Structure and Detailed Syllabus

of the Undergraduate Course (B.Sc.) in Biological Sciences under CBCS

Department of Life Sciences

Presidency University

Department of Life Sciences
(Faculty of Natural and Mathematical Sciences)
Presidency University
Hindoo College (1817-1855), Presidency College (1855-2010)
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Semester-wise Modules of the Undergraduate Course in Biological Sciences (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: Public Health and Management
	BIOS03C6: Cell Biology			
	BIOS03C7: Ecology			
Fourth	BIOS04C8:Systems Physiology		BIOS04GE4:Macromolecules of Life	BIOS04SEC2: Recombinant DNA Technology
	BIOS04C9:Molecular Biology			
	BIOS04C10:Metabolism and Integration			
Fifth	BIOS05C11:Growth and Reproduction	BIOS05DSE1: Biostatistics & Bioinformatics		
	BIOS05C12: Genetics	BIOS05DSE2: Analytical Techniques in Biology		
Sixth	BIOS06C13:Defense Mechanisms	BIOS06DSE3:Stress Biology		
	BIOS06C14: Evolutionary Biology	BIOS06DSE4: Classification, Biosystematics and Molecular Analysis		

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

PRESIDENCY UNIVERSITY
KOLKATA

Credit Allocation and Marks Distribution for the Undergraduate Course in Biological Sciences (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	Public Health and Management	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	Recombinant DNA Technology	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	Biostatistics & Bioinformatics	4	2		6	70	30		100
Fifth	Department Specific Elective	BIOS05DSE2	Analytical Techniques in Biology	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	Stress Biology	4	2		6	70	30		100
Sixth	Department Specific Elective	BIOS06DSE4	Classification, Biosystematics and Molecular Analysis	4	2		6	70	30		100
				Total Credit			**148**	**Total Marks**			**2600**

Semester I:

BIOS01C-1: CHEMISTRY (THEORY)

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 (ΔE) and enthalpy (ΔH) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of w,q, ΔE, and ΔH 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 Helmoltz 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 intra-molecular 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

centrers: 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 KMnO4.
3. Estimation of Fe (II) ions by titrating it with K2Cr2O7 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.

SEMESTER – I
BIOS01C-2: LIGHT AND LIFE (THEORY)
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, phycobilinoproteins, 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, O2 evolving complex; C3, C4, 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 (Phyto and 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 CO2 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 Luxmeter
    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)
    e. To study the estrous cycle of rat
2. Chemical separation of chloroplast pigments/Chromatographic separation of chloroplast pigments.
3. Demonstration of Blackman's law of limiting factors (using Hydrilla).
4. Study of the effect of red and blue light on seed germination
5. Photographs/slides/specimens of photoautotrophic and photosynthetic bacteria, chloroplast, quantasome, bioluminescent organisms (plants and animals)
6. To study the effect of light and darkness on the chromatophores of fish
7. To study the phototactic behavior of different larval instars of Spodoptera
8. To study the effect of light/darkness on development of insect (Spodoptera)
9. To test / survey for colour blindness using Ishihara charts
10. To study Diurnal variations in human body temperature

SEMESTER - II

BIOS02C-3: BIOPHYSICS (THEORY)

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.

SEMESTER – II

BIOS02C-4: BIODIVERSITY (THEORY)

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 mega biodiversity Nation. Hot spots 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 plant; Domesticated diversity; Spice diversity; Forest diversity and wild life.

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, Icthyophis/Uraeotyphlus, Salamander, Rhacophorus, Draco, Uromastix, 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/Wild life sanctuary/Botanical garden/ Zoological Garden. FLORA
8. Study through specimens/photographs/slides of

(a) Key stones species (b) Ecads, Ecotypes, Ecophenes (c) Source of Immunosuppresive 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

SEMESTER – III

BIOS03C-5: PROTEINS AND ENZYMES (THEORY)

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.

