

REVISED IN BOS MEETING HELD ON 30.09.2016

Department of Botany

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CHOICE-BASED CREDIT SYSTEM (CBCS)

*Scheme and course structure to be implemented from  
Academic Session 2015 onwards*

Course Code	Name of the Paper	Paper Category	IA	SE	Total Marks	Course Credits
<b>SEMESTER-I</b>						
MFC-001	Foundation Course	Foundation	50	150	200	6
MBO-101	Molecular Biology	Open Elective	25	75	100	4
MBO-102	Systematics of Cryptogams	Core	25	75	100	4
MBO-103	Systematics of Phanerogams	Core	25	75	100	4
MBO-104	Lab Course I (based on MBO-101, 102 & 103)	Core	25	75	100	7
<b>SEMESTER-II</b>						
MBO-201	Plant Physiology	Core	25	75	100	4
MBO-202	Plant Ecology	Core	25	75	100	4
MBO-203	Inheritance Biology	Core	25	75	100	4
MBO-204	Biostatistics & Bioinformatics p	Open Elective	25	75	100	4
MBO-205	Lab Course II (based on MBO-201,202,203 & 204)	Core	50	150	200	9
<b>SEMESTER-III</b>						
MBO-301	Molecules and their Interactions	Core	25	75	100	4
MBO-302	Developmental and Structural Botany	Core	25	75	100	4
MBO-303	Genetic Engineering	Core	25	75	100	4
MBO-304	Bioinstrumentation	Open Elective	25	75	100	4
MBO-305	Lab Course III (based on MBO-301,302, 303 & 304)	Core	50	150	200	9
<b>SEMESTER-IV</b>						
MBO-401	Plants and Environment	Discipline Centric Elective	25	75	100	4
MBO-402	Plant Diversity, Resource Utilization and Conservation	Core	25	75	100	4
MBO-403	Plant Tissue Culture & Microbiology	Core	25	75	100	4
MBO-404	Project based on review work	Core	25	75	100	4
MBO-405	Lab Course IV (based on MBO-401, 402 & 403)	Core	50	150	200	9

*For Open Elective papers, candidate has to compensate for the required credits per semester (25) if he/she chooses the elective paper from any other Department of Science Faculty.*

**UNIT-I: CHEMISTRY****Essential**

- Solution – Methods of expressing the concentration (Molality, Molarity, Normality etc). Colligative properties, Molecular mass determination using colligative properties, basics of Nanotechnology.
- Rate of reaction, order of reaction, molecularity of reaction.
- Ionic or Electrovalent bond, Covalent bond, Types of overlapping and nature of covalent bonds, Hybridization, examples of  $sp^3$ ,  $sp^2$  and  $sp$  Hybridization, Co-ordination bond, Hydrogen bonding.
- Principle of Chromatography, Classification of chromatographic techniques, TLC and paper chromatography, Application of chromatography
- Basics of Spectroscopy and applications.

**Desirable**

- Laws of mass action, Reaction Quotient, Chemical equilibrium constant, Relation of  $K_p$  &  $K_c$ , pH, buffer, buffer index, buffer capacity, Arrhenius equation & Nanotechnology.
- Principles and applications of GC, HPLC, Ion exchange and Size exclusion chromatography
- Principles of UV/VIS, IR and NMR Spectroscopic techniques and applications
- Synthesis and applications of Nanoparticles

**UNIT-II: BIOCHEMISTRY****Essential**

- **Biomolecules** : Carbohydrates, amino acids/proteins, lipids and nucleotides; Enzymes: Characteristics and nomenclature.
- **Cell Biology & Microbiology** : Prokaryotes & Eukaryotes; The cell and its composition; Cell organelles and subcellular fractionation; Viruses, Viroids, Virusoids and Prions; Bacterial culture and growth curve.
- **Bioenergetics and Intermediary Metabolism** : ATP as energy currency; Intermediary metabolism;
- **Immunology** - Active, passive, Humoral and Cellular immunity; Clonal selection theory; Cells of immune system; Immunoglobulins; Haptens, Antigens and Immunogens; Monoclonal & Polyclonal antibodies.

**Desirable**

- **Gene transfer Mechanisms in bacteria & Gene expression** : Conjugation, Transformation and Transduction; expression of eukaryotic genes in prokaryotes.
- **Clinical Biochemistry** : Biochemical tests; Quality assurance; Acid base disorders; Liver function test; Kidney function tests.
- **Glucose Metabolism** - Glycolysis and TCA cycle; oxidative phosphorylation; Aerobic & anaerobic Fermentation.
- **Hybridoma technology**.

### UNIT–III: BOTANY

#### Essential

- **Biodiversity** – Concept, levels and Conservation of biodiversity
- **Climate Change** – Consequence, CO<sub>2</sub> fertilization, global warming, sea level rise, UV radiation.
- **Ecosystem** - Producers, consumers and decomposers of food chain.
- **Natural Resources** - Renewable and non-renewable resources of energy.
- Plant drugs and their constituents used in allopathic system of medicine.

#### Desirable

- **Environment** - International efforts and India initiatives in biodiversity conservation, Endemism, biodiversity hotspots; bioremediation, Bioindicators, green house gases (trend and role), ozone layer and ozone hole; Environmental pollution;
- Toxic and poisonous plants, Petrocrops and energy plantation
- Plant breeding and crop improvement (wheat, cotton, *Brassica*)

### UNIT–IV: BIOTECHNOLOGY

#### Essential

- **Genetics of Inheritance** - Laws of inheritance, recombination, segregation of traits, segregation ratio, interaction between traits and quantitative inheritance.
- **Molecular Biology** - The genetic material, RNA as genetic material, fidelity of DNA replication, transcription, translation, gene regulation. Mutation and mutagenesis, Ames test, Transposons.
- **Genetic Engineering** - Essentials of gene manipulation, vectors & enzymes used in recombinant technology.

#### Desirable

- **Applications** - Stem cell research application, disease tolerant plants, insecticide and herbicide tolerant plants, increasing the shelf life of vegetables and fruits, improvement in quality (golden rice) and quantity of produce.
- **Biotech and Society** - Apprehensions for GM crops-effect on ecosystem, development of tolerance, loss of genetic base, loss of diversity, IPR concerns, adaptation, judicious implementation.

### UNIT–V: TOXICOLOGY

#### Essential

- **Introduction to Toxicology :**
  - (i) Various types of toxicity (Acute, subacute, subchronic and chronic).
  - (ii) Chemical interactions (Additive effect, potentiation, synergism and antagonism), Dose response relationship (ED<sub>50</sub>, LD<sub>50</sub>, EC<sub>50</sub>, LC<sub>50</sub>.)
  - (iii) Routes of exposure, absorption, distribution, elimination. In vitro and in vivo models in toxicological studies.
- **Metabolism of Xenobiotics** : Common toxicants of air, water & food –metabolism & their impact on human health.
- Concept and requirement of Good Laboratories Practices (GLP), GMP, GCP.

