Choice Based Credit System (CBCS)

UNIVERSITY OF DELHI

FACULTY OF SCIENCE

UNDERGRADUATE PROGRAMME
(Courses effective from Academic Year 2015-16)

SYLLABUS OF COURSES TO BE OFFERED
Core Courses, Elective Courses & Ability Enhancement Courses

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Undergraduate Programme Secretariat

Preamble

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by universities towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching–learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students. Presently the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades.

The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
2. **Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.
   - **2.1 Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).
   - **2.2 Dissertation/Project**: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.
   - **2.3 Generic Elective (GE) Course**: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.
     P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.
3. **Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course:** The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.
   - **3.1** AE Compulsory Course (AECC): Environmental Science, English Communication/MIL Communication.
   - **3.2** AE Elective Course (AEEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

Details of courses under B.A (Honors), B.Com (Honors) & B.Sc. (Honors)

Course	*Credits	
	Theory+ Practical	Theory + Tutorial
I. Core Course		
(14 Papers)	14X4= 56	14X5=70
Core Course Practical / Tutorial*		
(14 Papers)	14X2=28	14X1=14
II. Elective Course		
(8 Papers)		
A.1. Discipline Specific Elective	4X4=16	4X5=20
(4 Papers)		
A.2. Discipline Specific Elective		
Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		
B.1. Generic Elective/		
Interdisciplinary	4X4=16	4X5=20
(4 Papers)		
B.2. Generic Elective		
Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		

- **Optional Dissertation or project work in place of one Discipline Specific** E**lective paper (6 credits) in 6th Semester**

III. Ability Enhancement Courses		
1. **Ability Enhancement Compulsory**		
(2 Papers of 2 credit each)	2 X 2=4	2 X 2=4
Environmental Science		
English/MIL Communication		
2. **Ability Enhancement Elective** (Skill Based)		
(Minimum 2)	2 X 2=4	2 X 2=4
(2 Papers of 2 credit each)		
Total credit	**140**	**140**

Institute should evolve a system/policy about ECA/ General Interest/Hobby/Sports/NCC/NSS/related courses on its own.

*** wherever there is a practical there will be no tutorial and vice-versa**

Structure of B.Sc. (Hons) Biological Science under CBCS

Core Course

BS-C1: Chemistry
BS-C2: Light and Life
BS-C3: Biophysics
BS-C4: Biodiversity
BS-C5: Proteins and Enzymes
BS-C6: Concepts in Cell Biology
BS-C7: Functional Ecology
BS-C8: Systems Physiology
BS-C9: Concepts of Molecular Biology
BS-C10: Metabolism and Integration
BS-C11: Growth and Reproduction
BS-C12: Fundamentals of Genetics
BS-C13: Defense Mechanisms
BS-C14: Concepts of Evolutionary Biology

Discipline Specific Elective (*Any four*)

DSE-1: Analytical Techniques in Plant Sciences
DSE-2: Stress Biology
DSE-3: Natural Resource management
DSE-4: Wild Life Conservation
DSE-5: Animal Behavior and Chronobiology
DSE-6: Endocrinology
DSE-7: Biomaterials
DSE-8: Microbiology
DSE- 9: Plant Biochemistry

Ability Enhancement Compulsory Course

AE-1: English communication
AE-2: Environmental science

Skill Enhancement Elective Courses (*Any two*)

SEC-1: Medicinal Botany
SEC-2: Bio fertilizers
SEC-3: Medical Diagnostics
SEC-4: Public Health and Management
SEC-5: Biochemical Techniques
SEC-6: Recombinant DNA Technology

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B.Sc. BIOLOGICAL SCIENCE HONOURS

Semester	Core Courses (14)	Ability Enhancement Compulsory Course (2)	Skill Enhancement Course (SEC) (2)	Discipline specific elective (DSE (4)	Generic Elective (GE) (4)
I	Chemistry	English communication			GE-1
	Light and Life				
II	Biophysics	Environmental Science			GE-2
	Biodiversity				
III	Proteins and enzymes		SEC-1		GE-3
	Concepts in Cell Biology				
	Functional Ecology				
IV	Systems Physiology		SEC-2		GE-4
	Concepts of Molecular Biology				
	Metabolism and Integration				
V	Growth and Reproduction			DSE-1 DSE-2	
	Fundamentals of Genetics				
VI	Defense Mechanisms			DSE-3 DSE-4	
	Concepts of Evolutionary Biology				

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS
I	Ability Enhancement Compulsory Course – I	English communication / Environmental Science	2
	Core course – I	Chemistry	4
	Core course – I Practical	Chemistry	2
	Core course – II	Light and Life	4
	Core course – II Practical	Light and Life	2
	Generic Elective – 1	GE – 1	4
	Generic Elective – 1 Practical	GE – 1	2
II	Ability Enhancement Compulsory Course – II	English communications/ Environmental Science	2
	Core course – III	Biophysics	4
	Core course – III Practical	Biophysics	2
	Core course – IV	Biodiversity	4
	Core course – IV Practical	Biodiversity	2
	Generic Elective – 2	GE-2	4
	Generic Elective – 2 Practical	GE-2	2
III	Core course – V	Proteins and Enzymes	4
	Core course – V Practical	Proteins and Enzymes	2
	Core course – VI	Concepts in Cell Biology	4
	Core course – VI Practical	Concepts in Cell Biology	2
	Core course – VII	Functional Ecology	4
	Core course – VII Practical	Functional Ecology	2

	Skill Enhancement Course – 1	SEC-1	4
	Generic Elective – 3	GE-3	4
	Generic Elective – 3 Practical	GE-3	2
IV	Core course – VIII	Systems Physiology	4
	Core course – VIII Practical	Systems Physiology	2
	Core course – IX	Concepts of Molecular Biology	4
	Core course – IX Practical	Concepts of Molecular Biology	2
	Core course – X	Metabolism and Integration	4
	Core course – X Practical	Metabolism and Integration	2
	Skill Enhancement Course-2	SEC-2	4
	Generic Elective – 4	GE-4	4
	Generic Elective – 4 Practical	GE-4	2
V	Core course – XI	Growth and Reproduction	4
	Core course – XI Practical	Growth and Reproduction	2
	Core course – XII	Fundamentals of Genetics	4
	Core course – XII Practical	Fundamentals of Genetics	2
	Discipline Specific Elective – 1	DSE-1	4
	Discipline Specific Elective – 1 Practical	DSE-1	2
	Discipline Specific Elective – 2	DSE-2	4
	Discipline Specific Elective – 2 Practical	DSE-2	2
VI	Core course – XIII	Defense Mechanisms	4

	Core course – XIII Practical	Defense Mechanisms	2
	Core course – XIV	Concepts of Evolutionary Biology	4
	Core course – XIV Practical	Concepts of Evolutionary Biology	2
	Discipline Centric Elective – 3	DSE-3	4
	Discipline Centric Elective – 3 Practical	DSE-3	2
	Discipline Centric Elective – 4	DSE-4	4
	Discipline Centric Elective – 4 Practical	DSE-4	2

B.Sc. (HONOURS) BIOLOGICAL SCIENCES
CORE COURSES

S.No.	Code	Title
1	BS-C1	Chemistry
2	BS-C2	Light and Life
3	BS-C3	Biophysics
4	BS-C4	Biodiversity
5	BS-C5	Proteins and Enzymes
6	BS-C6	Concepts in Cell Biology
7	BS-C7	Functional Ecology
8	BS-C8	Systems Physiology
9	BS-C9	Concepts of Molecular Biology
10	BS-C10	Metabolism and Integration
11	BS-C11	Growth and Reproduction
12	BS-C12	Genetics
13	BS-C13	Defense Mechanisms
14	BS-C14	Evolutionary Biology

SEMESTER – I
BS-C1: CHEMISTRY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Chemical Bonding and Molecular Structure Ionic Bonding No. of Hours: 15

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 MO treatment of homonuclear diatomic molecules of 1st period and heteronuclear diatomic molecules such as CO, HF.

Unit 2 Chemical Thermodynamics No. of Hours: 15

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. Statements of Third Law of thermodynamics : calculation of absolute entropies of substances.

