week : 4

1. Demonstration of ELISA.
2. Affinity chromatography
3. To separate chloroplast pigments by column chromatography.
4. To separate proteins using PAGE.
5. To separate DNA (marker) using AGE.
6. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
7. Preparation of permanent slides (double staining).

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Students will learn the principle of workings of various tools and techniques that are commonly used in biological research.
2. They will have hands-on experience with the workings of some instruments.

**SEMESTER – V**

**BIOS05DSE-2B: ANIMAL MORPHO-ANATOMY AND HISTOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Unit 1: Animal Morpho-Anatomy**

Aquiferous system and endoskeleton in Porifera.

Coral and coral reef formation

Nervous system in Annelida, Arthropoda and Mollusca.

Water vascular system in Echinodermata.

Larval forms of invertebrates.

Filter-feeding in protochordates; progressive and retrogressive metamorphosis in Chordata

Exoskeletal structure in amniotes.

Comparative anatomy of heart, kidney and aortic arch.

Ruminant stomach.

### **Unit 2 Animal Histology**

Histology of mammalian stomach, liver, kidney, thyroid, pancreas and gonads

- i. Stomach (Basic subdivision and histology. Gastric mucosa; glands and cell types. Synthesis and secretion of HCl by Parietal cells).
- ii. Liver (Structural organization and blood supply. Liver lobules; classic lobule, portal lobule and liver acinus. Metabolic, exocrine and endocrine functions of liver)
- iii. Thyroid (Thyroid follicle; basic structure, cell types and function. Thyroglobulin; role in synthesis of thyroid hormones).
- iv. Pancreas (Basic structure and histology of exocrine and endocrine pancreas. Endocrine pancreas; cell types and function).
- v. Kidney: (Basic structure and histology of cortex and medulla. Juxtaglomerular apparatus. Nephron; role in production of hypertonic urine)
- vi. Gonads (basic structure, cell types and function of Ovary & testis)

Fixation - Non-additive and additive fixatives and their mode of actions

Histological dyes – physical and chemical classification of dyes, mordanting, metachromasia

### **Practical**

Credit: 2

Contact Hours per Week: 4

1. Submission of project report on any topic of exoskeletal modifications in invertebrates/ vertebrates.
2. Collection/ demonstration of larval forms of hemimetabolous and holometabolous insects.
3. Staining and mounting of cycloid and ctenoid scales of fishes.
4. Dissection/ virtual demonstration of Weberian Ossicles and air bladder of fishes.
5. General demonstration for tissue fixation, block preparation and microtomy.
6. Staining of histological slides (ovary, testis, liver, kidney, pancreas and lung) and identifications of the section with reasons.

### **Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Learn the anatomy, structural adaptations and biology of important non-chordates and chordates.
2. Understand the comparative anatomies of organs

3. Learn the histological architecture of tissues and organs
4. Know the working principles and mode of actions of fixatives, dyes and stains
5. Develop concept of data collection in field work and surveys
6. Develop skills in tissue fixation, microtomy and histological staining of tissue sections.

**SEMESTER – VI**

**BIOS06DSE-3A: STRESS BIOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Defining stress***

Acclimation and adaptation. Brief introduction to diverse stressors in plant, animals and human

***Unit 2: Environmental factors***

Abiotic stress (Water; Salinity, High light, Temperature); Biotics stress (Hypersensitive reaction; Pathogenesis-related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates) in plants and animals. Lifestyle and environment induced functional (hormonal, cardiovascular and hepato-renal) changes. Posture- related stress- system design, system optimisation.

***Unit 3: Stress sensing mechanisms***

Role of nitric oxide. Phospholipid signaling, growth factors and arachidonate signalling.

***Unit 4: Developmental and physiological mechanisms that protect plants, animals and human against environmental stress***

Morphological, biochemical and genetic adaptation in plants in osmotic stress; Xenobiotics and biotransformation.

***Unit 5: Redox imbalance, Reactive oxygen species, Production and scavenging mechanisms***

Sources of ROS, quenching mechanisms in the cell, antioxidants.

