CURRICULUM AND SYLLABUS DISTRIBUTION FOR CBCS BOTANY HONOURS

PAPER	SEGMENT OF SYLLABUS	SUB TOPIC	NUMBER OF LECTURES	MONTH ASSING	TEACHER ASSING
DC 1: PAPER-1: Algae and Microbiology	**Algae**	1. General characteristics; Ecology and distribution; range of thallus organization; Cell structure 2. and components; cell wall, pigment system, reserve food (of only groups represented in the 3. syllabus), flagella; methods of reproduction; 4. Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); *5.* Cyanophyta and Xanthophyta: Characteristic features, Morphology and life-cycle of *Anabaena* (Asexual cycle) and *Vaucheria*, Ultra Structure of cell; Heterocyst and role in N2 fixation. *6.* Chlorophyta and Charophyta: Characteristic features, Morphology and life-cycle of *Chlamydomonas, Volvox, Oedogonium and Chara.* 7. Phaeophyta and Rhodophyta: Characteristic features, Morphology and life-cycle of*Ectocarpus* and *Polysiphonia.* 8. Diatom: Cell structure, Cell division, Auxospore formation in Centrales and Pennales. 9. Role of algae in the environment, agriculture, biotechnology and industry.: Biotechnology	1-4 5-8 9-10 11-15 16-20 21-24 25-27 28-29 30	AUGUST	D.S

		potential of microalgae for SCP; Production of Agar-agar; Algae as bio-fertilizer; Mass cultivation of algae for bio- diseal production.			
	Microbiology	1. Introduction to microbial world: Discovery, general characteristics; Types- archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure: Flagella (ultrastructure) & Pilli; Cell wall – chemical structure and differences between Gram +ve & Gram – ve bacteria; Bacterial genome and plasmid; Endospore - formation, structure and function. 2. Bacterial reproduction: Vegetative and asexual; Genetic Recombination (a) Transformation – with special emphasis on Natural and Induced competence and DNA uptake, (b) Conjugation ─ F-factor, F+ x F−, Hfr x F−, concept of F', chromosome mobilization, (c) Transduction– Generalised and specialized. 3. Economic importance of bacteria: Industrial Production of Vinegar and Streptomycin	1-7 8-14 15-21	AUGUST	P.D

		(brief outline); Enzyme (Amylase, Protease); Plant Growth Promoting Rhizobacteria (PGPR): Biological nitrogen fixation and nodulation process in legumes. Role of PGPR in agriculture as Biofertilizer and Biopesticides. Concept of Bioplastics. 4. **Viruses:** Discovery, physiochemical and biological characteristics; classification (Baltimore), general, structure with special reference to viroids and prions; replication (general account), 5. DNA virus, (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases	22-27 28-30		
DC-1: PAPER 2 (Practical)	**Algae**	1. Work out of algal specimens through preparation of semi-permanent slides (stained with cotton blue) and drawing of reproductive structures with proper magnification	1-10	AUGUST	D.S

		using camera lucida drawing prism.: *Anabaena, Vaucheria, Volvox, Oedogonium, Chara, Ectocarpus and Polysiphonia*.			
	Microbiology	1. Types of Bacteria to be observed from permanent slides/photographs. Electron micrographs ofbacteria, binary fission, endospore, conjugation. 2. Gram Staining (Gram +Ve and Gram -Ve), Observation of Bacteriods in root Nodule (Simple staining: Methylene blue); Endospore staining with malachite green. (*Bacillus* spp.) 3. Electron micrographs/Models of viruses – T-	1-10	AUGUST	P.D

		Phage and TMV, Line drawings/ Photographs of Lyticand Lysogenic Cycle.			
DC2: PAPER 3: Fungi, Lichens and Plant Pathology (Theory)	**Fungi, Lichens**	1. Introduction to true fungi; General characteristics; Thallus organization; Cell wall composition;; Teleomorphic and Anamorphic; Degeneration of sex in fungi; Parasexuality; Nutrition; Life Cycle Patterns. 2. Classification (Ainsworth 1973) up to sub-division diagnostic characters and examples. *3.* Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to *Rhizopus, Ascobolus, Agaricus* and *Penicillium.* 4. Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction and ecological role in pollution monitoring; Mycorrhiza- Ectomycorrhiza, Endomycorrhiza, Phosphate mobilization by AMF. Significance and role in Agriculture.	1-10 10-13 14-22 23-25 26-28	SEPTEMBER AND OCTOBER	S.S