Unit 3 Fundamentals of Organic Chemistry No. of Hours: 15

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, dipoleinduced dipole and dispersion (London) forces. Hydrogen bond (both intramolecular and intermolecular), Effect of inter/intramolecular forces on physical properties such as solubility, vapour pressure, melting and boiling points of different compounds,Aromaticity.

Unit 4 Stereochemistry **No. of Hours: 15**

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, Conformational isomerism – ethane, butane and cyclohexane, diagrams and relative stability of conformers.

SUGGESTED READINGS

1. J.D.Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. Physical Chemistry, P.W.Atkins. Oxford University Press, 1978
3. Organic Chemistry, R.T. Morrison & R.N. Boyd. 6th Ed., Prentice Hall, 1992
4. Inorganic Chemistry: Principles of Structure and Reactivity, J.E.Huheey, E.A.Keiter & R.L.Keiter. 4th Ed.,Dorling Kindersley Pvt. Ltd.,2008

SEMESTER - I
BS-C1: CHEMISTRY (PRACTICALS)

TOTAL HOURS: 60 **CREDIT: 2**

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. Surface tension measurement (use of organic solvents excluded) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
5. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer
6. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide
7. Determination of melting and boiling points of organic compounds
8. Separation of the components of a given mixture of two amino acids by paper chromatography.
9. Separation of sugars present in the given mixture by paper chromatography.

SEMESTER – I
BS-C2: LIGHT AND LIFE (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Light and Life **No. of Hours: 15**

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, Foot Candle). Comparative account of chemistry and functional roles of pigments associated with harvesting light energy: pigments/receptors of light, chlorophylls, caroteniods, phycobilinoproteins, bacteriochlorophylls, phytochromes rhodopsin etc. Photoreception in animals, evolution of eye and visual processing in vertebrate retina.

Unit 2 Photosynthesis **No. of Hours: 15**

History, Photosynthetic equation, Light and dark reactions, mechanism of photolysis of water and oxygen evolution, Q cycle, O_2 evolving complex; C_3, C_4, CAM plants, photoautotroph vs photoheterotrophs; Photoautotroph vs. chemoautotroph, structure of chloroplast and quantasome, Anoxygenic and oxygenic photosynthesis, Reaction centers. Bacterial Photosynthesis

Unit 3 Bioluminescence **No. of Hours: 20**

Definition, discovery, diversity of organisms (plants and animals), photoreceptors - distribution, mechanism; Photoperiodism: LDP, SDP, DNP plants, vernalization, vernalin, etiolation and de-etiolation. 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 **No. of Hours: 10**

Circadian rhythms, jetlag, rhythm of heart beat, melanocytes and skin colour, chromatophores and colour changes in animals.. Light as an inducer for biosynthesis of enzymes, hormones and other biomolecules.

SUGGESTED READINGS

1. Plant Cell Biology: A Practical Approach, C.Hawes & B.Satiat-Juenemaitre. 2nd Ed. Oxford University Press, 2001
2. Biochemistry and Molecular Biology of Plants, B.B.Buchanan, W. Gruissem and R.L. Jones. American Society of Plant Physiologists,2000.
3. Photobiology: Science of Light and Life, L.O. Bjorn. 3rd Ed., Springer
4. Eckert , Animal Physiology-mechanisms and adaptations, D.Randall, W. Burggren & K. French. 5th Ed., W.H. Freeman and Co.
5. Photobiology, E.Kohen, R.Santus, J.G. Hirschberg. 1 Ed., Academic Press (1995)

SEMESTER - I
BS-C2: LIGHT AND LIFE (PRACTICALS)

TOTAL HOURS: 60 **CREDIT: 2**

1. Demonstration of
   (a) etiolation and de etiolation;
   (b) Light and CO_2 are essential for photosynthesis (Moll's half leaf experiment) and measure oxygen evolution during photosynthesis
   (c) Oxygen liberation during photosynthesis using *Hydrilla,* Measurement of light using Luxmeter, light penetration in water using Secchi di*sc*
   (d) *Berle*se funnel experiment to demonstrate the effect of light on soil fauna
   (e) Animal migration in aquatic ecosystems during day and night (pictures only)
   (f) To study the estrous cycle of rat
2. Chemical separation of chloroplast pigments/Chromatographic separation of chloroplast pigments.
3. Demonstration of Hill's reaction and study of the effect of light intensity (any two light conditions).
4. Demonstration of Blackman's law of limiting factors (using *Hydrilla*).
5. Study of the effect of red and blue light on seed germination and development of pigments during fruit ripening.
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\

SEMESTER – II
BS-C3: BIOPHYSICS (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Mechanics **No. of Hours: 14**

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 **No. of Hours: 12**

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, Malus Law, Polarizing materials, Polarizer, Analyzer

Unit 3 Biological membranes **No. of Hours: 16**

Colloidal solution, Micelles, reverse micelles, bilayers, liposomes, phase transitions of lipids, active, passive and facilitated transport of solutes and ions, Fick's Laws, Nernst Planck Equations, Diffusion, Osmosis, Donnan effect, permeabilily coefficient.

Ionophores, transport equation, membrane potential, water potential.

Unit 4 Spectroscopic techniques **No. of Hours: 18**

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, optical rotatory dispersion, magnetic resonance spectroscopy.

SUGGESTED READINGS

1. David Freifelder, Physical Biochemistry: Applications to Biochemistry and Molecular Biology, 2nd Ed., W.H. freeman and Company, 1982.

2. Hoppe *et. al.*, Biophysics, Translation of 2nd German Ed., Springer (Verlag), 1983.

3. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed., Cambridge University Press, 2005.

BS-C3: BIOPHYSICS (PRACTICALS)
SEMESTER - II

TOTAL HOURS: 60 **CREDIT: 2**

1. Determination of acceleration due to gravity using Kater's Pendulum
2. Determination of the acceleration due to gravity using bar pendulum
3. Determination of moment of inertia of a Fly wheel
4. Determination of the frequency of an electrically maintained tuning fork by Melde's Experiment
5. Determination of the coefficient of Viscosity of water by capillary flow method (Poiseuille's method)
6. Verification of Beer Law
7. Determination of Molar Extinction coefficient
8. Determination of CMC for a detergent
9. Effect of different solvents on UV absorption spectra of proteins.

SEMESTER – II
BS-C4: BIODIVERSITY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Defining Biodiversity **No. of Hours: 16**

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. Plant and Animal systematic. Species concept in biodiversity studies.

Unit 2 Modern Tools in the study of Biodiversity **No. of Hours: 14**

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, Bioresources.

Unit 3 Crop Diversity **No. of Hours: 12**

Wild relatives of cultivated plant; Domesticated diversity; Spice diversity; Forest diversity and wild life.

Unit 4 Bio-prospecting **No. of Hours: 18**

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.

SUGGESTED READINGS

1. Aber, J.D. and Melillo, J.M. Terrestrial Ecosystems. Saunders College Publishing, PhiladelphiA. 1991.
2. Ingrowille, M. Diversity and Evolution of land plants. chapman and Hall, London. 1992

SEMESTER - II
BS-C4: BIODIVERSITY (PRACTICALS)

TOTAL HOURS: 60 **CREDIT: 2**

1. **Study of following specimens**: *Euglena, Noctiluca, Paramecium, Sycon, , Physalia,*
    a. *Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus,*
    b. Hermitcrab, *Daphnia,* Millipede, Centipede, Beetle, Pila, *Chiton, Dentalium,*
    c. *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,*
    a. *Hippocampus, Labeo, Icthyophis/Uraeotyphlus, Salamander, Rhacophorus ,Draco,*
    b. *Uromastix, Naja, Viper,* any three common birds, Squirrel and Bat.
4. Study of a few endangered species of amphibians, reptiles, birds and mammals of
    a. 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.

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
    a. structures) of *Coleacheate, Vaucheria, Polysiphonia, Fucus* (*Fucus* permanent slides
    b. only); *Rhizopus*, *Penicillium* and *Agaricus*; *Riccia, Anthoceros, Funaria; Psilotum,*
    c. *Selaginella, Pteris; Cycas, Pinus, Gnetum*
10. Study of the characteristic features of any two flowers for each family
    a. Malvaceae/ Fabaceae/Cruciferae/Ranunculaceae (any one family), (b) Compositae
    b. Euphorbiaceae, (d) Poaceae/Liliaceae (any one family)

SEMESTER – III
BS-C5: PROTEINS AND ENZYMES (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Biomolecules: Diversity and Distribution **No. of Hours: 15**

Lipids: Role of lipids in cellular architecture and functions. Definition and classification of lipids. Structure and function of fatty acids, triacylglycerols, phospholipids and sterols.