### **Practical**

Credit : 2

Contact Hours per Week : 4

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.
2. Superoxide activity in seedlings in the absence and presence of salt stress.
3. Quantitative estimation of peroxidase and superoxide dismutase activity, catalase, glutathione reductase.
4. Estimation of superoxide anions.
5. Salt stress assay in plants
6. Assessment of different nutritional and physiological stress parameters in individuals involved in different workplace stressors.

### **Course Outcomes:**

#### **After successfully completing this course, the students will be able to:**

1. Understand the various mechanisms of stress in animals and plants.
2. Understand the effect of stress in various systems.
3. Understand mechanisms of stress response at the cellular level and mechanisms of amelioration.

### **SEMESTER – VI**

#### **BIOS06DSE-3B: MICROBIOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

### **Theory**

Credit : 4

Contact Hours per Week : 4

#### ***Unit 1: History of Microbiology, diversity and classification***

History of development of microbiology as a discipline, development of various microbiological techniques, concept of fermentation, establishment of fields of medical microbiology, immunology and environmental microbiology. Microbial diversity: cellular (bacteria, algae, fungi, protozoa) and acellular (virus) microbes, polyphasic bacterial taxonomy, extremophiles. Architecture of bacteria and virus: comparison between eubacteria and archaebacteria. Molecular methods of assessing microbial phylogeny- molecular chronometer, phylogenetic trees.

#### ***Unit 2: Microbial Cell organization and metabolism***

Cell size, shape and arrangement, glycocalyx, capsule, flagella, fimbriae and pili; Cell-wall: Composition and structure of Gram positive and Gram negative cell walls. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes; Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids; Endospore: Structure, formation, stages of sporulation. Microbial metabolism.

***Unit 3: Microbial Nutrition and Growth***

Nutritional types of microorganisms, growth factors, culture media, isolation of pure cultures, growth curves, mean growth rate constant, generation time; general concept of effect of environmental factors on growth of microbes; sterilization and disinfection.

***Unit 4: Microbial Genetics***

Genetic recombination in bacteria, basic concept of: transformation, conjugation, and transduction, gene mapping by interrupting mating technique. Bacterial plasmids - fertility factor, col plasmid; Bacterial conjugation- (Hfr, F<sup>+</sup>, F<sup>-</sup> X F<sup>-</sup>); Transformation; Transduction- generalized and specialized.

***Unit 5: Viruses***

General properties of viruses; Structure of viruses. Isolation, purification and cultivation of viruses; Viral Taxonomy; Bacteriophages - diversity, classification, lytic and lysogenic cycles; Viral life cycle- entry, replication and egress. Detection of viruses.

***Unit 6: Food and Microbiology***

Overview of importance of microbiology in food and industrial microbiology; Microorganism growth in food; extrinsic and intrinsic factors for food spoilage; microorganisms causing food spoilage in fresh food, milk, and canned food; Preservation of foods by aseptic handling, high temperature, low temperature, dehydration, osmotic pressure, chemicals and radiations; preparation of fermented food products, fermented milk such as yoghurt, curd and cheese.

***Unit 7: Industrial Microbiology***

Microbiological processes in industry; Basic design of fermenter – continuous and discontinuous; treatment of wastewater (Municipal treatment plant) and sewage; Preparation of wine, beer, cheese; Single cell proteins.

***Unit 8: Microbial diseases of plants and animals***

Basics of microbial pathogenesis: host, pathogen, pathogenicity factors, Koch's postulates, parasitism and synergism. Introduction to diseases caused by microbes.

***Unit 9: Antimicrobial chemotherapy***

Range of activity and mechanism of action of antibiotics.