#### Desirable

- Tumor Markers
  - Chemical carcinogenesis & dietary intervention
  - Enzyme inhibito
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**UNIT – I**

- DNA, RNA as genetic materials, Physical and chemical structure of DNA, A, B and Z form of DNA [4 Lectures]
- Mechanism of DNA replications, replication origin and fork, various enzymes involved and their role in maintaining fidelity of replication [4 Lectures]
- DNA damage and DNA repair mechanisms [2 Lectures]
- Structure and function of different types of RNAs, transcription units, RNA polymerases [2 Lectures]
- **Transcription (Prokaryotes and Eukaryotypes):** Initiation complex formation and initiation factors, regulation; Elongation and elongation factors; Termination of transcription; RNA processing and editing [4 Lectures]

**UNIT – II**

- **Mechanism of translation:** tRNA and its aminoacylation, aminoacyl tRNA synthetase, Translational proof reading, Post translational modification of proteins [6 Lectures]
- Genetic code [2 Lectures]
- Regulation of gene expression in prokaryotes (e.g. lactose and tryptophan operons) and in eukaryotes [6 Lectures]

**UNIT – III**

- **Cell membrane:** Structure, lipid bilayer and membrane protein models, Function of cell membrane [6 Lectures]
- **Cell wall:** Ultra-structure and function of cell wall [4 Lectures]
- Structure and function of cytoskeletons [4 Lectures]

**UNIT – IV**

- Ultra-structure and function of Plastids, Endoplasmic reticulum, Mitochondria, Golgi apparatus, Lysosomes, Peroxisomes, and Glyoxysomes, Ribosomes [10 Lectures]
- Genomes of mitochondria and chloroplast [2 Lectures]
- **Cell cycle:** Phases of cell cycle, Role of cyclins, cyclin dependent kinases, regulation of cell cycle [4 Lectures]

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**SUGGESTED READINGS**

1. Alberts B, Bray D, Lewis J, Raff M, Roberts K & Watson JD (1989). **Molecular Biology of the Cell**, Garland Publishing Inc., New York.
2. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D & Darnell J (2000). **Molecular Cell Biology**. W.H. Freeman and Co., New York, USA.
3. Richard M, Twyman & Wisden W (1999). **Advanced Molecular Biology**, Viva Books Pvt. Ltd.
4. Turner PC, Mclennan AG, Bates AD & White MRH (2001). **Instant Notes on Molecular Biology**, Viva Books Pvt. Ltd.
5. Benjamin Lewin (2007). **Genes IX**, Prentice Hall.
6. Brown WV & Berke MB (1974). **Text Book of Cytology**, Blackstains Sons & Co.
7. Brachet J & Mirsky AE (1959). **The Cell**, Academic Press, Vols. 16.
8. DeRobertis EDP & De Robertis EMF (2001). **Cell and Molecular Biology**, Lippincott Williams & Wilkins, Bombay.
9. Sharma AK & Sharma A (1980). **Chromosome Techniques**. Theory and Practice, Butterworth.
10. Roy SC & Kumar KDC (1977). **Cell Biology**, New Central Book Agency, Calcutta.
11. Wolfe SL (1993). **Molecular and Cellular Biology**, Wordsworth Publ. Co., California, USA.

**UNIT – I**

- Algal habitats; Reserve food, thallus organization, pigments and evolutionary trends among algae; Algal classification as per Smith, Fritsch, Bold and Wyne and Christensen [6 Lectures]
- Cell organization, thallus type, asexual reproduction, heterocyst and interrelationships of Cyanophyta, Chlorophyta, Charophyta, Phaeophyta and Rhodophyta [8 Lectures]

**UNIT – II**

- Outline classification of fungi as per Smith, Ainsworth et al., Alexopoulos, Mims and Blackwell [2 Lectures]
- Habit or modes of life of fungi; Thallus organization, nutrition-saprotrophs, biotrophs, necrotrophs, symbiotrophs and evolutionary trends among fungi [2 Lectures]
- Asexual and sexual methods of reproduction in fungi; Evolution of sex in fungi; Heterothallism; Parasexuality and compatibility; Fungal sex hormones [2 Lectures]
- Comparative account of thallus structure and spore producing organs, interrelationship, life cycle pattern and phylogeny of Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina [8 Lectures]

**UNIT – III**

- Habit and Habitat, Distribution & Outline classification of Bryophytes [4 Lectures]
- Morphology and anatomy of vegetative and reproductive structures of Hepaticopsida, Anthocerotopsida and Bryopsida [10 Lectures]

**UNIT – IV**

- General characters of pteridophyte; Classification of pteridophytes [2 Lectures]
- Origin of the pteridophyte; Plant body organization; Telome theory; Gametophyte and sporophyte; Alternation of generation [6 Lectures]
- Stellar system in pteridophytes [2 Lectures]
- Eusporangiate and leptosporangiate sporangia; Heterospory and seed habit; Biological importance of heterospory [4 Lectures]

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**SUGGESTED READINGS**

1. Kumar HD (1988). **Introductory Phycology**. Affiliated East-West Press Ltd., New Delhi.
2. Morris J (1986). **An Introduction to the Algae**. Cambridge University Press, U.K.
3. Round FE (1986) **The Biology of Algae**. Cambridge University Press, U.K.
4. Alexopoulos CJ, Mims CW & Blackwell M (1996). **Introductory Mycology**. John Wiley & Sons.
5. Webster J (1985). **An Introduction to Fungi**: by Cambridge Univ. Press.
6. Parihar NS (1996). **The Biology and Morphology of Pteridophytes**. Central Book Depot, Allahabad.
7. Puri P (1980). **Bryophytes**. Atma Ram & Sons, New Delhi.
8. Sporne KR (1991). **The Morphology of Pteridophytes**. B.I. Publ. Pvt. Ltd.

**UNIT – I**

- Habit, Habitat, Distribution, Plant body organization, Life cycle pattern of Gymnosperms [2 Lectures]
- Comparative account of systems of classification of Gymnosperms [2 Lectures]
- Comparative account of structure of sporophyte and gametophyte of Cycadales, Ginkgoales, Coniferales, Gnetales, Ephedrales, Welwitschiales [7 Lectures]
- Indian contribution in the field of paleobotany [1 Lectures]
- Gymnosperm as prospective ancestor of angiosperms [2 Lecture]

**UNIT-II**

- **Plant Systematics:**– Aims and Principles, Definitions of the terms systematics, taxonomy, evolution, classification, identification, nomenclature and phylogeny. Historical background of angiosperm classification with special reference to Linnaeus and Bentham and Hooker's classification. A comparison of Pre-Darwinian and Post-Darwinian classifications. Brief outline and relative merits and demerits of Hutchinson, Takhtajan and Cronquist's system of classification [14 Lectures]

**UNIT-III**

- **Evolutionary taxonomy:** The concept of primitive and advance characters, monophyly and polyphyly, parallelism and convergence, homology and analogy. Phenetic versus phylogenetic (cladistic) methods. Salient features and outline of Angiosperms Phylogeny Group (APG) system of plant classification [8 Lectures]
- **The species concept:** Taxonomic hierarchy, species, genus, families and other categories [4 Lectures]
- **Plant Nomenclature:** History of ICBN, principles of nomenclature, important rules (Rank of taxa, Nomenclatural types, Priority of publication, Effective and valid publication, author citation, Name changes etc.). Introduction to proposed phylocode and Biocode [4 Lectures]

**UNIT-IV**

- Phytogeography and terminology of plant description [2 Lectures]
- **Systematic evidence:** Contribution of palynology, embryology, phytochemistry, molecular systematics and taxometrics to systematics [6 Lectures]
- **Resources in plant systematics:** Plant collection and herbarium techniques. Botanical gardens, Herbaria and Taxonomic literature [4 Lectures]
- Flora of Delhi (General Account) [2 Lectures]