Carbohydrates: Biological roles of carbohydrates. Structure of monosacharides- Hexoses and pentoses. Disacharides-Sucrose, lactose, maltose. Storage and structural polysacharides-Glycogen, starch and cellulose. Nucleic acids: Role of nucleic acids in living system. Composition of nucleic acids-the purine and pyrimidine bases.

Unit 2 Proteins **No. of Hours: 10**

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 qua ternary structure of proteins.

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 **No. of Hours: 15**

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 inhibitions. Catalytic mechanism of lysozyme or chymotrypsin. Regulation of enzyme activity allosteric enzymes, feedback inhibition with ATcase as an example.

Unit 4 Isolation and purification of enzymes **No. of Hours: 10**

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

Unit 5 Role of Metal ions in Biology **No. of Hours: 10**

Metalloprotein, Metalloenzymes, metal base drug interaction and inhibition; metallo porphyrins, Redox. Carriers in mitochondrial electron transport chain.

SUGGESTED READINGS

1. Nelson, D. L. and Cox, M.M. Lehninger, Principles of Biochemistry, 5th Ed., W.H. Freeman and Company (N.Y., USA.), 2008**.**
2. Voet, D. and Voet, J.G. Biochemistry, 3rd Ed., John Wiley & Sons, Inc. USA., 2004.

SEMESTER - III
BS-C5: PROTEINS AND ENZYMES (PRACTICALS)

TOTAL HOURS: 60 **CREDIT: 2**

1. Preparation of buffers
2. Determination of PKa value for acetic acid
3. Estimation of proteins by Biuret method
4. Estimation of proteins by Lowry's method
5. Separation of sugars by Thin Layer chromatography
6. Assay of the enzyme acid phosphatase from germinated mungdal or β-amylase from Sweet potato beams
7. Effect of pH on the activity of an enzyme
8. Progress curve of an enzyme

SEMESTER – III
BS-C6: CONCEPTS IN CELL BIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 An Overview of Cells and Techniques in Cell Biology **No. of Hours: 10**

History, Cell theory, Overview of Prokartyotic and Eukaryotic Cells, Plant and Animal cells, exceptions to cell theory, Phages, Virioids, Mycoplasmas, 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. 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 2 Cell wall, Extra Cellular Matrix and Cell interactions **No. of Hours: 5**

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 3 Cell membrane and Nucleus **No. of Hours: 10**

Structure and functions, active and passive transport, proton pumps associated (Na-K, Ca-calmodulin etc. and their distribution), phagocytosis, pinocytosis, exocytosis. Nuclear envelope, structure of nuclear pore complex, nuclear lamina, transport across nuclear membrane, Nucleolus, rRNA processing.

Unit 4 Mitochondria, Chloroplasts, Lysosomes, Gloxysomes and Peroxisomes **No. of Hours: 8**

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

Unit 5 Cytoskeleton **No. of Hours: 7**

Structure and organization of actin, myosin and intermediate filaments, microtubules, and their role

Unit 6 Protein sorting and Transport, Cell Signaling and Cancer **No. of Hours: 20**

Structure and functions of Endoplasmic reticulum and Golgi apparatus, GERL. Signaling molecules and their receptors, functions; intracellular signal transduction pathways (with special reference to some selected pathways); signaling networks and cross talk. 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.

SUGGESTED READINGS

1. Cell and Molecular Biology: Concepts and Experiments, Karp, G. 6th Ed., John Wiley & Sons. Inc.2010
2. Cell and Molecular Biology, EDP De Robertis, and RE De Robertis. 8th Ed., Lippincott Williams and Wilkins, Philadelphia. 2009
3. The Cell: A Molecular Approach, G.M. Cooper & R.E. Hausman. 5th Ed., Sinnauer Associates Inc. 2009
4. The World of the Cell, W.M. Becker, L.J. Kleinsmith and G.P. Bertni. 7th Ed. Pearson Benjamin Cummings Publishing, San Fransisco ,2009

SEMESTER - III
BS-C6: CONCEPTS IN CELL BIOLOGY (PRACTICALS)

TOTAL HOURS: 60 **CREDIT: 2**

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. Preparation of temporary slides of the following (Onion epidermal peel/ root tips or any other suitable available material like *Crinum*, Wheat caryopsis etc.):
    a. Cytochemical staining of DNA by Fuelgen
    b. Cytochemical staining of RNA by Methyl Green Pyronin
    c. Cytochemical staining of polysaccharides by PAS
    d. Cytochemical staining of proteins by Bromophenol blue
    e. Cytochemical staining of histones by fast green
    f. Vital staining of mitochondria by Janus green B in cheek epithelial cells
5. Identification and study of types of cancer, cancer cells by permanent slides/ photographs.
6. Study of the following microscopic techniques by photographs: Fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching, shadow casting
7. Study of ultastructure of cell (Cell wall, Primary and secondary pits, Plasodesmata, 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/photgraphs

SEMESTER – III
BS-C7: FUNCTIONAL ECOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Ecology **No. of Hours: 10**

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 **No. of Hours: 20**

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, functional and numerical responses. Phenotypic and genotypic plasticity, canalization. Species interactions in brief classified based on their reciprocal effects.

Unit 3 Ecosystem and Community Ecology **No. of Hours: 20**

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 **No. of Hours: 10**

Social, reproductive & territorial behavior, kin selection. Evolution of optimal life history, tradeoffs, semelparity and iteroparity, reproductive structure and mating system

SUGGESTED READINGS

1. Wilkinson, D.M. Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A. 2007.
2. Aber J.D. & Melillo J M - Terrestrial Ecosystems. Aber, J.D., Melillo, J.M. Terrestrial ecosystems, Saunders College Publishing, (Philadelphia). 1991
3. Smith R.L. Elements of ecology. 9th Ed., Benjamin Cummings. 2014.
4. Robert Ricklefs. Economy of Nature. 6th Ed., W H Freeman & Co. 1976.
5. Odum, E.P. Fundamentals of ecology. 5th Ed. Cengage Learning India Pvt. Ltd., (New Delhi). 2005.

SEMESTER - III
BS-C7: FUNCTIONAL ECOLOGY (PRACTICALS)

TOTAL HOURS: 60 **CREDIT: 2**

1. Study through specimens/photographs/slides of Parasitic angiosperms, Saprophytic angiosperms, VAM fungi, Root nodules, Corolloid roots, Mycorrhizal roots, Velamen roots, Lichen as pollution indicators.
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.

SEMESTER – IV
BS-C8: SYSTEMS PHYSIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Movements and Bulk Transport **No. of Hours: 15**

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

Unit 2 Gas exchange in organism; Generation and utilization of energy

No. of Hours: 15

Exchange in unicellular organisms and plants; Respiratory organs in aquatic and terrestrial systems ; Physiology of aquatic breathing and aerial breathing; Feeding patterns, digestive tract systems; Digestion of food

Unit 3 Regulatory Physiology **No. of Hours: 15**

Mechanism of opening and closing of stomata. Regulation of water and solutes in aquatic and terrestrial animals; Osmoregulatory organs. Transpiration in plants; Excretion of nitrogenous wastes in animals; Patterns of Thermoregulation : Ectotherms and Endotherms; Structural and functional adaptation to stress

Unit 4 Integrative Physiology **No. of Hours: 15**

An overview of neuronal structure and function; Sensory physiology -mechano, chemo, thermo, photo and electro receptors; Endocrine systems in animals and their physiological effects; Plant hormones and their physiological effects; Regulation of metabolism and response to environmental cues.