**Practical**

Credit : 2

Contact Hours per Week : 4

1. To study disinfectants and sterilization techniques.
2. To study types of Media and perform media preparation.
3. To perform subculturing- streaking techniques (T streaking). .
4. To study Growth Curve of bacteria.
5. To study the effect of pH/temperature/UV light on bacterial growth.
6. To perform Gram's staining.
7. To perform Negative staining
8. To perform an Antibiotic resistance assay.
9. Enumeration of CFU of E.coli by serial dilution and spread plate method.
10. Conjugation experiment
11. Milk quality testing by Methylene Blue dye reductase test.
12. Isolation of bacteria from any natural sources (air/soil/water)
13. Endospore staining
14. Capsule staining
15. Water quality analysis by MPN method.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Learn the peculiarities in the structure and biochemistry of bacteria and viruses.
2. Understand the specialized nutritional requirements of bacteria
3. Understand the various applications of microbiology in industry and research
4. Gain a basic understanding of microbial diseases and their management
5. Learn basic microbial techniques.

**SEMESTER – VI**

**BIOS06DSE-4A: CLASSIFICATION, BIOSYSTEMATICS AND MOLECULAR PHYLOGENETICS**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Animal classification***

Classification of Protozoa up to Phylum; Classification of non-chordates up to subclass; Classification of chordates up to order.

**Unit 2: Plant Classification**

A brief outline of Bentham and Hooker (1862-1883) and Angiosperm Phylogeny Group (APG Classification) of plants

**Unit 3: Biosystematics and Molecular Phylogenetics**

Concept of systematics and taxonomy, alpha, beta and gamma taxonomy, phenon, taxon, taxonomic category, Linnaean hierarchy

Nomenclature of animal and plant taxa and International code of Zoological and Botanical nomenclature

Type concept and its applications

Different species concept, their merit and demerits

Characters; OTU, Principles and theories of animal classification (Phenetics and Cladistics concept)

Phenogram and Cladogram constructions

Concept of cytotaxonomy, Biochemical taxonomy and Molecular Taxonomy

Phylogenetic tree reconstruction (cluster analysis)

**Practical**

Credit : 2

Contact Hours per Week : 4

1. Study of museum specimen for preparations of taxonomic key (non-chordates and chordates)
2. Herbarium preparation of plant samples collected from diverse geographical and ecological regions
3. Analysis of cytotaxonomic and biochemical taxonomic data. Construction of phylogenetic tree by using sequence data
4. Study of a few important plant families and their representative taxa.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Identify and classify different organisms.
2. Understand the systematic position of different organisms and any or all relationships among them.
3. Perform molecular analysis will help to develop knowledge on evolutionary relationships or phylogenetic relationships between different groups of organisms.

**SEMESTER – VI**

**BIOS06DSE-4B: APPLIED HUMAN PHYSIOLOGY**

**Credits - 6: (Theory- 04, Practical- 02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Nutrition and Dietetics***

Nutrition, health and malnutrition; Constituents of food and their significance. Basal metabolic rate Respiratory quotient. Calorific value of foods. Body calorie requirements – adult consumption unit. Dietary requirements symptoms of deficiency and excess. Balanced diet and principles of formulation of balanced diets for growing child, adult man and woman, pregnant woman and lactating woman. Nutrition for different occupations. Nitrogen balance. Biological value of proteins, supplementary value of protein. Protein efficiency ratio and net protein utilization of dietary proteins; Dietary fibers. Principle of diet survey. Composition and nutritional value of common foodstuffs. Physiology of starvation and obesity. Elementary idea of glycaemic index; functional foods, nutraceuticals, probiotics and food supplements. Food adulterants and food additives.

***Unit 2: Skin, sensation and higher neural function***

Structure and functions of skin. Cutaneous circulation. Sweat glands Sweat formation, secretion and its regulation. Regulation of body temperature in homeotherms, pyrexia, hyperthermia and hypothermia Sensory receptors and function, Classification of general and special senses. Receptors as biological transducers. Physiology of Olfaction and Gustation, Acoustic physiology, Physiology of vision, Emotion, sleep, speech and aphasia

***Unit 3: Regulation of Human Physiology***

Hypothalamus as a neuroendocrine organ. Pineal gland, Hormones in Metabolism. Neuro immunology, Human Embryology,

***Unit 4: Social physiology***

Population problem, principles and methods of family planning. IVF. Malnutrition deficiency diseases and their social implications. Implications of Diabetes, CHD. Principles and social importance of immunization against diseases. Epidemiology and prevention of common diseases. Integration of systemic physiology and metabolism in daily life and disease. Life style diseases and management.