**SUGGESTED READINGS**

1. Daniel, M. (2009). Taxonomy: Evolution at Work. Narosa Publishing House, New Delhi
2. David, P.H. & Heywood, V.H. (1963). Principles of Angiosperm Taxonomy: Oliver and Boyd, London.
3. Jones, S.B. Jr. & Luchinger, A.E. (1986). Plant Systematics. 2<sup>nd</sup> Ed. McGraw-Hill Book, New York.
4. Judd, W.S., Campbell, C.S., Kellogg, E.A. & Stevens, P.F. (1999). Plant Systematics: A Phylogenetic Approach. Sinauer Associates, Inc. Sunderland, M.A., USA.
5. Naik, V.N. (1984). Taxonomy of Angiosperms. Tata McGraw-Hill, New Delhi.
6. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, New York.
7. Singh, Gurcharan (2007). Plant Systematics. Oxford & IBH Publishing Co, New Delhi.
8. Stace, C.A. (1989). Plant Taxonomy and Biosystematics. 2<sup>nd</sup> Ed. Edward Arnold, London.
9. Sporne KR (1965). The Morphology of Gymnosperms. Hutchinson Univ. Library

**ALGAE**

Morphological study (through section cutting and permanent slides) of representative members of Algae

**FUNGI**

Identification of fungi – Pathological anatomy of white rust, powdery mildew, rusts, smuts, tikka disease of groundnut and paddy blast

**BRYOPHYTES**

Morphological study (through section cutting and permanent slides) of representative members of bryophytes

**PTERIDOPHYTES**

Observation of morphological, anatomical and reproductive structures of representative members of Pteridophytes

**GYMNOSPERMS**

Observation of morphological, anatomical (through C.S., RLS & TLS) and reproductive structure of gymnosperms

**PLANT TAXONOMY**

- Description of a specimen from representative (locally available) families.
- Description of a specimen to study intraspecific variation and a collection exercise.
- Description of various species of a genus, location of key characters and preparation of keys at generic level.
- Location of key characters and use of keys at family level.
- Field trips within and nearby areas in the campus, compilation of field notes and preparation of herbarium sheets of such plants wild or cultivated that are abundant.
- Training in using floras and herbarium for identification of specimens described in the class.

**UNIT – I**

- Uptake, transport and translocation of water and nutrients by plants. Ascent of sap and transpiration **[6 Lectures]**
- Essential nutrients, deficiencies and plant disorders **[4 Lectures]**
- Physiology of assimilation of nitrate and ammonium, biological nitrogen fixation **[4 Lectures]**

**UNIT – II**

- General concepts of photosynthesis, photosynthetic pigments, light harvesting complexes, mechanisms of photosynthetic electron transport (non cyclic and cyclic), photoprotective mechanisms **[6 Lectures]**
- The carbon cycle, photorespiration and its significance, C<sub>4</sub> and CAM pathways and their physiological and ecological significance **[6 Lectures]**
- Translocation of photosynthates by phloem, phloem loading and unloading **[2 Lectures]**

**UNIT – III**

- History of discovery of phytochromes, structure and function of phytochrome, phytochrome induced plant responses **[5 Lectures]**
- Cryptochrome and its role in photomorphogenesis **[3 Lectures]**
- Photoperiodism and its significance, flowering stimulus, vernalization, endogenous clock and its regulation **[6 Lectures]**

**UNIT – IV**

- Plant growth regulators: Physiological effects and mode of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, jasmonic acid and salicylic acid **[8 Lectures]**
- Overview of Signal transduction, G-proteins, and secondary messengers **[3 Lectures]**
- Stress physiology: Water deficit and its physiological consequences, drought tolerance mechanisms, salinity stress and plant responses, heat stress and heat shock proteins, metal toxicity **[6 Lectures]**

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**SUGGESTED READINGS**

1. Devlin RM & Witham FH (1986). **Plant Physiology**. CBS Pubs. and Distributors, New Delhi.
2. Hopkins WG (1995). **Introduction to Plant Physiology**, John Wiley & Sons. Inc., New York, USA.
3. Moore TC (1989). **Biochemistry and Physiology of Plant Hormones**. Springer Verlag, New York, USA.
4. Singhal et al. (1999). **Concepts in Photobiology, Photosynthesis and Phytomorphogenesis**, Narosa Pub. House, N. Delhi.
5. Taiz & Zeigler (2006). **Plant Physiology 4<sup>th</sup> Edn**. Sinauer Associates Inc., Publishers, Sunderland.
6. Mengel K & Kirkby EA (2001). **Principles of Plant Nutrition**. Kluwer Academic Press
7. Salisbury FB & Celon W (1986). **Plant Physiology 3<sup>rd</sup> Edn**. CBS Publishers, New Delhi.



**UNIT – I**

- **The nature of ecology:** Biotic and abiotic components of environment and their interactions [2 Lectures]
- **Habit and niche:** Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement [6 Lectures]
- **Population ecology:** Characteristics of a population; population growth curve; population regulation; life history strategies (r and k selection) [6 Lectures]

**UNIT – II**

- **Ecological succession:** Types; mechanism; changes involved in succession. Sere (hydrosere, xerosere, mesosere) concept of climax [4 Lectures]
- **Dynamic phytogeography:** Basic principles, age and area theory, centre of origin theory, endemism, plant migration and continental drift [4 Lectures]
- **Biome:** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India [6 Lectures]

**UNIT – III**

- **Ecosystem:** Structure and function, energy flow and mineral (CNP) and water cycling; Biogeocenoses [6 Lectures]
- **Ecological management:** Natural resources, concept of sustainable development. Conservation of natural resources [6 Lectures]
- The biosphere as man's environment [2 Lectures]

**UNIT – IV**

- Concept of soil, origin, nature and classification of parental material.
- Factors affecting weathering of rocks
- The soil profile and its layer
- Inorganic and organic soils, soil and plant relations

**SUGGESTED READINGS**

1. Pierzynski GM, Sims JT & Vance GF (2005). Soils and Environmental Quality. CRC, London.
2. Perk M (2006). Soil and Water Contamination from Molecular to Catchment Scale. Taylor & Francis. The Netherlands.
3. Coley D (2008). Energy & Climate Change. John Wiley & Sons, London.
4. Itanez JG, Hernandez-Esparza M, Doria-Serano C, Fregoso-Infante A & Singh MM (2007). Environmental Chemistry, Fundamentals. Springer.
5. Suresh G (2007). Environmental Studies and Ethics. IK International, New Delhi.
6. Odum EP & Barrett GW (2005). Fundamentals of Ecology. V Edn, Thomson Asia, Pvt. Ltd.
7. Chapman JL & Reiss MJ (1995). Ecology Principles & Applications. Cambridge University Press.
8. Brady, NC, The nature and properties of soils, Prentice, Hall of India Pvt. Ltd.