2. 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 Km and Vmax. 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; metallo porphyrins, 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.
3. Estimation of proteins by Biuret method
4. Estimation of proteins by Lowry's method
5. Estimation of glucose / sucrose / lactose in milk by Benedict's method
6. 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

SEMESTER – III
BIOS03C-6: CELL BIOLOGY (THEORY)
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 Prokartyotic 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

MAJOR EXPERIMENTS:

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. MINOR EXPERIMENTS:
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, Pyronin Cytochemical 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

SEMESTER – III

BIOS03C-7: ECOLOGY (THEORY)

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: monoclimax 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, tradeoffs, 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, Corolloid roots, Mycorrhizal roots, Velamen roots, Different types of lichen.
2. Principle and function of Sechi disc, Atmometer, Anemometer, Hygrometer, Hair hygrometer, Luxmeter, Rain guage, 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_4 , NO_3, 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_2
10. Study of animal behavior in natural habitat (Forest/ aquatic ecosystem).

SEMESTER - IV
BIOS04C-8: SYSTEMS PHYSIOLOGY (THEORY)
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.

SEMESTER - IV

***BIOS04C-9*: MOLECULAR BIOLOGY (THEORY)**

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-tRNAsynthetases, 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 chromosomal DNA from *E. coli* cells.
6. Purity of isolated DNA by A260/A280 Ratio.

SEMESTER – IV

BIOS04C-10: METABOLISM AND INTEGRATION (THEORY)

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, β-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

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

SEMESTER – V

BIOS05C-11: GROWTH AND REPRODUCTION (*THEORY*)

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).

SEMESTER – V
BIOS05C-12: GENETICS (THEORY)
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 and co-dominance, Multiple alleles, pseudoallele, Lethal alleles, Epistasis, Pleiotropy, mutation rate, gene transfer, recombination, 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: ClB method, Attached X-method, DNA repair mechanisms.

Unit 4 Extra chromosomal Inheritance

Chloroplast mutation/Variegation 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.

7. Estimation of size of a DNA fragment after electrophoresis using DNA markers.
8. Construction of Restriction digestion maps from data provided.
9. Demonstration of DNA fingerprinting.

SEMESTER – VI
BIOS06C-13: DEFENSE MECHANISMS (THEORY)
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 bio pest control.

Practical
Credit : 2
Contact Hours per Week : 4

1. Survey of structural plants defenses: viz. cuticle, wax, lignin, bark, thorns, prickles, trochomes,
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

SEMESTER – VI
BIOS06C-14: EVOLUTIONARY BIOLOGY (THEORY)
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, 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 – Stelar 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

(A) Evidences of fossils

1. Study of types of fossils (e.g. trails, casts and moulds and others) and Index fossils of Palaeozoic era
2. Connecting links/transitional forms - Eg. Euglena, Neopilina, Balanoglossus, Chimaera, Tiktaalik, Archaeopteryx, Ornithorhynchus
3. Living fossils - Eg. Limulus, Peripatus ,Latimeria, Sphaenodon
4. Vestigial, Analogous and Homologous organs using photographs, models or specimen

(B) Variations.

1. Sampling of human height, weight and BMI for continuous variation

2. 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)

(C) Selection Exemplifying Adaptive strategies (Colouration, Mimetic form, Co-adaptation and co-evolution; Adaptations to aquatic, fossorial and arboreal modes of life) using Specimens

(D) Neo-Darwinian Studies

1. Calculations of genotypic, phenotypic and allelic frequencies from the data provided

2. Simulation experiments using coloured beads/playing cards to understand the effects of Selection and Genetic drift on gene frequencies

(E) Phylogeny

1. Digit reduction in horse phylogeny (study from chart),

2. Study of horse skull to illustrate key features in equine evolution

3. Study of monkey and human skull - A comparison to illustrate common primate and unique Hominin features

DISCIPLINE SPECIFIC ELECTIVES

(CBCS STRUCTURE)

SEMESTER – V

BIOS05DSE-1: BIOSTATISTICS & BIOINFORMATICS (THEORY)

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, Gen Bank, 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/ Clustal W/ 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 od 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.