***Unit 5: Work, Exercise and Sports Physiology***

Concept of work. Muscle tone, posture and regulation, servo control mechanism. Physical work—its definition and nature. Power and capacity relation, Classification of workload. Exercise inducing equipment –Aerobic and anaerobic

power—Energetics of exercise – Short-term and long term, Mechanism of Fatigue and recovery. Concept of endurance, strength and speed in sports activities. Principles of training and detraining. Brief general idea about nutritional aspects of sports, Idea on doping. Lactate threshold, lactate tolerance and their usefulness,

### **Unit 6: Applied Physiology**

Physiological basis of medical laboratory investigations. Cybernetic approach to physiology. Tools to detect genetic defects in the early stages of fetal development. Pathological cases to explain cardiac physiology, Disease markers.

#### **Practical**

Credit : 2

Contact Hours per Week : 4

1. Anthropometry, posture analysis, pain mapping-REBA, RULA, Nordid questionnaire
2. Muscle strength estimation
3. Co-analysis
4. Videography
5. Diet survey/ Nutritional assessment of any specific group
6. Survey of common diseases in population
7. Field study
8. Identification of common food adulterants in food items.
9. Identification of normal and abnormal constituents of urine.
10. Measurement of heart rate and blood pressure by sphygmomanometer
11. Study of daily variation of body temperature
12. Determination of colour blindness and visual field.
13. Basic concepts of thermal stress indices-WBGT

#### **Course Outcomes:**

##### **After successfully completing this course, the students will be able to:**

1. Understand the various considerations for diet and nutrition for various populations based on their sex, physiology and occupation
2. Understand regulation of various physiological functions such as temperature regulation and metabolism
3. Gain insight into higher neuronal functions such as memory and sleep.
4. Understand the physiology of work and exercise
5. Understand the physiology of various diagnostic procedures.

## **SKILL ENHANCEMENT COURSES (SEC)**

### **SEMESTER – III**

#### **BIOS03SEC-1A: PUBLIC HEALTH AND MANAGEMENT**

**Credits - 4: (Theory- 04)**

#### **Theory**

Credit : 4  
Contact Hours per Week : 4

#### ***Unit 1: Introduction***

Energetics of work- aerobic and anaerobic, Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.

#### ***Unit 2: Pollution***

Air, water, noise pollution sources and their health effects

#### ***Unit 3: Waste Management and hazards***

Types and characteristics of wastes, biomedical waste handling and disposal, Nuclear Waste Handling and disposal, Waste from thermal power plants. Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath. Good Laboratory Practice, airborne and water borne diseases/ hazards

#### ***Unit 4: Disease Management***

Social and economic factors of disease including role of health services and other organizations: Infectious (Common Bacterial; Viral- Protozoan); Lifestyle and Inherited/genetic diseases, Immunological diseases; Cancer; Diseases impacting on Western versus developing societies. Diet survey, Field study, survey on endemic diseases.

#### ***Unit 5: Basic pharmacology***

Basic concepts on pharmacokinetics, pharmacodynamics and biotransformation.

#### **Course Outcomes:**

#### **After successfully completing this course, the students will be able to:**

1. Learn about pollution and the environment and diseases affecting humans by different pollutants and major environmental disasters in the world.
2. Learn about microbes and the microbial world and diseases infected the pathologies of infection and treatment modalities.

3. Get idea about some common pathophysiological disorders and their mode of treatment
4. Understand Common pharmacology
2. Learn about Waste management and its tools

**SEMESTER – III**

**BIOS03SEC-1B: PLANT RESOURCE UTILIZATION**

**Credits - 4: (Theory- 04)**

**Theory**

Credit : 4

Contact Hours per Week : 4

***Unit 1: Plants as Industrial products.***

Algae as food and source of phycocolloid (Agar-agar, Algin, Carrageenan), Diatomite, Potential microalgae for SCP,  $\beta$ -carotene, Biodiesel production.

Forest Resources: Fibre-plants, timber plants; Non-timber Forest Produces (NTFP); Bamboos, gums, dyes, decorative elements; Forest based cultural practices & Livelihood.