**UNIT – I**

- **Mendelian Inheritance:** Principle of Mendelian Inheritance, dominance, independent assortment, segregation [2 Lectures]
- **Concept of gene:** Allele, multiple alleles, pseudoallele, complementation tests [4 Lectures]
- **Extension of Mendelian principles:** Codominance, incomplete dominance, gene interactions, pleiotrophy [4 Lectures]
- Sex chromosome, sex determination, dosage compensation, sex linked characters [4 Lectures]

**UNIT – II**

- Linkage and Crossing over, molecular / genetic markers, Linkage / Chromosomal maps [4 Lectures]
- Recombination (homologous, nonhomologous), site specific recombination [6 Lectures]
- Extra chromosomal inheritance; Inheritance of mitochondrial and chloroplast genes, maternal inheritance [4 Lectures]
- Polygenic inheritance [2 Lectures]

**UNIT – III**

- Cytogenetics of Polyploids and Aneuploids; Autopolyploidy, origin, chromosome pairing and breeding behaviour, phenotypic effect [4 Lectures]
- Allopolyploids, origin, types, important allopolyploid plants, uses [4 Lectures]
- **Aneuploids:** monosomic, trisomic etc. and their uses [4 Lectures]

**UNIT – IV**

- **Mutation:** Mutation types, molecular basis of mutation, spontaneous and induced mutations, mutation induced by transposons (insertional mutagenesis), Somatic versus germinal mutants, physical and chemical mutagens, effect of mutagens on chromosomes/ DNA (loss and gain of function) [6 Lectures]
- Cancer at cellular level, protooncogenes/ oncogene, tumour suppressor genes [4 Lectures]
- Structural alterations of chromosomes; deletion, duplication, inversion, translocation etc [2 Lectures]
- Numerical alteration of ploidy and their implications [2 Lectures]

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**SUGGESTED READINGS**

1. Strickburger M (1990). **Genetics**. MacMillan Publishing Company, New York.
2. Gardner J (1991). **Principle of Genetics**. John Wiley & Sons, New York.
3. Klug WS & Cummings MR (1997). **Essential of Genetics**. Prentice Hall Publishing Co., New Jersey.
4. Brown T (1989). **Genetics: A Molecular Approach**. Chapman & Hall, London.
5. Goodenough U (1984). **Genetics**. Sandir College Publishing, Philadelphia.
6. Lewin, B. (2007). **Genes Vol. 9**. Oxford University Press.

**SECTION-A: BIOSTATISTICS****UNIT – I**

- Arithmetic mean, Median and Mode (Theory and simple numerical problem) **[2 Lectures]**
- **Measure of variation:** Standard deviation, variance, coefficient of variation, properties (Theory and simple numerical problems) **[4 Lectures]**
- **Correlation:** Types of correlation, methods of correlation, simple, multiple and linear and non linear correlation, spearman's correlation coefficient, Rank correlation (Theory and simple numerical problems) **[4 Lectures]**
- **Regression:** Linear regression, curvilinear regression (for two variables X and Y only), Regression lines by least square methods, Regression equations of X and Y and Y on X only (Theory and simple numerical problems) **[4 Lectures]**

**UNIT – II**

**Tests of significance:** Null hypothesis, standard error, level of significance, degrees of freedom, significance in mean for large samples, significance in means for small samples (student t-test)/Significance in ratio of two samples. F-test (for difference between variance of two samples), chi square test (simple numerical examples and theory), analysis of variance test (ANOVA) for one and two way classification. Signed rank test, Dunnet's t-test (Theory and numerical examples) **[14 Lectures]**

**SECTION-B: BIOINFORMATICS****UNIT – III**

- Introduction and type of databases **[2 Lectures]**
- **Primary nucleotide sequence databases** - EMBL, GeneBank, DDBJ **[2 Lectures]**
- **Secondary nucleotide sequence databases** - UniGene, SGD, EMI Genomes, Genome Biology **[4 Lectures]**
- **Protein sequence databases** - SwissProt/TrEMBL, PIR **[4 Lectures]**
- **Sequence motif databases** - Pfam, PROSITE **[2 Lectures]**

**UNIT – IV**

- **Sequence alignment and database searching** - PAM, BLOSUM, FASTA, BLAST, ClustalW, 3.2.3. PSI-BLAST, HHM based multiple-sequence alignment, SAM **[6 Lectures]**
- **Protein structure databases** - Protein Data Bank, SCOP, CATH **[4 Lectures]**
- **Other relevant databases** - KEGG, PQS, DockGround **[4 Lectures]**

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**SUGGESTED READINGS**

1. Daniel W (1977). **Biostatistics**, John Wiley, New York.
2. Gupta SP (1969). **Statistical Methods**, Sultan Chand & Sons, New Delhi.
3. Sundar Rao PSS & Richard J (1999). **An Introduction to Biostatistics. A Manual for Students in Health Sciences**, Prentice Hall of India Pvt. Ltd., New Delhi.
4. Khan, IA & Khanum, A (1994). **Fundamentals of Biostatistics**. Ukaaz Publications, Hyderabad.

## PLANT PHYSIOLOGY

- Estimation of chlorophyll 'a', chlorophyll 'b', carotenoid and total chlorophyll content in leaves
- Determination of water potential of plant leaves
- Determination of osmotic potential of cell sap by plasmolytic method
- In vitro assay of nitrate reductase enzyme

## PLANT ECOLOGY

- Determination of maximum size of quadrat (area-species curve) of the grassland ecosystem
- Determination of minimum number of quadrats required for grasslands
- Determination of frequency, density and cover
- Determination of Important Value Index (IVI)
- Analysis of soil texture, moisture content and water holding capacity
- Vulnerability factor and associated variables
- Measurement/Calculation of vulnerability factor

## INHERITANCE BIOLOGY

- Introduction and applications of chi-square test in Mendelian Genetics.
- Use of chi-square test to analyze Monohybrid and Dihybrid experiments of Mendel
- Genetic interactions and chi square test.
- Meiosis study of model plant, *Allium cepa*.
- Study of meiosis of translocation - a case study in *Rhoeo* sp.
- Effect of mutagen on chromosomes.

**UNIT-I**

- Structure of atoms, molecules and chemical bonds    **[4 Lectures]**
- Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding and hydrophobic interaction)    **[6 Lectures]**
- Principles of biophysical chemistry (pH and buffer, colligative properties)    **[3 Lectures]**

**UNIT-II**

- Enzymes, principles and mechanism of enzyme catalysis, enzyme kinetics, enzyme regulation, isozymes    **[7 Lectures]**
- Composition, structure and function of carbohydrates    **[2 Lectures]**
- Bioenergetics, glycolysis, TCA cycle, oxidative phosphorylation, chemiosmosis (coupled reaction), substrate level phosphorylation (group transfer), biological energy transducers (chloroplast and mitochondria)    **[7 Lectures]**

**UNIT-III**

- Composition, structure and function of proteins    **[4 Lectures]**
- Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains, motif and folds)    **[7 Lectures]**
- Stability of protein and nucleic acid structures and nucleotides    **[4 Lectures]**

**UNIT-IV**

- Composition, structure and function of lipids    **[6 Lectures]**
- Metabolism of lipids fatty acid synthesis and  $\beta$ -oxidation    **[3 Lectures]**
- Structure and functions of vitamins    **[5 Lectures]**

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**SUGGESTED READINGS**

1. Voet & Voet (1995). **Biochemistry 2<sup>nd</sup> Edn**, John Wiley & Sons, Inc., New York, USA.
2. Nelson DL & Cox MM (2000). **Lehninger Principles of Biochemistry**. Macmillan Worth Publishers, Madison Av., New York
3. White R et al. (1959). **Principles of Biochemistry 2<sup>nd</sup> Edn**, McGraw Hill Publications, NY.
4. Farago P & Lagnado J (1972). **Life in Action: An Introduction to Biochemistry**. Heinemann Publ, London.
5. Lehninger AL (1993). **Principle of Biochemistry**. CBS Publishers, New Delhi.
6. Cooper, A (2004). **Biophysical Chemistry**. Royal Society of Chemistry, Cambridge Publication.
7. Hames, BD, Hooper NM & Houghton JD (1998). **Instant Notes in Biochemistry**. Viva Books, New Delhi.