SUGGESTED READINGS

1. Knut Schmidt – Nielsen. Animal Physiology 5th Ed., Cambridge University Press. 2005
2. Randall D, Burggren W & K French, EcKert Animal Physiology,. 5th Ed.,W.H. Freeman ,2002
3. WG Hopkins & NPA Huner, Introduction to Plant Physiology,. 4th Ed., Wiley, 2009
4. Salisbury F & Ross C, Plant Physiology, 4th Ed., Brooks Cole,1991

SEMESTER - IV

BS-C8: SYSTEMS PHYSIOLOGY (PRACTICALS)

TOTAL HOURS: 60 **CREDIT : 2**

1. Effect of isotonic, hypotonic and hypertonic salines on erythrocytes
2. Enumeration of RBC using haemocytometer
3. Estimation of total count of WBC using haemocytometer
4. Study of the effect of various environmental factors on transpiration in an excised twig/leaf
5. Calculation of the stomatal index, stomatal frequency and percentage of leaf area open through stomata in a mesophyte and a xerophytes
6. Study of the mechanism of stomatal opening and closing

SEMESTER - IV
BS-C9: CONCEPTS OF MOLECULAR BIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Genes and Genomic organization **No. of Hours: 10**

Definition of a gene, organization of genes in viruses, bacteria and eukaryotes. Complexity of eukaryotic genes and chromosomes, 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 **No. of Hours: 10**

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. Comparison of replication in prokaryotes and eukaryotes.

Unit 3 DNA Repair **No. of Hours: 5**

Mutations and cancer, mismatch repair, base excision repair, nucleotide excision repair, direct repair, recombination repair, error-prone translesion DNA synthesis.

Unit 4 DNA-dependent synthesis of RNA **No. of Hours: 10**

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 **No. of Hours: 5**

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 **No. of Hours: 10**

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 **No. of Hours: 10**

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. 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.

SUGGESTED READINGS

1. Nelson, D.L. and Cox, M.M, Lehninger: Principles of Biochemistry,. 6th Ed., W.H. Freeman & Company (New York) ,2013.
2. J.D.Watson, T.A. Baker, S.P Bell, A. Gann, M. Levine and R. Losick, Molecular Biology of the Gene,. 6th Ed., Cold Spring Harbor Laboratory Press (New York) , 2008.

SEMESTER - IV
BS-C9: CONCEPTS OF MOLECULAR BIOLOGY (PRACTICALS)

TOTAL HOURS: 60 **CREDIT : 2**

1. Estimation of DNA by DPA method.
2. Estimation of RNA by Orcinol method.
3. Separation of nucleotide bases by paper chromatography.
4. Extraction of total nucleic acids from plant tissue.
5. Isolation of chromosomal DNA from E. coli cells.
6. Purity of isolated DNA by A_{260}/A_{280} Ratio

SEMESTER – IV

BS-C10: METABOLISM AND INTEGRATION (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Concept of Metabolism **No. of Hours: 8**

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

Unit 2 Metabolic Pathways **No. of Hours: 25**

Carbohydrates metabolism - Glycolysis, alcoholic and lactic acid fermentation, Pasteur Effect, gluconeogenesis, Coricycle, 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 C-16 palmitic acid.

Unit 3 Nutritional Disorder **No. of Hours: 5**

PEM (Kwashiorkar and Marasmus), Obesity. Metabolic disorders-Diabetes. Inborn errors of metabolism- i) Protein-PKU, Alkaptonuria and Maple syrup and Gauchers. Protein catabolism - Transamination and deamination, Urea cycle, glucogenic and keogenic amino acids.

Unit 4 Metabolic Integration **No. of Hours: 6**

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

Unit 5 Oxidative phosphorylation **No. of Hours: 6**

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

Unit 6 Microbial Role in Metabolism **No. of Hours: 10**

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

SUGGESTED READINGS

1. Schlegel H.G., General Microbiology , Cambridge University Press Cambridge, 1993
2. Thomas M.Devlin, Text Book of Biochemistry with Clinical Correlations, 6th Ed., Wiley-Liss, 2006
3. Peter W. Hochachka and George. N. Somero ,Strategies of Biochemical Adaptation, Saunders College Publishing, 1973

SEMESTER - IV
BS-C10: METABOLISM AND INTEGRATION (PRACTICALS)

TOTAL HOURS: 60 **CREDIT: 2**

1. Estimation of blood glucose – Glucose Oxidase method
2. Estimation of Cholesterol – Hyper Cholesteremia samples
3. Estimation of SGPT and SGOT
4. Estimation of Bilirubin
5. Estimation of creatinine
6. Identification of organelles by marker enzymes – SDH, LDH and acid phosphatase

SEMESTER – V
BS-C11: GROWTH AND REPRODUCTION (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Growth and Reproduction **No. of Hours: 15**

General growth patterns in animals and plants: the plant cell as a model of growing system; biophysical basis of plant cell growth; the role of cell wall in cell growth ;extension growth of multicellular organs in plants. Juvenile,vegetative and reproductive phases in growth: 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.

Unit 2 Pre Fertilization Changes **No. of Hours: 15**

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 and oogenesis, types of eggs in animals; relative sexuality in plants and heterothallism in fungi.

Unit 3 Post Fertilization Changes and Early Development **No. of Hours: 20**

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

Unit 4 Differentiation **No. of Hours: 10**

Organogenesis: Formation of CNS, Organogenesis of secondary girth

SUGGESTED READINGS

1. Gilbert S.F., Developmental Biology, 9th Ed. Sinauer Assosiates, Inc., (Sunderland, MA), 2010
2. Carlson B.M. Pattern's Foundations of Embryology, 6th Ed., McGraw Hill, 1996

SEMESTER - V
BS-C11: GROWTH AND REPRODUCTION (PRACTICALS)

TOTAL HOURS: 60 **CREDIT: 2**

1. Study of whole mounts of frog and 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. Study of gamete/spores in algae, moss, liverwort, pteridophyte and gymnosperm
9. Embryo development in flowering plant-slides only; dissection of endosperm and embryo
10. Study of apical and lateral meristem, hypertrophy and hyperplasia
11. Survey of dispersal mechanisms of seeds

SEMESTER – V

BS-C12: FUNDAMENTALS OF GENETICS (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Mendelian Genetics and Extensions **No. of Hours: 10**

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, Lethal alleles, Epistasis, Pleiotropy

Unit 2 Linkage, Crossing over and Chromosomal Mapping **No. of Hours: 6**

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

Unit 3 Mutations **No. of Hours: 10**

Chromosomal mutations, Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; 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 **No. of Hours: 6**

Chloroplast mutation/Variegation in four 'o clock plant and *Chlamydomonas,* Mitochondrial mutations in *Neurospora* and yeast, Maternal effects, Infective heredity-Kappa particles in *Paramecium*

Unit 5 Genome Dynamics-Transposable Genetic Elements **No. of Hours: 8**

Prokaryotic transposable elements-IS elements, Composite transpossons, Tn-3 elemenets; Eukaryotic transposable elements- Ac-Ds system in maize and P-elements in *drosophila;* Uses of transposons

Unit 6 Genomics, Bioinformatics and Proteomics **No. of Hours: 10**

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; Post-translational analysis-Protein interaction

Unit 7 Population and Evolutionary Genetics **No. of Hours: 10**

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

SUGGESTED READINGS

1. D.P. Snustad, and M.J. Simmon , Genetics, 6th Ed., John Wiley & Sons. (Singapore) 2012

2. B.A Pierce, Genetics - A Conceptual Approach,. 4th Ed., W.H. Freeman & Co. (New York) 2012

3. A.J.F Griffiths, S. R Wessler, S. B Carroll & J. Doebley, An Introduction to Genetic Analysis,. 10th Ed., W.H. Freeman & Company (New York) 2010

SEMESTER - V
BS-C12: FUNDAMENTALS OF GENETICS (PRACTICALS)

TOTAL HOURS: 60 **CREDIT : 2**

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
6. Restriction enzyme digestion 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
BS-C13: DEFENSE MECHANISMS (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Defense Mechanisms **No. of Hours: 10**

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

Unit 2 Innate Immunity in plants **No. of Hours: 5**

Chemical and morphological defence in plants; elicitors, receptors , Basal resistance and innate biochemical host defenses

Unit 3 Innate Immunity in animals **No. of Hours: 5**

Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response. Complement activation by classical, alternate and MBL pathway, biological consequences of complement activation, regulation and complement deficiencies.