Other economically important plant products: Volatile oils: Clove, *Mentha*, *Eucalyptus*, , *Citronella*; *Taxus*, *Ephedra*, Resins: origin, chemistry and uses; Wax : origin and uses; Aroma product: Jasmine, Rose.

***Unit 2: Ethnobotany, and Drug discovery***

Ethnobotany: concept, field survey and applications. Ethnopharmacology, concept of polyherbals and synergism, Use of statistical indices in ethnobotany.

Systematic position and Medicinal properties and chemistry of active compounds of *Rauwolfia Serpentina*, *Adhatoda Vasica*, *Ocimum sanctum*, *Cannabis sativa*, *Azadiracthaindica*, *Withaniasomnifera*, *Trichopuszeylanicus*.

Biopiracy and Intellectual Property Rights

***Unit 3: Plant Resources for Agriculture and Horticulture.***

Biofertilizers and its application [*Rhizobium*, *Azospirillum*, *Azotobacter*, *Anabaena*, *Azolla*]; Mycorrhizal symbiosis, rhizospheric microbial consortia of agricultural crops.

Cultivation and morphological characters of some plants with economic importance (Rice-Poaceae, Mustard-Brassicaceae, Brinjal-Solanaceae, Gourd-Cucurbitaceae)

Floriculture & Horticultural, Rose, Tuberose, Marigold, Gladiolus, Gerbera as cash-crop; plants for cottage industries; road-side trees, banana, genetic engineering for improvement of horticultural traits.

**Unit 4: Plant Disease management and Pollution management.**

Diverse plant pathogens, pathogenesis, disease triangle, disease detection and forecasting, Transmission and spread of plant diseases; strategies to prevent disease; Economic impact, symptom, disease cycle and control of Bacterial, Integrated Pest Management.

Phytoremediation, Afforestation, Environmental Impact Assessment (EIA).

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Appreciate the use of plants in a variety of different avenues such as in Industry, drugs, agriculture, horticulture.
2. Learn basic concepts in Plant disease management.
3. Learn how plants are used in pollution management.

**SEMESTER – IV**

**BIOS04SEC-2A: RECOMBINANT DNA TECHNOLOGY**

**Credits - 4: (Theory- 04)**

**Theory**

Credit : 4

Contact Hours per Week : 4

**Unit 1: Introduction to recombinant DNA technology**

Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules, separation of DNA by gel electrophoresis. Extraction and purification of plasmid DNA.

**Unit 2: Cloning vectors for prokaryotes and eukaryotes**

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids, pBR322, pUC8, pGEM3Z. Joining of DNA fragments: ligation of DNA molecules. DNA ligases, sticky ends, blunt ends, linkers and adapters.

**Unit 3: Introduction of DNA into cells**

Uptake of DNA by cells, preparation of competent cells, Selection for transformed cells. Identification for recombinants - insertional inactivation, blue-white selection, Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Methods for clone identification: The problem of selection, direct selection, marker rescue. Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.

**Unit 4: Applications of RDT**

Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy. Applications in agriculture - plant genetic engineering, herbicide resistant crops, problems with genetically modified plants, safety concerns. Introduction to DNA sequencing, genome sequencing, polymerase chain reaction, RT-PCR, expression vectors.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Understand the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.
2. Get detailed knowledge of gene transfer methods and identify suitable hosts for cloning.
3. Acquire theoretical knowledge in the techniques, tools, application and safety measures of genetic engineering.
4. Learn about the genome mapping and sequencing and methods for transgenesis in plants and animals.

**SEMESTER – IV**

**BIOS04SEC-2B: ECONOMIC ZOOLOGY**

**Credits - 4: (Theory- 04)**

**Theory**

Credit : 4  
Contact Hours per Week : 4

1. Prawn, Pearl culture.
2. Induced breeding and hybridization techniques in Fish, Composite fish culture.
3. Industrial Entomology – sericulture, apiculture and lac culture
4. Pest biology – bionomics and control of jute, brinjal and sugarcane pests
5. Strategies of Integrated pest management
6. Poultry farming and management
7. Concept of dairy technology with reference to cryopreservation and in vitro fertilization technique.
8. Field training at protected area/poultry farm/fishery farm/ sericulture/apiculture/lac culture farm.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Develop skills and understanding of modern industrial applications of animal science
2. Generate skill and idea of agricultural pests and their control
3. Get accustomed to induced breeding and hybridization techniques in Fishes
4. Acquire field experience on economic farming like poultry, sericulture etc.