**UNIT – I**

- Genesis of reproductive organs in angiosperms [2 Lectures]
- **Male gametophyte:** Microsporogenesis, role of tapetum, pollen germination [4 Lectures]
- **Female gametophyte:** Structure and development of ovule, megasporogenesis, organization and structure of the embryo sac [4 Lectures]
- **Pollen-pistil interaction and fertilization:** Double fertilization; polyembryony and apomixes [4 Lectures]

**UNIT – II**

- Ultra structure and coordinated activity of different cell components [2 Lectures]
- Organization of the shoot apical meristem (SAM), Cytological and molecular analysis of SAM [4 Lectures]
- Control of tissue differentiation, especially xylem and phloem; Secretory ducts and laticifers [4 Lectures]
- Leaf growth and root apical meristem [4 Lectures]

**UNIT – III**

Origin and development of vascular cambium; Procambium-metacambium-cambium continuum; Cambial cytology, Cell division patterns: periclinal, anticlinal, transverse segmentation; Cambial ontogeny: size and relative proportions of cambial initials; Environmental factors influencing cambial periodicity; External regulation of cambial growth: role of hormones, sugar and water potential; Differentiation of young derivatives of the cambium [14 Lectures]

**UNIT – IV**

Comparative features of gymnospermous and angiospermous secondary phloem; phloem fibre distribution; Differentiation of secondary phloem with special emphasis on sieve tube elements; Morphology and chemistry of P-proteins; Factors affecting periderm formation; Differentiation of secondary xylem with special reference to vessel segments; Sapwood and heartwood: physical, structural and chemical properties; Reaction wood: tension wood and compression wood; Ecological wood anatomy [14 Lectures]

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**SUGGESTED READINGS**

1. Mahswari P (1950). **An Introduction to Embryology of Angiosperms.**
2. Bhojwani SS & Bhatnagar SP (2000). **Embryology of Angiosperms** (4<sup>th</sup> Revised and enlarged edition).
3. Burgess J (1985). **An Introduction to Plant Cell Development**, Cambridge University Press, Oxford.
4. Fahn A (1982). **Plant Anatomy** 3<sup>rd</sup> Edn, Pergamon Press, Oxford.
5. Esau, K. (1993). **Plant Anatomy**, Wiley Eastern Ltd.
6. Steeve TA & Sussex IM (1989). **Patterns in Plant Development**, 2<sup>nd</sup> Edn, Cambridge University Press, Cambridge.
7. Iqbal M (1995). **The Cambial Derivatives**, Gebrüder Borntraeger, Stuttgart, Germany.
8. Iqbal M (1994). **Growth Patterns in Vascular Plants**, Dioscorides Press, Portland, USA.
9. Iqbal M (1990). **The Vascular Cambium**, R.S.P., Taunton, UK.
10. Larson PR (1995). **The Vascular Cambium**, Springer Verlag, Heidelberg, Germany.

**UNIT – I**

- Principle of electrophoresis [4 Lectures]
- General technique, and Operational procedure of gel electrophoresis [4 Lectures]
- Native, Denaturing, Isoelectric focusing, 2D gel Electrophoresis [4 Lectures]
- Rotors, Bench top, Low speed, High speed, Cooling Ultracentrifuge [2 Lectures]

**UNIT – II**

- Principle and application of gel filtration [4 Lectures]
- Principle and application of ion Exchange chromatography [4 Lectures]
- Principle, instrumentation and application of High Performance Liquid Chromatography [2 Lectures]
- Principle, instrumentation and application of gas chromatography [2 Lectures]
- Principle, instrumentation and application of thin layer chromatography [2 Lectures]

**UNIT – III**

- Principle and application of UV/visible Spectrophotometer [5 Lectures]
- Principle and application of Circular dichroism spectrometer [3 Lectures]
- Principle and application of Atomic absorption spectrometer and Flame photometer [4 Lectures]
- Different types of mass spectrometry and surface plasma resonance methods [2 Lectures]

**UNIT – IV**

- Resolving powers of different microscopes; Visualization of cells and sub-cellular components by light microscopy [2 Lectures]
- Scanning and transmission microscopes [4 Lectures]
- Microtomy; Different fixation and staining techniques for EM [4 Lectures]
- Freeze-etch and freeze-fracture methods for EM [2 Lectures]
- Image processing methods in microscopy [2 Lectures]

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**SUGGESTED READINGS**

1. Snyder LR (1968). **Principles of Adsorption Chromatography: The Separation of Nonionic Organic Compund**. Marcel Dekker Publ, New York.
2. Wildon K & Walker J (2000). **Practical Biochemistry: Principles and Techniques 5<sup>th</sup> Edn**, Cambridge University Press.
3. Skoog, DA, Holler FJ & Timothy N (1998). **Principles of Instrumental Analysis 5<sup>th</sup> Edn**. Sauders College Publishing.
4. Wise DL (1991). **Bioinstrumentation and Biosensors**. Marcel Dekker, New York.
5. Clark BT, Frost T & Russell MA (1993). **UV Spectroscopy: Techniques, Instrumentation, Data Handling**. Chapman & Hall
6. Ewing, GW (1990). **Analytical Instrumentation Handbook**. Marcel Dekker, New York.

**UNIT – I**

- Cloning vectors based on *E. coli* plasmids,  $\lambda$ -bacteriophage and M13 bacteriophage [4 Lectures]
- Cosmid, BAC and YAC vectors [2 Lectures]
- Enzymes involved in genetic engineering – Restriction endonuclease, DNA ligase, DNA modifying enzymes: Polynucleotide Kinase, DNA polymerase, Reverse transcriptase, Alkaline phosphatase, Terminal transferase, S1-nuclease [6 Lectures]
- Linkers and adaptors [2 Lectures]

**UNIT – II**

- Transformation of bacterial cells with plasmid DNA [2 Lectures]
- Transformation of bacterial cells with phage DNA [2 Lectures]
- Transformation of non-bacterial cells [2 Lectures]
- Analysis of recombinants [2 Lectures]
- Generation of genomic library and cDNA library [6 Lectures]

**UNIT – III**

- Methods of direct and indirect gene transfer in plants [6 Lectures]
- Application of genetic engineering [2 Lectures]
- Transgenic plants for insect, fungal, bacterial disease resistance, lignin, modification, abiotic stress tolerance, production of useful products [6 Lectures]

**UNIT – IV**

- Polymerase chain reaction [2 Lectures]
- DNA Sequencing [2 Lectures]
- RAPD and RFLP [2 Lectures]
- Restriction mapping [2 Lectures]
- Micro-array based technique [2 Lectures]
- Proteomics [2 Lectures]
- Gene silencing [2 Lectures]

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**SUGGESTED READINGS**

1. Hill WE (2000). **Genetic Engineering**. Hardwood Academic Publishers, The Netherlands.
2. Brown T (1995). **Gene Cloning**. Chapman & Hall, London.
3. Ranjan R (1996). **Transgenic Plant**. Agro Botanica, Bikaner.
4. Setlor J (1999). **Genetic Engineering**. Plenum Press, New York.
5. Tombs M (1990). **Biotechnology and Genetic Engineering Reviews**. Intercept, U.K.
6. Old RW & Primrose SB (1985). **Principle of Gene Manipulation: An Introduction to Genetic Engineering**, Blackwell