Unit 4 Adaptive Immunity in Plants **No. of Hours: 17**

Abiotic- strategies and mechanisms; effect of UVB light on herbivory. Biotic- interactions with symbionts, pathogens. Biochemical host defenses, Basal resistance and basic compatibility; epidemiological and population genetics, co-evoluton in natural plant pathogen systems. Gene for gene concept; interaction in host-pathogen systems, receptor-elicitor model, plant gene-gene interaction. Cytological protection and induced resistance. Passive and active defences; Jasmonic acid, MAPKS,SROS,HPL, systemins, Heatshock proteins, oxylipin, Basic ROS cycle and adaptation during stress, Phytolexins, mechanism of production and scavenging of NO. Herbivory related signals and other induced signals.

Unit 5 Adaptive Immunity in Animals **No. of Hours: 15**

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 - HLA and Disease; T cell differentiation – Positive and Negative selection, Antigen Presentation, Activation of T and B cells. Cytokines and Chemokines.

Unit 6 Immune dysfunction and applications **No. of Hours: 8**

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

SUGGESTED READINGS

1. J.B. Deverall, Defense mechanisms of Plants , Cambridge University Press, 1997.
2. T.J. Kindt, R.A. Goldsby, & B.A. Osborne, Kuby Immunology,. 6th Ed., WH Freeman and Co, (New York) 2007
3. K. Murphy, P. Travers & M. Walport, Janeway's Immunobiology, Garland Science, Taylor and Francis Group, LLC, 2008

SEMESTER - V
BS-C13: DEFENCE MECHANISMS (PRACTICALS)

TOTAL HOURS: 60 **CREDIT: 2**

1. Characterization of diseases symptoms and identification of pathogenic organisms (at least one each from viral, fungal, pest and nematodes injection).
2. Survey of structural plants defences: viz. cuticle, wax, lignin, bark, thorns, prickles, trochomes, armour in different plants species including thigmonasty, camouflage, mimicry.
3. Survey: Quantitative and qualitative secondary metabolites in plants: alkaloids, glycosides, glycosinolates, terpinoids, phenolics, gammosis etc. in healthy and diseased plant/plant organs.
4. Partial purification of Immunoglobulin's by Ion Exchange chromatography
5. Immunodiffusion – DID and SRID.
6. Immunoelectrophoresis (IEP)
7. Countercurrent IEP, Rocket IEP
8. Spleen cell isolation and Counting.

SEMESTER – VI
BS-C14: CONCEPTS OF EVOLUTIONARY BIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Historical Review of Evolutionary Concept **No. of Hours: 7**

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 **No. of Hours: 6**

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 build-up. Endosymbiotic theory – Evolution of Eukaryotes from Prokaryotes

Unit 3 Evidences of Evolution **No. of Hours: 4**

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 **No. of Hours: 7**

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

No. of Hours: 8

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

No. of Hours: 5

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 **No. of Hours: 6**

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 **No. of Hours: 2**

Periodic extinctions , Mass-scale extinctions – Causes and events

Unit 9 Evolution of Plants and Fungi **No. of Hours: 9**

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

Unit 10 Human Ancestry and Phylogeny **No. of Hours: 6**

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

SUGGESTED READINGS

1. M. Ridley, Evolution,. 3rd Ed.. Blackwell Scientific Publishing ,2004
2. B. K Hall & B. Hallgrimson Strickberger's Evolution,. 4th Ed.. Jones and Barlett , 2008
3. C. Zimmer & D. J. Emlen,.Evolution: Making Sense of Life, 1st Ed. Roberts & Co. Publishers, 2013
4. D. Futuyma, Evolutionary Biology,. 3rd Ed. Sinauer Assoc. Inc. 1998
5. NH Barton, DEG Briggs, JA Eisen, DB Goldstein and NH Patel, Evolution,.1st Ed., Cold Spring Harbor Laboratory Press, 2007

SEMESTER – V

BS-C14: CONCEPTS OF EVOLUTIONARY BIOLOGY (PRACTICALS)

TOTAL HOURS: 60 **CREDIT : 2**

(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 characterstics (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

B.Sc. (HONOURS) BIOLOGICAL SCIENCES
DISCIPLINE SPECIFIC ELECTIVES

S.No.	Code	Title
1	DSE-1	Analytical Techniques in Plant Sciences
2	DSE-2	Stress Biology
3	DSE-3	Natural Resource Management
4	DSE-4	Wild Life Conservation
5	DSE-5	Animal Behavior and Chronobiology
6	DSE-6	Endocrinology
7	DSE-7	Biomaterials
8	DSE-8	Microbiology
9	DSE-9	Plant Biochemistry

SEMESTER – V/VI
DSE-1: ANALYTICAL TECHNIQUES IN PLANT SCIENCES (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1: Imaging and related Techniques **No. of Hours: 15**
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 **No. of Hours: 8**
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Radioisotopes **No. of Hours: 4**
Use in biological research, auto-radiography, pulse chase experiment.

Unit 4: Spectrophotometry **No. of Hours: 4**
Principle and its application in biological research.

Unit 5: Chromatography **No. of Hours: 8**
Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6: Characterization of Proteins and Nucleic acids **No. of Hours: 6**
Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit 7: Biostatistics **No. of Hours: 15**
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; Chi-square test for goodness of fit.

SUGGESTED READINGS

1. D.T Plummer, An Introduction to Practical Biochemistry,. 3rd Ed. Tata McGraw-Hill Publishing Co. Ltd. (New Delhi). 1996
2. S.E. Ruzin, Plant Microtechnique and Microscopy, Oxford University Press, (New York) 1999
3. F Ausubel, R. Brent, R. E. Kingston, D.D Moore, J.G.Seidman, J.A.Smith & K. Struhl, Short Protocols in Molecular Biology,.3rd Ed., John Wiley & Sons. 1995
4. JH Zar, Biostatistical Analysis, 4th Ed. Pearson Publication, 2012

SEMESTER – V/VI
DSE-1: ANALYTICAL TECHNIQUES IN PLANT SCIENCES (PRACTICALS)

TOTAL HOURS: 60 **CREDITS: 2**

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separation DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).

SEMESTER – V/VI
DSE-2: STRESS BIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1: Defining Plant Stress **No. of Hours: 2**
Acclimation and adaptation.

Unit 2: Environmental Factors **No. of Hours: 20**
Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.

Unit 3: Stress Sensing Mechanisms in Plants **No. of Hours: 20**
Role of nitric oxide. Calcium modulation, Phospholipid signaling

Unit 4: Developmental and Physiological Mechanisms that protect plants against Environmental Stress **No. of Hours: 12**
Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; osmotic adjustment; Compatible solute production.

Unit 5: Reactive oxygen species **No. of Hours: 6**
Production and scavenging mechanisms.

SUGGESTED READINGS

1. WG Hopkins & NPA Huner, Introduction to Plant Physiology,. 4th Ed., Wiley, 2009
2. L. Taiz, E. Zeiger, IM Muller and A. Murphy, Plant Physiology and Development,. 6th Ed.Sinauer Associates, 2015

SEMESTER – V/VI
DSE-2: STRESS BIOLOGY (PRACTICALS)

TOTAL HOURS: 60 **CREDITS: 2**

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. Zymographic analysis of peroxidase.
4. Zymographic analysis of superoxide dismutase activity.
5. Quantitative estimation and zymographic analysis of catalase.
6. Quantitative estimation and zymographic analysis of glutathione reductase.
7. Estimation of superoxide anions.

SEMESTER – V/VI
DSE-3: NATURAL RESOURSE MANAGEMENT (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1: Natural Resources and Sustainable Utilization **No. of Hours: 10**
Definition and types of Natural resources. Concept, approaches (economic, ecological and socio-cultural) of Sustainable utilization

Unit 2: Land and Water **No. of Hours: 14**
Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit 3: Biological Resources **No. of Hours: 12**
Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).