**GENERIC ELECTIVES (GE)**

*These courses are inter-departmental courses, offered to students of other Departments of Presidency University. DLS students have a choice of courses offered by Humanities and Science Departments that are listed at the beginning of the semester to choose from.*

**BIOS01GE1: WORLD OF ANIMALS**

**Credits - 6: (Theory- 04, Practical-02)**

**Theory**

Credit : 4

Contact Hours per Week : 4

1. General organization and diversity of animals.
2. Animals of economic importance.
3. Animals as pests - Bionomics and control.
4. Animals as vectors - Bionomics and medical importance.
5. India as a Megadiverse country.
6. Threats to biodiversity.
7. Animal conservation— aims, in-situ and ex-situ strategies of conservation, threatened and endangered animals of India.

**Practical**

Credit : 2

Contact Hours per Week : 4

1. Pictorial classification of insects and mammals (up to order).
2. Identification and adaptive features of insects, birds and mammals.
3. Identification of economically important pests, vectors and pollinators.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Understand characteristic features of different animal life forms.
2. Understand basic concepts and importance of conservation of biodiversity.
3. Learn about the economically important Animal species

**BIOS02GE2: ECONOMIC APPLICATIONS OF PLANT AND MICROBIAL BIOTECHNOLOGY**

**Credits - 6: (Theory- 04, Practical-02)**

**Theory**

Credit : 4  
Contact Hours per Week : 4

1. Economic importance of lower plant groups: algae, bryophytes, pteridophytes and gymnosperms: pharmacological and medical uses
2. Economic importance of fungi and mushrooms: antibiotics, medicine and food.
3. Medicinally important angiosperms: active constituents and clinical importance.
4. Applied Microbiology: wine and cheese production, bio fertilizers, SCP, biofuel.
5. Introduction to Plant Biotechnology and its importance - Brief introduction to plant cell structure and functions of organelles.
6. Introduction to plant tissue culture, Lab equipment and their working principles -Various sterilization and preparation techniques, used in plant tissue culture.
7. Introduction to secondary metabolites and industrial products

**Practical**

Credit : 2  
Contact Hours per Week : 4

1. Field study on economically and or medicinally important plants from the same geographic region.
2. Herbarium preparation techniques.
3. Identification of some medicinal algae, bryophytes, pteridophytes and gymnosperms from permanent preparations.
4. Working principles of some laboratory instruments.
5. Basic techniques related to sterilization of plant and microbial samples.
6. Media preparation for microbial and plant culture.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Understand the economic importance of lower plant groups
2. Learn to identify different species of economically important plant species
3. Learn basic concepts of Applied Microbiology and Plant Biotechnology
4. Learn about the importance of secondary metabolites in plants
5. Gain hands on training in plant tissue culture techniques