**MOLECULES AND THEIR INTERACTIONS**

- Absorption spectrum of chlorophylls
- Determination of reducing sugars of fruits by Nelson Somogyi's method
- Qualitative tests for carbohydrates (Iodine, Anthrone, Fehlings, Benedict etc.)
- Determination of nitrate reductase enzyme

**DEVELOPMENTAL AND STRUCTURAL BOTANY**

- Demonstration of slides showing embryological peculiarities (male and female gametophytes, endosperm, embryo)
- Training in paraffin wax method for preparation of serial sections from fixation to mounting of permanent slides.
- Sectioning and staining, Slide preparation
- Study of cambium, Study of angiospermous and gymnospermous wood (T.S., R.L.S. & T.L.S.)
- Study of anomalous structure

**GENETIC ENGINEERING**

- Preparation of competent cells of *E. coli* DH<sub>5</sub> $\alpha$  for transformation.
- Transformation of *E. coli* DH<sub>5</sub> $\alpha$  strain with recombinant DNA
- Restriction digestion of plasmid
- RAPD analysis of plant DNA using PCR

**BIOINSTRUMENTATION**

- Demonstration of pH meter, centrifuges, electronic balance, HPLC, GLC, AAS, UV-Vis spectrophotometer, HPTLC, polarimeter, PCR, Flame photometer, FT-IR
- Purification of protein by affinity chromatography
- Separation and identification of amino acids by TLC
- Extraction and estimation of total lipid content in the given sample of oil seed by column chromatograph
- Determination of  $\lambda$ -max a given metabolite by UV-Vis spectrophotometer and preparation of its standard curve
- Agarose gel electrophoresis of plasmid DNA

**UNIT-I**

- Concept of Environment and Environmental Pollution, Introduction of air pollution, Water Pollution, soil Pollution, Noise and radiation pollution.
- Sources of environmental pollution.
- Types of Pollutants: gaseous and particulate air pollutants, their interaction with environmental factors.
- Current global status of air pollution.

**UNIT-II**

- Plant responses to pollution stress: Foliar responses (Injuries & Epidermal traits).
- Effect of pollutants on tissue and tissue system.
- Production and quality of wood under polluted environments.
- Effect on reproductive growth, seed development under polluted atmosphere.

**UNIT-III**

- Metabolism of Carbohydrate, Proteins and lipids in plants exposed to pollutants.
- Resistance mechanism in plants exposed to air pollution: role of enzyme and PGRs.
- Formation of stress proteins: Phonetic compounds and prolines in air pollution stressed plants.

**UNIT-IV**

- Plant growth and environmental factor (Temperature, rain fall, light, wind etc.)
- Growth and decline of forests. Plant growth responses to elevated levels of atmospheric CO<sub>2</sub>.
- Pollution Pathogen interaction and its impact on plant performance.
- Plants as a biological indicators and mitigators of pollution.

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**SUGGESTED READINGS**

1. Magill, PL., Holden, ER. & Ackley, C (1956). Air pollution Hand Book. MC Graw-Hill Book Co.
2. Coley, D. (2008). Energy & climate change, John Wiley & Sons. London.
3. Null, Air Pollution and plant life
4. Saxena, MM. Environmental analysis water soil and air
5. Fulekar, M. H. Environmental Biotechnology
6. Sawicki, E. Handbook of environmental genotoxicology
7. Lyons, J. J. Principles of air pollution meterology
8. McCaull, J. Water Pollution

### UNIT – I

- Origin, botany, cultivation and uses of food crops: Rice, Wheat and Sorghum
- Origin, botany, cultivation and uses of vegetable crops: Potato, tomato and chillies
- Origin, botany, cultivation and uses of fibre crops
- Distribution, description and uses of timber yielding plants: *Tectona*, *Dalbergia* and *Rosewood*
- Distribution, description and uses of medicinal plants: *Rawolfia*, *Withania*, *Embllica*, *Andrographis* and *Aloe*      Production and applications of biofuels – Biogas, hydrogen and methane

### UNIT – II

- Indian systems of medicine; International plant drugs, their export and import; Important controversial medicinal plants and their substitutes; Endangered and medicinal plants of India; Role of plant drugs in Pharmaceutical industry

### UNIT – III

- **Biodiversity** – Current concept, levels and status in India; Role of Biodiversity in ecosystem functions and stability; Speciation and extinction; Sustainable development; Relationships between biodiversity and Biotechnology; Intellectual property rights
- IUCN categories of threat, causes of biodiversity loss; biodiversity management approaches; keystone species, endemism

### UNIT – IV

- Conservation of Biology; Current practice in conservation in India and abroad; Organisations involved in resource conservation IUCN, WWF, UNEP, UNESCO; Hotspots of India and world; Important international conventions/treaties
- **In situ conservation:** Indian initiatives; protected areas in India – sanctuaries, national parks, biosphere reserves, wetlands, mangrove.
- **Ex situ conservation:** Principles and practices; botanical garden, field gene bank, seed bank, in vitro repositories; Cryopreservation; general account of the activities of Botanical Survey of India (BSI); National Bureau of Plant Genetic Resources (NBPGR); Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves)

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### SUGGESTED READINGS

1. Jain SK, Sinha BK & Gupta RC (1991). **Notable Plants in Ethnomedicine of India**. Deep Publications, New Delhi.
2. Chowdhery HJ & Murti SK (2000). **Plant Biodiversity and Conservation in India: An Overview**. Bishen Singh, Mahendrapal Singh, Dehradun.
3. Jain SK (1991). **Contribution of Indian Ethnobotany**. Scientific Publishers, Jodhpur.
4. Singh VK & Abrar MK (1990). **Medicinal Plants and Folkories**. Today & Tomorrows Printers & Publishers, New Delhi.
5. Ghosh, AK (2008). A Comprehensive Handbook on Biodiversity, TERI, New Delhi.
6. Ghosh, AK (208). Simplifying Climate Change. TERI, New Delhi.
7. Sampson, Garey P (2005). The WTO and Sustainable Development, TERI, New Delhi.
8. Somayaji S & Somayaji G (2009). Environmental Concerns and Sustainable Development. TERI, New Delhi.
9. Saikia, Ranjane (2009). Making Sense of Climate Change. TERI, New Delhi.
10. Lovejoy TE & Hannah L (2005). Climate Change and Biodiversity, TERI, New Delhi.