Unit 4: Forests and Energy **No. of Hours: 12**
Definition, Cover and its significance (with special reference to India); Major and minor Forest products; Depletion; Management. Renewable and non-renewable sources of energy

Unit 5: Contemporary practices in Resource Management **No. of Hours: 12**
EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management. National and international efforts in resource management and conservation

SUGGESTED READINGS

1. N. Vasudevan, Essentials of Environmental Science, Narosa Publishing House, (New Delhi), 2006
2. J. S.Singh, S.P Singh and S. Gupta, Ecology, Environment and Resource Conservation, Anamaya Publications, (New Delhi), 2006
3. An P.P Rogers, K.F Jalal and J.A Boyd, Introduction to Sustainable Development,. Prentice Hall of India Private Limited (New Delhi), 2008

SEMESTER – V/VI
DSE-3: NATURAL RESOURSE MANAGEMENT
(PRACTICALS)

TOTAL HOURS: 60 **CREDITS: 2**

1. Estimation of solid waste generated by a domestic system (biodegradable and non biodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modeling.

SEMESTER – V/VI
DSE-4: WILDLIFE CONSERVATION AND MANAGEMENT (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1: Introduction to Wild Life Conservation and Management **No. of Hours: 2**
Values and ethics of wildlife conservation; importance of conservation.

Unit 2: Habitat Analysis **No. of Hours: 12**
Evaluation and management of wild life - Physical parameters and Biological Parameters; Standard evaluation procedures: Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method, Geographical Information System (GIS), Global Positioning System (GPS), and Remote Sensing (RS).

Unit 3: Human-wildlife Conflict **No. of Hours: 8**
Poaching, illegal trading, conflict management and shifting from extraction to preservation; effect of extinction of a species on ecosystem; Forest landscape restoration.

Unit 4: Modern Concepts of Management **No. of Hours: 15**
Protected Area Network (PAN), WWFN, IUCN, and CITES. Wild life Legislation – Wild life Protection act (1972), its amendments and implementation. IUCN Red data book and red list categories (only names), Protected areas National parks & sanctuaries, Community reserve; Important features of protected areas in India; Project Tiger and Project Elephant.

Unit 5: Management of excess Population and Translocation **No. of Hours: 6**
Bio- telemetry; Common diseases of wild animal; Quarantine; Population Viability and Habitat Analysis (PVHA), captive breeding and propagation, rescue, rehabilitation and reintroduction, gene banks, ex-situ and in-situ conservation.

Unit 6: Sustainable Wildlife Management **No. of Hours: 12**
Eco tourism / wild life tourism in forests; various Environmental movements in India: Bishnoi movement, Chipko movement, Narmada bachao andolan, Silent valley movement, Baliyapal movement.

SUGGESTED READINGS

1. G. Caughley & A.R.E. Sinclair, Wildlife Ecology and Management, Blackwell Science, 1994
2. R Woodroff, S Thirgood and A. Rabinowitz, People and Wildlife, Conflict or Co-existence?,. Cambridge University Press, 2005
3. T A Bookhout, Research and Management Techniques for Wildlife and Habitats,. 5th Ed. The Wildlife Society, Allen Press, 1996
4. W J Sutherland, The Conservation Handbook: Research, Management and Policy, , Blackwell Sciences, 2000
5. ML Hunter, J.B. Gibbs and E.J. Sterling, Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory,. Blackwell Publishing. 2008

SEMESTER – V/VI
DSE-4: WILDLIFE CONSERVATION AND MANAGEMENT (PRACTICALS)

TOTAL HOURS: 60 **CREDITS: 2**

1. Identification and Study of any five endangered mammalian fauna, avian fauna, herpeto-fauna
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)
3. Familiarization and study of animal evidences in the field: Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers.
4. PCQ, Ten tree method, Circular, Square & rectangular plots, Parker's 2 Step and other methods for ground cover assessment,
5. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)

SEMESTER – V/VI
DSE-5: ANIMAL BEHAVIOUR AND CHRONOBIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1: Introduction to Animal Behavior and Chronobiology **No. of Hours: 2**
Origin and history of ethology

Unit 2: Mechanisms of Behavior **No. of Hours: 8**
Innate behavior, Instinct, Stimulus filtering, Sign stimuli, Code breakers

Unit 3: Patterns of Behavior **No. of Hours: 15**
Reflexes: Types of reflexes, reflex path, characteristics of reflexes (latency, after discharge, summation, fatigue, inhibition) and its comparison with complex behavior. Orientation: Primary and secondary orientation; kinesis-orthokinesis, klinokinesis; taxis-tropotaxis and klinotaxis, menotaxis (light compass orientation). Learning: Associative learning, classical and operant conditioning, Habituation, Imprinting

Unit 4: Social Behavior **No. of Hours: 10**
Insects' society; Honey bee: Society organization, polyethism, foraging, round dance, waggle dance, Experiments to prove distance and direction component of dance, learning ability in honey bee, formation of new hive/queen

Unit 5: Altruism **No. of Hours: 6**
Reciprocal altruism, Hamilton's rule and inclusive fitness with suitable examples

Unit 6: Sexual Behavior and Biological Clocks **No. of Hours: 19**
Asymmetry of sex, Sexual dimorphism mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Infanticide, Consequences of mate choice for female fitness, Sexual conflict for male verses female parental care, Courtship behavior in 3-spine stickleback. Circadian rhythms, Tidal rhythms, Lunar rhythms, Advantages of biological clocks, Jet lag, Entrainment

SUGGESTED READINGS

1. McFarland David, Animal Behavior: Psychobiology, Ethology and Evolution.. 3rd Ed. Benjamin Cummings, 1998
2. An A. Manning & MS Dawkins, Introduction to Animal Behavior, , Cambridge University Press, 2012
3. J. Alcock, Animal Behavior,. 10th Ed., Sinauer Associate Inc., 2013
4. W. Paul, Sherman and J Alcock, Exploring Animal Behavior, ,Sinauer Associate Inc., Massachusetts, 2013

SEMESTER – V/VI
DSE-5: ANIMAL BEHAVIOUR AND CHRONOBIOLOGY
(PRACTICALS)

TOTAL HOURS: 60 **CREDITS: 2**

1. To study different types of animal behavior such as habituation, social life, courtship behavior in insects, and parental care from short videos/movies and prepare a short report.
2. To study nests and nesting habits of the birds and social insects.
3. To study the behavioral responses of wood lice to dry condition.
4. To study behavior responses of wood lice in response to humid condition.
5. To study geotaxis behavior in earthworm.
6. To study the phototaxis behavior in insect larvae.
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioral activities of animals and prepare a short report.

SEMESTER – V/VI
DSE-6: ENDOCRINOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

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Unit 1: Introduction to Endocrinology **No. of Hours: 3**
History of endocrinology, characteristic of Hormones, Classification –Local and circulating hormones, chemical classification, Neurosecretions and neurohormones

Unit 2: **Hypothalamic-Pituitary system** **No. of Hours: 12**
Hypothalamus; structure of hypothalamus, names and functions of important hypothalamic nuclei, neuroendocrine regulation of endocrine glands and feedback mechanisms. Pituitary Gland, structure of pituitary, its hormones, their secretion, transportation, storage, functions and hypothalamic regulation; disorders of pituitary gland. Pineal gland, secretions and their functions in biological rhythms and reproduction.

Unit 3: Thyroid-Parathyroid system **No. of Hours: 8**
Thyroid gland; structure of thyroid gland, synthesis and functions of thyroid hormones, regulation of thyroid hormone secretion; thyrocalcitonin. Disorders of thyroid gland. Parathyroid Glands: Secretion Action of parathyroid Hormones, role of parathyroid hormone and calcitonin in calcium metabolism, disorders of parathyroid gland

Unit 4: **Adrenal gland and its hormones** **No. of Hours: 12**
Structural of Adrenal Gland – Synthesis and structure of hormones of the adrenal cortex and medulla; Biological Action of glucocorticoids, mineralocorticoids, adrenaline and noradrenaline on carbohydrate and protein metabolism; and cardiovascular system, osmoregulation, Stress and diseases related to adrenal cortex and medulla.

Unit 5: **Pancreas and its hormones** **No. of Hours: 10**
Structure of Pancreatic Islets of Langerhans and hormones secreted by it; insulin secretion (proinsulin) its activation, Glucagon secretion, mechanism of action of both hormones in controlling the blood glucose level. Diabetes mellitus.

Unit 6: Reproductive endocrinology **No. of Hours: 10**
Male Reproductive system; hormonal control of testes; chemistry and biosynthesis of testosterone, functions of testosterone. Female Reproductive system, role of hormones in Female Sexual cycle, placental hormones; parturition and lactation

Unit 7: Gastrointestinal hormones **No. of Hours: 5**
A brief account of hormones of gastrointestinal tract and kidney.