		5. Applied Mycology: Role of fungi in biotechnology; Application of fungi in food industry. Fungi as Biocontrol agents; Mycotoxins. 6. Industrial production of Cheese, Ethanol, Baker's yeast, Amylase and Rivoflavin.	29-30		
	Plant Pathology	1. Introduction to plant pathology; Plant pathology in India and Global prospective; Concept of Disease in Plants and Types of Diseases. 2. Terms and definitions: Disease concept, Symptoms, Etiology, Inoculum and Infection, Pathogenesis, SAR and ISR, Disease triangle and disease cycle, Epidemic and Endemic, Sporadic and Pandemic Disease. Koch's postulate. 3. Mechanism of infection (Pre-penetration, Penetration and Post-Penetration), Plant defense responses with reference to Phytoalexins and PR proteins. Signal transduction leading to SAR and ISR. 4. Concept of plant disease management: IPM, Chemical, Biological and Quarantine. Concept of crop rotation. 5. Symptoms, Causal	1-7 8-15 16-20 21-25 26-28	OCTOBER	P.D

		organism, Disease cycle and control measures of: Bacterial diseases – Citrus canker, Viral diseases – Tobacco Mosaic Disease. Fungal diseases – Late blight of potato and Black stem rustof wheat. 6. Worldwide development of plant pathology as a profession: Indian and International institutions of crop protection, Plant disease clinics.	29-30		
DC2: PAPER 4 (Practical)	**Fungi and Lichens**	*1.* Study of asexual stage from temporary mounts, drawing and microscopic measurement: *Rhizopus,Ascobolous / Peziza* and *Agaricus.* *2.* Study from permanent slides: Sexual stage in *Rhizopus,* Conidia of *Penicillium*, *Aspergillus* spp. *3.* Isolation of AMF from soil through wet sieving and decanting method and comment on the type andnature of spore. (Demonstration) *4.* Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates through museum specimen.	1-10	SEPTEMBER	S.S
	Plant	1. Study from temporary mounts	1-10	NOVEMBER	P.D

	Pathology	(Histopathology): Late Blight of Potato, Stem rot of Jute, Loose smut of wheat, Leaf rust of *Justicia*. *2.* Study from permanent slides: Uredial, Telial, Pycnidial and Aecial stages of *Puccinia graminis,* 3. Herbarium specimens of bacterial diseases; Citrus Canker; Viral diseases: TMV, Fungal diseases: Late and Early blight of Potato, Black stem rust of Wheat, Stem rot of Jute, Red rot of Sugarcane, leaf rust of *Justicia*, Tikka disease of Groundnut and White rust of Crucifers.			

2nd semester

DC 3: PAPER 5: Archegoniate and Paleobotany (Theory)	**Archegoniate**	1. Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations. 2. **Bryophytes:** General characteristics; Adaptations to land habit; Classification (Proskauer, 1957) up to class. Range of thallus organization. Ecological and economic importance of bryophytes with special reference to *Sphagnum*. *3.* Type Studies- Bryophytes: Morphology, anatomy and reproduction and sporophyte development and alternation of generation of *Marchantia, Anthoceros, Sphagnum and Funaria.* 4. **Pteridophytes:** General	1-3 4-12 13-21	JANUARY	D.S P.D

		characteristics; Classification up to class (Sporne, 1975); Concept of heterospory and origin of seed habit; Apogamy, and apospory; Stelar evolution. Ecological and economic importance of pteridophytes. Early land plants *Rhynia* and *Lepidodendron* (Reconstructed).	22-37		S.S
		5. Type Studies- Pteridophytes: Morphology, anatomy and reproduction of *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included).	38-47		
		6. **Gymnosperms:** General characteristics, classification up to order (Stewart and Rothwell, 1993), Ecological and economic importance.	48-52		S.S
		7. Vegetative morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included)	53-55		
		8. **Paleobotany:** Fossil: types and modes of preservation (Schopf, 1975), conditions of preservations, fossilization process;Geological time scale and major events of plant life through geological ages.: Indian Gondwana system with major megafossil assemblages; Importance of study of fossil.	56-60		D.S

DC 3: PAPER 6 (Practical)	**Bryophyte**	i. Morphology of thallus and permanent slide preparations of the following ii. *Marchantia:* Whole mount of rhizoids& scales, vertical section Gemma cup, Antheridiophore, Archegoniophore iii. *Anthoceros*- Dissection of sporophyte (to show stomata, spores, pseudoelaters, columella). iv. *Funaria*- Whole mount of leaf, rhizoids, operculum, peristome, annulus, spores and longitudinalsection of capsule.	1-10	JANUARY	P.D
	Pteridophytes	i. Morphology and permanent slide preparations of the following ii. *Selaginella* and *Lycopodium* : Transverse section of stem, whole mount of strobilus, longitudinalsection of strobilus. iii. *Equisetum*- Transverse section of internode, longitudinal section of strobilus, transverse section ofstrobilus, whole mount of sporangiophore. iv. *Pteris*- Transverse section of sporophyll, whole mount of sporangium, mount of spores.	1-10	FEBRUARY	S.S
	Gymnosperms	i. *Cycas*- Morphology (bulbil, leaf), whole mount of microsporophyll Microsporophyll, whole mount of spores (temporary slides). ii. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male cones), transverse section of	1-10	MARCH	S.S