SEMESTER – V

BIOS05DSE-2: ANALYTICAL TECHNIQUES IN IN BIOLOGY (THEORY)

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 separation 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)

SEMESTER – VI

BIOS06DSE-3: STRESS BIOLOGY (THEORY)

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. Calcium modulation, Phospholipid signaling, growth factors, salicylic acid signalling, arachidonate.

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

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.

SEMESTER – VI

BIOS06DSE-4: **CLASSIFICATION, BIOSYSTEMATICS AND MOLECULAR PHYLOGENETICS *(THEORY)***

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

a. Concept of systematics and taxonomy, alpha, beta and gamma taxonomy, phenon, taxon, taxonomic category, Linnean hierarchy
b.Nomenclature of animal and plant taxa and International code of Zoological and Botanical nomenclature
c. Type concept and its applications
d.Different species concept, their merit and demerits
e. haracters; OTU, Principles and theories of animal classification (Phenetics and Cladistics concept)
f. Phenogram and Cladogram constructions
g. concept of cytotaxonomy, Biochemical taxonomy and Molecular Taxonomy
h. 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 Study of a few important plant families and their representative taxa

SKILL ENHANCEMENT COURSES

SEMESTER – III

BIOS03SEC-1: PUBLIC HEALTH AND MANAGEMENT

Theory

Credit : 4

Contact Hours per Week : 4

Unit I: 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 Mangement

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.

SEMESTER – IV

BIOS04SEC-2: RECOMBINANT DNA TECHNOLOGY

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, polymerase chain reaction, expression vectors.

GENERIC ELECTIVES

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.

BIOS02GE-2: 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 plant from 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.

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, carpel 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.

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 & anti-codon 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

Laboratory Experiments

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

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.
3. An Introduction to Practical Biochemistry (1996) 3rd ed., Plummer, D.T. Tata McGraw-Hill Publishing Co. Ltd. (New Delhi).
4. Buchanan B, Gruissem 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 fransisco.
8. Berne and Levy Physiology
9. Cooper G. M. Hausman R. E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinnauer Academic Press.
10. Carlson B.M. Patterns; Foundations of Embryology.
11. Cutter, S.L. (1999).Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi.
12. De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
13. David Randall, Eckert's Animal Physiology, W.H.Freeman and Co.
14. Deverall, Brain J. 1977. Defences mechanisms of plants, Cambridge University Press.
15. Elli Kohen, Rene Santus, Joseph G. Hirschberg: Photobiology Academic press.
16. Peter A. Ensminger: Life under the sun , Yale University Press
17. Futuyma, D. (1998) Evolutionary Biology. III Edn. Sinauer Assoc. Inc.
18. Guyton and Hall Text Book of Medical Physiology
19. 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.
20. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
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23. Hoppe et. al., Biophysics, Translation of 2nd German Edition, Springer Verlag, 1983.
24. Hall, B. K. and Hallgrimson, B. (2008) Strickberger's Evolution. IV Edn. Jones and Barlett
25. Hawes C &Satiat-Jeunemaitre - 2001 Plant Cell Biology : Practical approach
26. Ingrowille, M Diversity and Evolution of land plants 1992 chapman and Hall Nelson, D. L. and Cox, M.M. (2008).Lehninger,
27. iGenetics: A Molecular Approach 3rd Edition, by Peter J Russell, Pearson Education Limited ISBN-13: 978-0321569769/ ISBN-10: 0321569768
28. J.D.Lee: A New Concise Inorganic Chemistry, E.L.B.S.
29. James E.Huheeyetal. : Inorganic Chemistry: Principles of Structure and reactivity,
30. Joseph, F. L. and Louver, B.D. (1997). Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey.
31. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition, Cambridge University Press, 2005.
32. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition, John Wiley & Sons.Inc.
33. K. Murphy, P. Travers, M. Walport. 2008. Janeway's Immunobiology, Garland Science, Taylor and Francis Group, LLC
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50. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
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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
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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.
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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.
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63. Zimmer, C. and Emlen, D. J. (2013) Evolution: Making Sense of Life. Roberts & Co.