SUGGESTED READINGS

1. J. Larry Jameson, editor. Harrison's Endocrinology. 2nd Ed McGraw-Hill Press (New York) 2010
2. Turner, D.C. and Bagnara, J.T. (Editor). General Endocrinology. W. B. Saunders Company (Philadelphia, Pennsylvania), 1976
3. Guyton A.C., Hall, J.E. Textbook of Medical Physiology 11th Ed. Elsevier Saunders 2006

SEMESTER – V/VI
DSE-6: ENDOCRINOLOGY
(PRACTICALS)

TOTAL HOURS: 60 **CREDITS: 2**

1. Study of the permanent slides of all the endocrine glands
2. Esrous cycle of rat.- Vaginal smear
3. Compensatory ovarian hypertrophy or adrenal hypertrophy
4. Castration/ ovariectomy

SEMESTER – V/VI
DSE-7: BIOMATERIALS (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1: Introduction to Biomaterials **No. of Hours: 20**

Classification, Chemistry and characterization of biomaterials. The state of the art of biomaterials and the challenges. Disciplines involved in biomaterials science and the path from a need to a manufactured medical device. Material selection requirements for biomaterials – metals, composites, ceramics and polymers. Tissue environment of the implanted biomaterial: unit cell processes. Tissue responses to implants. Nanomaterials: fullerenes, carbon nanotubes, nanomembranes. Synthesis of bio-materials, Characterization of chemical, physical, mechanical properties, visco elasticity, end group analysis, determination of molecular weight of a polymer.

Unit 2: Biocompatibility **No. of Hours: 10**

Biocompatibility of Bio-materials, wound-healing process, body response to implants, blood compatibility. Tests to assess biocompatibility of a polymer, modifications to improve biocompatibility. Reactions of biomaterials with cellular and extra cellular components

Unit 3: Modified Biomaterials **No. of Hours: 10**

Biodegradative biomaterials, Bioactive polymers and biosynthetic polymers, inert biomaterials, genetically engineered biomaterials

Unit 4: Applications of Biomaterials **No. of Hours: 20**

Tissue Replacement Implants, Acute Wound Healing, Blood Clotting, Chronic Wound Healing and Foreign Body Response. Soft-tissue replacements, sutures, surgical tapes, adhesive, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal Fractures fixation devices, joint replacements. Artificial Organs Artificial Heart, Prosthetic cardiac Valves, Limb prosthesis, Externally Powered limb, prosthesis, Dental Implants, Other applications. Liposomes, hydrogels and Nanomaterials in drug delivery. Biomaterials in diagnostics and bioanalytical techniques.

SUGGESTED READINGS

1. S V. Bhat. Biomaterials, 2nd Ed., Narosa Publishing House, New Delhi 2006)
2. BD. Ratner, AS. Hoffman, FJ Schoen & JE Lemons. Biomaterials Science: An Introduction To Materials In Medicine, 2nd Ed., Academic Press. 2004
3. FW Billmeyer, Text book of Polymer Science, John Wiley & sons publications, 1994
4. B.G. Katsung, Basic & Clinical Pharmacology. 10th Ed., McGraw-Hill 2007

SEMESTER – V/VI
DSE-7: BIOMATERIALS (PRACTICALS)

TOTAL HOURS: 60 **CREDITS: 2**

1. Understand and follow guidelines regarding biological safety and maintain a laboratory notebook that follows the guidelines given in class. Prepare a laboratory report
2. Demonstrate aseptic cell culture techniques
3. Perform transformation into a bacterial cell
4. Describe and demonstrate basic concepts and examples of biomedical signal and image processing, biomaterials, biomechanics, and cellular and molecular biotechnology
5. Perform literature search
6. Prepare a scientific poster
7. Collect, analyze, and interpret physiological measurements
8. Visit to a R&D section of a leading Pharmaceutical company/ surgical theatre of Hospital. Prepare a laboratory report

SEMESTER – V/VI

DSE-8: MICROBIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1: History of Microbiology and Classification **No. of Hours: 6**

History of development of microbiology as a discipline, Spontaneous generation versus biogenesis, development of various microbiological techniques, concept of fermentation, establishment of fields of medical microbiology, immunology and environmental microbiology Molecular methods of assessing microbial phylogeny- molecular chronometer, phylogenetic trees, rRNA, DNA and proteins as indicator of phylogeny. Major Divisions of life- Domains, Kingdoms.

Unit 2: Microbial Nutrition and Growth **No. of Hours: 8**

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of 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; activity, use of physical methods (heat, low temperature, filtration, radiation)and chemical agents (phenolics, halogens, heavy water, sterilization gases).

Unit 3: Microbial Cell organization and Microbial Genetics **No. of Hours: 13**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, fimbriae and pili; Cell-wall: Composition and detailed structure of Gram positive and Gramnegative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS) and protoplasts. Effect ofantibiotics and enzymes on the cell wall; 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. Bacterial recombination: general and site specific and replicative; Bacterial plasmids - fertility factor, col plasmid; Bacterial conjugation- (Hfr, F`, F+ X F-); Transformation; Transduction- generalized and specialized.

Unit 4: Viruses **No. of Hours: 10**

Induction - general properties of viruses; Structure of viruses - viral envelopes and enzymes; Isolation, purification and cultivation of viruses; Viral Taxonomy; Bacteriophages - diversity, classification, lytic and lysogenic phages; Viral multiplication and replication strategies – replication and transcription in DNA viruses-Influenza virus, reteroviruses-HIV; Viroids, Virusoids and Prions

Unit 5: Food and Industrial Microbiology **No. of Hours: 11**

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. Microbiological processes in industry; Basic design of fermenter –

continuous and discontinuous; treatment of waste water (Municipal treatment plant) and sewage; Preparation of wine, beer, cheese; Single cell proteins.

Unit 6: Microbial diseases of plants and animals and Antimicrobial Chemotherapy

No. of Hours: 12

Introduction to diseases caused by microbes; Bacterial diseases; Protozoan diseases; Helminthic diseases; fungal diseases. Range of activity and mechanism of action of antibiotics-sulfa drugs, penicillin, aminoglycosides, quinolones, cyclosporine, tetracycline and macrolides.

SUGGESTED READINGS

1. J Willey, L. Sherwood & C. Woolverton, Prescott's Microbiology,. 7th Ed., McGraw Hill international, 2007
2. MJ Chan, ECS Krieg & NR Pelczar, Microbiology, McGraw Hill International, 1986
3. M. Madigan, J.Martinko & J.Parkar, Brock Biology of microorganisms, 12th Ed., Pearson Education International. 2009

SEMESTER – V/VI
DSE-8: MICROBIOLOGY (PRACTICALS)

TOTAL HOURS: 60 **CREDITS : 2**

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 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.

SEMESTER – V/VI
DSE-9: PLANT BIOCHEMISTRY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1: Introduction to Plant Cell Structure **No. of Hours: 4**
Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes.

Unit 2; Photosynthesis and Carbon Assimilation **No. of Hours: 14**
Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration.

Unit 3: Respiration **No. of Hours: 12**
Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.

Unit 4: Nitrogen Metabolism **No. of Hours: 14**
Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by Glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

Unit 5: Regulation of Plant growth and Secondary Metabolites **No. of Hours: 8**
Introduction to plant hormones and their effect on plant growth and development, regulation of plant morphogenetic processes by light. Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.

Unit 6: Plant Tissue Culture **No. of Hours: 4**
Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.

SUGGESTED READINGS

1. C Bowsher, M Steer, A Tobin, Plant Biochemistry, Garland Science 2008
2. B.B.Buchanan, W. Gruissem and R.L. Jones. Biochemistry and Molecular Biology of Plants, 2nd Ed. Wiley ,2015
3. P.M Dey and J.B. Harborne, Plant Biochemistry, Academic Press, 1997

SEMESTER – V/VI
DSE-9: PLANT BIOCHEMISTRY (PRACTICALS)

TOTAL HOURS: 60 **CREDITS: 2**

1. Induction of hydrolytic enzymes proteinases /amylases/lipase during germination
2. Extraction and assay of Urease from Jack bean
3. Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables
4. Separation of photosynthetic pigments by TLC
5. Culture of plant plants (explants).