**SECTION-A: PLANT TISSUE CULTURE****UNIT – I**

- General introduction, history, basic concept of cellular totipotency [2 Lectures]
- Tissue culture media – preparation and sterilization procedures [4 Lectures]
- Micropropagation / clonal propagation [4 Lectures]
- Somatic embryogenesis and artificial seeds [4 Lectures]

**UNIT – II**

- Haploidy and its importance in plant breeding [2 Lectures]
- Callus, suspension and shoot meristem culture and their applications [4 Lectures]
- Somaclonal variation, origin, molecular aspects and utility [2 Lectures]
- Protoplast isolation, fusion and culture, production of hybrids, hybrid selection and regeneration, possibilities, achievement and limitations of protoplast research, cybrids [6 Lectures]

**SECTION-B: MICROBIOLOGY****UNIT – III**

- Introduction, classification of bacteria, morphology of bacteria [2 Lectures]
- **Microbial genetics:** Methods of genetic transfers – transformation, conjugation, transduction and sex-duction [4 Lectures]
- **Microbial Biotechnology:** Microbes in the production of alcohol, beer, wine and vinegar. Commercial production of antibiotics, therapeutic vaccines, biopesticides. Microbes and bioremediation [6 Lectures]

**UNIT – IV**

- Structure and composition of viruses, Detail orphological structure of virus, Complex symmetry, Nucleic acids of viruses, viral enzymes, Biochemical constituents of envelope, Viroids, Sattelite viruses and Prion, Classification and phylogeny, Replication and multiplication cycle [14 Lectures]

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**SUGGESTED READINGS**

1. Razdan MK (1993). **An Introduction of Plant Tissue Culture**. Oxford & IBH, New Delhi.
2. Thorpe TA (1995). **In Vitro Embryogenesis in Plant**. Kluwer Publishers, Dordrecht.
3. Evans DA, Sharp WR & Amirato PY (1986). **Handbook of Plant Tissue Culture**. Macmillan Publishing Company, New York.
4. Alcamo IE (1994). **Fundamentals of Microbiology**, The Benjamim/Cummings Publishing Co., New York.
5. Bilgrami KS & RK Sinha (1992). **Essentials of Microbiology**, CBS Publishers, Delhi.
6. Purohit SS (1998). **Microbiology: Fundamentals and Applications**, Agrobotanica, Bikaner.
7. Locke DM (1974). **Viruses: The Smallest Enemy**, Crown Publishers, New York.
8. Trever G, Faull J, Ketteridge S & Springham D (1995). **Introductory Microbiology**, Chapman & Hall, London.
9. Pelizar MJ, Chan ECS & Krig NR (1993). **Microbiology**, McGraw Hill Book Co., New York

The students will be allotted topics for project work in the beginning of the academic session, under the supervision of the concerned teacher(s) as decided by the Head of the Department, keeping in view the student's desire and the teacher's consent. The students will complete the assigned work in the department or at any other laboratory/institute identified and arranged for this purpose. **They will submit a dissertation which will contain some original experimental data and their interpretation, in addition to the survey of relevant literature.** The student may deliver a seminar lecturer or face the viva voce by a panel of teachers appointed by the Head of the Department. The dissertations will be examined by a panel of examiners including the external examiner(s) who will also conduct oral examination of the students.

## PLANT AND ENVIRONMENT

- Survey of environment (around the Badarpur Thermal Power Station, Indraprastha Power Plant & NTPC Dadri) and study of vegetational symptoms (Chlorosis Necrosis, Glazing Banding and Silvering).
- Comparative Study of epidermal traits
- Determination of vulnerability factor of different plant species from different environmental condition
- Compare the chl. a, chl. b, Total chlorophyll, carotenoid & CHNS content in the plants grown under polluted and controlled condition.

## PLANT BIODIVERSITY, RESOURCE UTILIZATION AND CONSERVATION

- Field survey of important plants of the region for biodiversity.
- Morphology, anatomy and economically important parts of the food and vegetable crops included in the theory.
- Study of the characters and medicinal properties of the plants included in the theory.
- Mapping of Hotspots and Biosphere Reserves

## PLANT TISSUE CULTURE & MICROBIOLOGY

- Preparation of stock solution for Murashige and Skoog (MS) medium
- MS basal medium preparation
- Inoculation of seeds on agar medium for germination
- Induction of callus and determination of biomass (fresh and dry weight) of cultivated tissues
- Demonstration of organogenesis and somatic embryogenesis using appropriate explants
- Liquid medium preparation and establishment of suspension culture
- Demonstration and preparation of artificial seed
- Demonstration of androgenesis in plant like *Datura*

Course Credit: 08

Marks: 200

Time: 120 hrs

**UNIT-I: CHEMISTRY : 30 Hrs.****Essential**

- 1 Solution – Methods of expressing the concentration (Molality, Molarity, Normality etc).
- 2 Laws of mass action Reaction Quotient, Chemical equilibrium constant. Relation of  $K_p$  &  $K_c$ , pH, buffer, buffer index, buffer capacity, Arrhenius equation.
- 3 Colligative properties: Molecular mass determination using colligative properties.
- 4 Rate of reaction, order of reaction.
- 5 Different types of chemical bonds
- 6 Principles, classification and applications of chromatographic techniques.
- 7 Basics of Spectroscopy and applications.
- 8 Basic applications of Nanotechnology

**UNIT-II: BIOCHEMISTRY : 30 Hrs****Essential**

- 1 Biomolecules Carbohydrates, amino acids/proteins, lipids and nucleotides; Enzymes: Characteristics and nomenclature.
- 2 Cell Biology & Microbiology Prokaryotes & Eukaryotes; The cell and its composition; Cell organelles and subcellular fractionation; Viruses, Viroids, Virusoids and Prions; Bacterial culture and growth curve.
- 3 Bioenergetics and Intermediary Metabolism: ATP as energy currency; Intermediary metabolism.
- 4 Immunology - Active, passive, Humoral and Cellular immunity; Clonal selection theory; Cells of immune system; Immunoglobulins; Haptens, Antigens and Immunogens; Monoclonal & Polyclonal antibodies.
- 5 Clinical Biochemistry: common biochemical tests; Acid base disorders: Liver function test; Kidney function tests.

**UNIT-III: BOTANY: 30 Hrs**

- 1 Biodiversity – Concept, levels and Conservation of biodiversity.
- 2 Climate Change – Consequence.
- 3 Ecosystem - Producers, consumers and decomposers of food chain.
- 4 Plants with medicinal values
- 5 Environmental pollution bioremediation

#### **UNIT–IV: BIOTECHNOLOGY : 30 Hrs**

##### **Essential**

- 1 Genetics of Inheritance - Laws of inheritance, recombination, segregation of traits, segregation ratio, interaction between traits and quantitative inheritance.
- 2 Molecular Biology - The genetic material, RNA as genetic material, fidelity of DNA replication, transcription, translation, gene regulation. Mutation and mutagenesis, Ames test.
- 3 Genetic Engineering - Essentials of gene manipulation, vectors & enzymes used in recombinant technology.
- 4 Biotechnology: Applications and Ethical aspects : Stem Cell and its application concept of GM Crops and their relevance to society.

#### **UNIT–V: TOXICOLOGY : 30 Hrs**

##### **Essential**

- 1 Introduction to Toxicology
- 2 Various types of toxicity (Acute, subacute, subchronic and chronic).
- 3 Chemical interactions (Additive effect, potentiation, synergism and antagonism), Dose response relationship ( $ED_{50}$ ,  $LD_{50}$ ,  $EC_{50}$ ,  $LC_{50}$ .)
- 4 Routes of exposure, absorption, distribution, elimination. In vitro and in vivo models in toxicological studies.
- 5 Xenobiotics: Common toxicants of air, water & food and their adverse effect on health.

#### **UNIT – VI: DRUG DEVELOPMENT PROCESS (CLINICAL RESEARCH) : 30 Hrs**

- 1 Process of Drug development
- 2 Phase of clinical trials
- 3 Drug regulatory affairs
- 4 Principles of GLP, GMP & GCP
5. Basic concepts of intellectual Property rights

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##### **NOTE:**

- A student studying a specific subject in his/her M. Sc. Programme will be exempt from taking the foundation course unit on that particular subject.
- A student can choose 04 units out of the rest of the 05 units leading to gain of 8 credits.