**BIOS03GE3: MODERN LIFESTYLE, BEHAVIOURS AND AILMENTS**

**Credits - 6: (Theory- 04, Practical-02)**

**Theory**

Credit : 4  
Contact Hours per Week : 4

1. Necessities and requirements in the recently adopted lifestyle with special emphasis on stresses, availability of fast food, micro family concept and dual income families. Awareness and necessary life style changes: different components of lifestyle such as food style, work pattern, environmental conditions, and their possible modifications.
2. Basic concept of aggression and its management in various settings- in school: effect of punishments, aggression/ violence by children; effect of social media; road traffic violence; child abuse. Unsocial behaviours- too much texting, video game playing; Effect of isolation,
3. Physiological stress from lifestyle patterns, mechanism of developing ailments, food habits and effect of junk food. Good nutrition and balanced diet. The risk factors in relation to some common diseases: diabetes, obesity, stress syndrome, ischemic heart disease, cancer, asthma. Addiction- alcoholism, narcotics.
4. Common endocrinological disorders of thyroid and pancreas and its management by dietary intervention.
5. Work and its related issues: Posture related problems- low back pain, carpal tunnel syndrome.
6. Social behaviours and communicable diseases: AIDS, spread of viral diseases in the modern day society: Dengue, food and waterborne diseases, bioterrorism, antibiotic resistance, multidrug resistant strains, nosocomial infections. A brief overview and changes in different physiological parameters in relation to them. Vaccine and public health.
7. Autism, awareness and social response towards mental retardation/ physical impairment.
8. Effects of delayed marriage- delayed childbirth and associated genetic problems. Family adjustments to normal physiological alterations during adolescence and menopause.
9. Effects of air, water and noise pollution on social life.
10. Management of stress and social issues related to modern lifestyle ailments: discussion on dietary changes, dealing with stress and psychological alleviation.

**Practical**

Credit : 2  
Contact Hours per Week : 4

1. Survey of family members/ neighbours on modern lifestyle and public health issues discussed during the course. Analysis of data and its interpretation.
2. Biochemistry: estimation of cholesterol (different components) and blood sugar by kit method.
3. Estimation of common adulterants in food.
4. Histology: comparative study of the features of normal and diseased state: slides of polycystic ovary and cirrhotic liver.
5. Experimental: demonstration of the effect of nicotine on the cardiac (amphibian) function or intestinal (mammalian) movement.

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Have an understanding of how stress contributes to common lifestyle diseases and how it can be managed.
2. Understand the physiology of various types of stress and their contribution to disease manifestations.
3. Develop an understanding of how behaviour, environment, microbes and diet affect disease pathology and prognosis.
4. Develop an understanding of the real life scenario by conducting surveys.

**BIOS04GE4: MACROMOLECULES OF LIFE**

**Credits - 6: (Theory- 04, Practical-02)**

**Theory**

Credit : 4  
Contact Hours per Week : 4

1. **Proteins:** building blocks of life. Basic ideas about proteins; amino acids, primary, secondary, tertiary and quaternary structure, enzymes and their functions. Part of the food, daily household, medical and industrial usage. 'Brief overview of protein synthesis, Concept of codon & anticodon in respect to translation.
2. **Carbohydrates:** the fuel of life. Classification of carbohydrates, structures, functions, part of the food, daily household and industrial usage, etc.
3. **Lipids:** the storage. Structure, classification, functions, part of the food, household and industrial usage.
4. **Nucleic acids:** the coders. Structure, classification, functions of both DNA and RNA. Common techniques used for Nucleic acid Analysis. A basic idea on the effect of nucleic acid dysfunction. DNA computers – a new future?

**Practical**

Credit : 2  
Contact Hours per Week : 4

1. Identification of substances of biological importance by biochemical tests.
2. Estimation of proteins by Biuret method/ Lowry's method / UV absorption spectroscopy
3. Estimation of glucose / sucrose / lactose in milk by Benedict's method
4. Estimation of DNA / RNA by UV absorption spectroscopy

**Course Outcomes:**

**After successfully completing this course, the students will be able to:**

1. Learn the basic concepts regarding the building blocks of biological system
2. Understand the basic structure and function of nucleic acids, learn about isolation procedure from the cells
3. Understand the basic structure and function of proteins, lipids and carbohydrates
4. Gain hands-on training on biochemical analysis of biological important components.

**ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)**

The AECC courses are inter-departmental courses and follow a central syllabus.