B.Sc. (HONOURS) BIOLOGICAL SCIENCES

SKILL ENHANCEMENT COURSES

S.No.	Code	Title
1	SEC-1	Medical Botany
2	SEC-2	Biofertiizers
3	SEC-3	Medical Diagnostics
4	SEC-4	Public Health and Management
5	SEC-5	Biochemical Techniques
6	SEC-6	Recombinant DNA Technology

SEMESTER – III/IV
SEC-1: MEDICINAL BOTANY

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1: History, Scope and Importance of Medicinal Plants **No. of Hours: 10**
Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit 2: Conservation of Endangered and Endemic Medicinal Plant **No. of Hours: 10**
Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant. Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 3: Ethnobotany and Folk Medicines **No. of Hours: 10**
Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. Folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases.

SUGGESTED READINGS

1. Trivedi P C,. Medicinal Plants: Ethnobotanical Approach, Agrobios, 2006
2. Purohit and Vyas,. Medicinal Plant Cultivation: A Scientific Approach, 2nd edition. Agrobios, 2008

SEMESTER – III/IV
SEC-2: BIOFERTILIZERS

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1: Introduction **No. of Hours: 4**
General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

Unit 2: Azospirillum **No. of Hours: 8**
Isolation and mass multiplication – carrier based inoculant, associative, effect of different microorganisms.Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.

Unit 3: Cyanobacteria (blue green algae) **No. of Hours: 4**
Azolla and Anabaena azollae association, nitrogen
fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.

Unit 4: Mycorrhizal Association **No. of Hours: 8**
Types of mycorrhizal association, taxonomy, occurrence and
distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5: Organic Farming **No. of Hours: 6**
Green manuring and organic fertilizers, Recycling of biodegradable, municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field application.

SUGGESTED READINGS

1. Dubey, R.C., A Text book of Biotechnology S.Chand & Co, New Delhi, 2005
2. Kumaresan, V., Biotechnology, Saras Publications, New Delhi, 2005
3. John Jothi Prakash, E.. Outlines of Plant Biotechnology. Emkay Publication, New Delhi, 2004
4. Sathe, T.V. Vermiculture and Organic Farming. Daya publishers, 2004
5. Subha Rao, N.S., Soil Microbiology, Oxford & IBH Publishers, New Delhi, 2000
6. Vayas,S.C, Vayas, S. and Modi, H.A. Bio-fertilizers and organic Farming Akta Prakashan, Nadiad, 1998

SEMESTER – III/IV
SEC-3: MEDICAL DIAGNOSTICS

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1: Biomedical Basis of Diseases **No. of Hours: 10**

Infectious diseases (Bacterial, Viral, Protozoan); Inherited/genetic diseases (Diabetes, Hypertension); Immunological diseases [Autoimmune hemolytic anemia (AHA), Di George's Syndrome, Systemic Lupus Erythematosus (SLE)]; Cancer- Nature/ types; Treatment How pathogenesis relates to symptoms, diagnosis and treatment.

Unit 2: Analytical Technology **No. of Hours: 10**

Brief and relevant description of the following Wet techniques: UV Chromatography Methods- LC, HPLC and GC-MS Nuclear Magnetic Resonance Spectroscopy (NMR) Atomic Force and Scanning Electron Microscopy (AFM and SEM) Electrochemistry Molecular Modeling and Chemical Databases

Unit 3: Diagnostic Methods **No. of Hours: 10**

Outline methods used in hospital histopathology, biochemistry, haematology and microbiology laboratories, and apply some of these in the laboratory. Theoretical Knowledge- ECG, Echo, X-ray, CT, MRI, Ultrasound

SUGGESTED READINGS

1. Daniel W.W. Biostatistics-A Foundation for Analysis in the Human Health, 9th Edition, John Wiley & Sons, 2009
2. Robbins S.L. Pathological basis of Disease. W B Saunders Company, 1974
3. Macleod J.: Davidson's Principles & Practice of Medicine: A textbook for students and doctors' 14th Edition. Churchill Livingstone, 2013
4. Guyton A.C. and Hall J.E. Textbook of Medical Physiology 11th edn. Saunders, 2006
5. Hage D S and Carr J D, Analytical Chemistry & Quantitative Analysis, Prentice Hall, 2010
6. Berg J.M., Tymoczko J.L., Stryer L. Biochemistry, 5th edn. W.H. Freeman & Co. 2002
7. Brant W.E. and Helms C.A. Fundamentals of Diagnostic Radiology, 3rd edn. Lippincott Williams &Wilkins, 2007

SEMESTER – III/IV
SEC-4: PUBLIC HEALTH AND MANAGEMENT

TOTAL HOURS: 30 **CREDITS: 2**

Unit I: Introduction to Public Health and Management **No. of Hours: 3**
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 **No. of Hours: 9**
Air, water, noise pollution sources and effects

Unit 3: Waste Management and Hazards **No. of Hours: 8**
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.

Unit 4: Diseases **No. of Hours: 10**
Social and economic factors of disease including role of health services and other organizations: Infectious (Bacterial-Tuberculosis, Typhoid; Viral- AIDS, Poliomyelitis, Hepatitis; Protozoan- Leishmaniasis, Malaria); Lifestyle and Inherited/genetic diseases, Immunological diseases; Cancer; Diseases impacting on Western versus developing societies.

SUGGESTED READINGS

1. Cutter, S.L. Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi. 1999
2. Kolluru R., Bartell S., Pitblado R. and Stricoff, S., Risk Assessment and Management Handbook. McGraw Hill Inc., New York. 1996
3. Kofi, A.D., Risk Assessment in Environmental management, John Wiley and sons, Singapore, 1998.
4. Joseph, F. L. and Louver, B.D., Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey. 1997

SEMESTER – III/IV
SEC-5: BIOCHEMICAL TECHNIQUES

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1: Spectroscopic Techniques **No. of Hours: 8**

Principle of UV-Visible absorption spectrophotometry, instrumentation and applications, Flourimetry: Phenomena of fluorescence, intrinsic and extrinsic fluorescence, instrumentation and applications

Unit 2: Chromatography **No. of Hours: 8**

Basic principles of chromatography: Partition coefficient, concept of theoretical plates, various modes of chromatography (paper, thin layer, column), preparative and analytical applications, LPLC and HPLC. Principle and applications of: Paper Chromatography, Thin Layer Chromatography. Molecular Sieve Chromatography, Ion Exchange Chromatography, Affinity Chromatography

Unit 3: Electrophoresis **No. of Hours: 8**

Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native and denaturing gels. Agarose gel electrophoresis, buffer systems in electrophoresis. Electrophoresis of proteins and nucleic acids, protein and nucleic acid blotting, detection and identification. Molecular weight determination, Isoelectric Focusing of proteins

Unit 4: Centrifugation **No. of Hours: 6**

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges, different types of rotors, differential centrifugation, density gradient centrifugation (Rate zonal and Isopycnic)

SUGGESTED READINGS

1. Freifelder, D., Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd ed., W.H. Freeman and Company (New York). 1982
2. Plummer D. T, An Introduction to Practical Biochemistry, 3rd ed.,., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), 1998

SEMESTER – III/IV
SEC-6: RECOMBINANT DNA TECHNOLOGY

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1: Introduction to Recombinant DNA Technology **No. of Hours: 6**
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 **No. of Hours: 8**
Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids, pBR322, pUC8, pGEM3Z. Joining of DNA fragments: **l**igation of DNA molecules. DNA ligases, sticky ends, blunt ends, linkers and adapters.

Unit 3: Introduction of DNA into Cells **No. of Hours: 8**
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 **No. of Hours: 8**
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.

SUGGESTED READINGS

1. Brown, T.A., Gene Cloning and DNA Analysis, 6th ed.,., Wiley-Blackwell publishing (Oxford), 2010.
2. Primrose, S.B., and Twyman, R. M., Principles of Gene Manipulation and Genomics, 7th ed., Blackwell publishing (Oxford), 2006
3. Glick B.R., Pasternak, J.J. and Patten, C.L., Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th ed., ASM Press (Washington DC)