**Section A: Genetics****UNIT – I**

- DNA, RNA as genetic materials, Physical and chemical structure of DNA, A, B and Z form of DNA, nucleosome. DNA packaging in eukaryotes.
- Mechanism of DNA replications, replication origin and fork, various enzymes involved and their role in maintaining fidelity of replication.
- DNA damage and DNA repair mechanisms.
- Structure and function of different types of RNAs, transcription units, RNA polymerases.

**UNIT – II**

- **Transcription and translation (Prokaryotes and Eukaryotypes):** Initiation and termination of transcription, RNA processing and editing.
- tRNA and its aminoacylation, aminoacyl tRNA synthetase,
- Translation initiation complex formation and factors, Elongation and elongation factors, Post translational modification of proteins.
- Genetic code.
- Regulation of gene expression in prokaryotes (e.g. lactose and tryptophan operons) and in eukaryotes.

**Section B: Cell Biology****UNIT – III**

- **Cell membrane:** Structure, lipid bilayer and membrane protein models, Function of cell membrane [6 Lectures]
- **Cell wall:** Ultra-structure and function of cell wall.
- Structure and function of cytoskeletons.

**UNIT – IV**

- Ultra-structure and function of Plastids, Endoplasmic reticulum, Mitochondria, Golgi apparatus, Lysosomes, Peroxisomes, and Glyoxysomes, Ribosomes.
- Genomes of mitochondria and chloroplast.
- **Cell cycle:** Phases of cell cycle, Role of cyclins, cyclin dependent kinases, regulation of cell cycle

**SUGGESTED READINGS**

12. Alberts B, Bray D, Lewis J, Raff M, Roberts K & Watson JD (1989). **Molecular Biology of the Cell**, Garland Publishing Inc., New York.
13. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D & Darnell J (2000). **Molecular Cell Biology**. W.H. Freeman and Co., New York, USA.
14. Richard M, Twyman & Wisden W (1999). **Advanced Molecular Biology**, Viva Books Pvt. Ltd.
15. Turner PC, Mclennan AG, Bates AD & White MRH (2001). **Instant Notes on Molecular Biology**, Viva Books Pvt. Ltd.
16. Benjamin Lewin (2007). **Genes IX**, Prentice Hall.
17. Brown WV & Berke MB (1974). **Text Book of Cytology**, Blackstains Sons & Co.
18. Brachet J & Mirsky AE (1959). **The Cell**, Academic Press, Vols. 16.
19. DeRobertis EDP & De Robertis EMF (2001). **Cell and Molecular Biology**, Lippineott Williams & Wilkins, Bombay.
20. Sharma AK & Sharma A (1980). **Chromosome Techniques**. Theory and Practice, Butterworth.
21. Roy SC & Kumar KDC (1977). **Cell Biology**, New Central Book Agency, Calcutta.
22. Wolfe SL (1993). **Molecular and Cellular Biology**, Wordsworth Publ. Co., California, USA.

**UNIT – I**

- **Mendelian Inheritance:** Principle of Mendelian Inheritance, dominance, independent assortment, segregation . Allele, multiple alleles, pseudoallele.
- Codominance, incomplete dominance, gene interactions, pleiotrophy .
- Sex chromosome, sex determination, dosage compensation, sex linked characters.

**UNIT – II**

- Linkage and Crossing over, molecular / genetic markers, Linkage / Chromosomal maps, Two & Three factor crosses, interference.
- Recombination (homologous, nonhomologous), Molecular events of recombination.
- Extra chromosomal inheritance; mitochondrial and chloroplast genes.
- Polygenic inheritance, Heritability.

**UNIT – III**

- Polyploids and Aneuploids; Autopolyploidy, origin, chromosome pairing and breeding behaviour, phenotypic effect.
- Allopolyploids, origin, types, important allopolyploid plants.
- **Aneuploids:** monosomic, trisomic etc.
- Numerical alteration of ploidy and their implications.

**UNIT – IV**

- **Mutation:** Mutation types, molecular basis of mutation, spontaneous and induced mutations, mutation induced by transposons (insertional mutagenesis), Insertion sequence (IS), composite transposons (Tn). AC-DS system in maize, somatic verses germinal mutants, physical and chemical mutagens, effect of mutagens on chromosomes/ DNA
  - Structural alterations of chromosomes; deletion, duplication, inversion, translocation etc
  - Cancer at cellular level, protooncogenes/ oncogene, tumour suppressor genes
  - Complementation tests
- 

**SUGGESTED READINGS**

7. Strickburger M (1990). **Genetics**. MacMillan Publishing Company, New York.
8. Gardner J (1991). **Principle of Genetics**. John Wiley & Sons, New York.
9. Klug WS & Cummings MR (1997). **Essential of Genetics**. Prentice Hall Publishing Co., New Jersey.
10. Brown T (1989). **Genetics: A Molecular Approach**. Chapman & Hall, London.
11. Goodenough U (1984). **Genetics**. Sandir College Publishing, Philadelphia.
12. Lewin, B. (2007). **Genes Vol. 9**. Oxford University Press.

### SECTION-A: PLANT TISSUE CULTURE

#### **UNIT – I**

- General introduction, history, basic concept of cellular totipotency.
- Tissue culture media – components, preparation and sterilization procedures.
- Haploidy and its importance in plant breeding.
- Micropropagation / clonal propagation
- Callus and suspension culture
- Shoot meristem culture and their applications.

#### **UNIT – II**

- Somatic embryogenesis.
- Artificial seeds
- Somaclonal variation, origin, molecular aspects and utility.
- Protoplast isolation, fusion and culture.
- Production of hybrids, hybrid selection and regeneration, possibilities, achievement and limitations of protoplast research, cybrids.

### SECTION-B: MICROBIOLOGY

#### **UNIT – III**

- Introduction, classification of bacteria, morphology of bacteria.
- **Microbial genetics:** Methods of genetic transfers – transformation, conjugation, transduction and sex-duction.
- **Microbial Biotechnology:** Microbes in the production of alcohol, beer, wine and vinegar. Commercial production of antibiotics, therapeutic vaccines, biopesticides. Microbes and bioremediation.

#### **UNIT – IV**

- Structure and composition of viruses, Detail orphological structure of virus, Complex symmetry, Nucleic acids of viruses, viral enzymes, Biochemical constituents of envelope, Viroids, Sattelite viruses and Prion, Classification and phylogeny, Replication and multiplication cycle.

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10. Razdan MK (1993). **An Introduction of Plant Tissue Culture**. Oxford & IBH, New Delhi.
11. Thorpe TA (1995). **In Vitro Embryogenesis in Plant**. Kluwer Publishers, Dordrecht.
12. Evans DA, Sharp WR & Amirato PY (1986). **Handbook of Plant Tissue Culture**. Macmillan Publishing Company, New York.
13. Alcamo IE (1994). **Fundamentals of Microbiology**, The Benjamim/Cummings Publishing Co., New York.
14. Bilgrami KS & RK Sinha (1992). **Essentials of Microbiology**, CBS Publishers, Delhi.
15. Purohit SS (1998). **Microbiology: Fundamentals and Applications**, Agrobotanica, Bikaner.
16. Locke DM (1974). **Viruses: The Smallest Enemy**, Crown Publishers, New York.
17. Trever G, Faull J, Ketteridge S & Springham D (1995). **Introductory Microbiology**, Chapman & Hall, London.
18. Pelizar MJ, Chan ECS & Krig NR (1993). **Microbiology**, McGraw Hill Book Co., New York