### **SUGGESTED READING**

1. Aber, J.D. and Melillo J.M., *Terrestrial Ecosystems*: 1991, W.B. Saunders
2. *An Introduction to Genetic Analysis* (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN:10: 1-4292-2943-8.
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4. Buchanan B, Grissem G & Jones R - 2000 - *Biochemistry and Molecular Biology of Plants*.
5. Bjorn, Lars Olof (Editors) , *Photobiology: The science of light and life*, Springer
6. Becker W. M., Kleinsmith L.J. and Bertni G. P. 2009. *The World of the Cell*. 7th
7. Barton, Briggs, Eisen, Goldstein and Patel. (2007) *Evolution*. Cold Spring Harbor Laboratory Press Edition. Pearson Benjamin Cummings Publishing, San Francisco.
8. *Berne and Levy Physiology*
9. Brooker, R. J. (2014). *Genetics: Analysis & principles*.
10. Cooper G. M. Hausman R. E. 2009. *The Cell: A Molecular Approach*. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinauer Academic Press.
11. Carlson B.M. *Patterns; Foundations of Embryology*.
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13. De Robertis, E. D. P. and De Robertis R. E. 2009. *Cell and Molecular Biology*, 8<sup>th</sup> edition. Lippincott Williams and Wilkins, Philadelphia.
14. David Randall, *Eckert's Animal Physiology*, W.H. Freeman and Co.
15. Deverall, Brain J. 1977. *Defence mechanisms of plants*, Cambridge University Press.
16. Elli Kohen, Rene Santus, Joseph G. Hirschberg: *Photobiology Academic press*.
17. Peter A. Ensminger: *Life under the sun* , Yale University Press
18. Futuyma, D. (1998) *Evolutionary Biology*. III Edn. Sinauer Assoc. Inc.
19. *Guyton and Hall Text Book of Medical Physiology*
20. *Genetics - A Conceptual Approach* (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.
21. *Genetics* (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
22. *Gene Cloning and DNA Analysis* (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK).
23. *Harper's Biochemistry*
24. Hoppe et. al., *Biophysics, Translation of 2nd German Edition*, Springer Verlag, 1983.
25. Hall, B. K. and Hallgrimson, B. (2008) *Strickberger's Evolution*. IV Edn. Jones and Barlett
26. Hawes C & Satiat-Jeunemaitre - 2001 *Plant Cell Biology : Practical approach*
27. Ingrowille, M *Diversity and Evolution of land plants* 1992 Chapman and Hall Nelson, D. L. and Cox, M.M. (2008). *Lehninger*,
28. *iGenetics: A Molecular Approach* 3rd Edition, by Peter J Russell, Pearson Education Limited ISBN-13: 978-0321569769/ ISBN-10: 0321569768
29. J.D. Lee: *A New Concise Inorganic Chemistry*, E.L.B.S.
30. James E. Huheey et al. : *Inorganic Chemistry: Principles of Structure and reactivity*,
31. Joseph, F. L. and Louver, B.D. (1997). *Health and Environmental Risk Analysis fundamentals with applications*, Prentice Hall, New Jersey.
32. Keith Wilson and John Walker, *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Edition, Cambridge University Press, 2005.
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36. Kofi, A.D. (1998). Risk Assessment in Environmental management, John Wiley and sons, Singapore.
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41. Molecular Biology of the Cell, 4th edition, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. New York: Garland Science; 2002, ISBN-10: 0-8153-3218-1 ISBN-10: 0-8153-4072-9
42. Molecular Cell Biology by Lodish and Baltimore.
43. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC).
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46. P.W. Atkins: Physical Chemistry, Oxford University Press
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51. Plant Microtechnique and Microscopy (1999) Ruzin, S.E. Oxford University Press, (New York) U.S.A.
52. Plant Physiology (2015) Taiz, L., Zeiger, E., Muller, I.M. and Murphy, A
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54. R.T. Morrison & R.N. Boyd: Organic Chemistry, Prentice Hall
55. Randall, Burggren, French: Eckert, Animal Physiology-mechanisms and adaptations, W H Freeman and company
56. Ricklefs Economy of nature
57. Short Protocols in Molecular Biology (1995) 3rd ed., Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. John Wiley & Sons.
58. Smith R.L. Elements of ecology
59. The Biology of Cancer - Robert A. Weinberg
60. T. J. Kindt, R. A. Goldsby, and B.A. Osborne. 2007. Kuby Immunology, W.H. Freeman and Co, New York.
61. Voet, D. and Voet, J.G. (2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc. USA.
62. Wilkenson DM - 2007 - Fundamental Processes in Ecology
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