		Needle, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides). v. Morphological studies of reproductive structures of *Pinus* (male and female cones), *Cycas* (Megasporophyll and Microsporophyll) *Gnetum* (male and female cones); , Transverse section of coralloid root, leaflet anatomy, (permanent slide).			
	Paleobotany:	i. Morphological study: *Ptilophyllum*, *Vertebraria*, and *Glossopteris* leaf fossils *ii.* Study from permanent slides: T.S. of stem of *Rhynia, Lepidodendron, Calamites, Lyginopteris, Cordaites, and Medullosa.*	1-10		D.S
DC 4 : PAPER 7: Morphology and Anatomy of Angiosperms (Theory)	**Morphology and Anatomy of Angiosperms**	1. Introduction to angiospermic morphology, Palynology and Anatomy, scope and applications in systematics, forensic and pharmacognosy. 2. Leaf: Types, Margin, Base, Venation and Phyllotaxy, Petiole and modifications. 3. Inflorescence: types with examples; Flower: Floral parts, Thalamus and insertion of floral parts, Calyx, Corolla, Aestivation, Perianth, floral diagram and floral formula. Stamen: Types and anther	1-12 13-24 25-36	MARCH	D.S

		shape. Carpel : types, placentation-types, ovule structure and types; Fruit types with examples. 4. Meristimatic and permanent tissues: Organization of shoot apex (Tunica-corpus concept) and organization of root apex (Korper-Kappe concepts); Structure of dicot and monocot leaf, Kranz anatomy. Structure of Xylem and Phloem tissue; Types and evolution of stele; Vascular bundle -types and function. Root-Stem transition and its significance; Normal and Anomalous secondary growth (citing examples of *Bignonia* and *Dracaena* and *Tinospora* root), different types of wood. Concept and application of Dendrochronology. 5. Adaptive and Protective Systems: Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni- and multicellular, glandularand nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation;Anatomical adaptations of xerophytes and hydrophytes.	37-48 49-60		
DC 4: PAPER 8 (Practical)	**Morphology and Anatomy of Angiosperms**	1. Morphology: Morphological studies (No working out): Different types of phyllotaxy in plants; Types of special inflorescence; Aestivations, Anther types and Placentation; Different types of fruits. 2. Anatomy: Study of anatomical details through permanent slides/temporary stain mounts/ macerations/	1-10	APRIL	D.S

		museum specimens with the help of suitable examples. 1. Apical meristem of root, shoot and vascular cambium 2. Root: monocot, dicot, secondary growth 3. Stem: monocot, dicot - primary and secondary growth 4. C4 leaves (Kranz anatomy) (Temporary stain mounts and Permanent slide) *1.* Anamolous secondry growth in *Bignonia* and *Dracaena* , *Tinospora root* 2. Stomata types; trichomes: non-glandular and glandular 3. Adaptive Anatomy: a. Hydrophyte: *Eichhornia, Hydrilla* and *Ludwigia adscandens*. *b.* Xerophyte: *Nerium* and *Casuarina* 4. Secretory tissues: raphids, sclerides, aleurone, lithocysts and laticifers.			

3rd semester

DC 5: PAPER 9: Plant Systematics **(Theory)**	**Plant Systematics**	1. Significance of Plant systematics: Introduction to systematics; Plant identification, Classification, Nomenclature. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation:	1-7	AUGUST	D.S

		Flora, Monographs, Journals; Keys: Single access and Multi-access. 2. Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). 3. Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids. 4. Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Outline of classification systems of Linnaeus (1753), Bentham and Hooker (1862-1883) upto series and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification. 5. Biometrics, numerical taxonomy and cladistics : Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences). 6. Phylogeny of Angiosperms:Terms and concepts (primitive and	7-14 15-25 26-33 34-47 48-51		

		advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). 7. Diagnostic features of Families: **Dicotyledons-** Ranunculaceae, Brassicaceae, Malvaceae, Leguminosae(sensu lato), Apiaceae, Solanaceae, Lamiaceae, Cucurbitaceae, Rubiaceae, Euphorbiaceae, Asteraceae. **Monocotyledons-** Alismataceae, Poaceae, Zingiberaceae and Orchidaceae.	52-60		
DC5: PAPER 10: (Practical)	**Plant Systematics**	1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Ranunculaceae- *Ranunculus, Delphinium* Brassicaceae- *Brassica, Alyssum / Iberis* Malvaceae- *Sida / Abutilon* Apiaceae- *Coriandrum /Anethum / Foeniculum*	1-10	SEPTEMBER	D.S

		Solanaceae- *Solanum /Physalis/ Nicotiana* Lamiaceae- *Salvia/Ocimum/ Leucas/Leonurus* Cucurbitaceae: *Cephalandra/ Nukia* Rubiaceae: *Dentella/ Spermacoce/Oldenladia* Euphorbiaceae: *Jatropha / Croton / Acalypha* Asteraceae- *Sonchus/ Launaea, Vernonia/ Ageratum/ Tridax* Mounting of a properly dried and pressed specimen of at least 20-30 collected Angiospermic plants with herbarium label and arranged according to Bentham and Hookers system of classification			
DC 6: PAPER 11: Plant Ecology , Phytogeography and Biodiversity (Theory)	**Plant Ecology**	1. Introduction : Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. 2. **Soil**: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development. **Water**: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table. 3. **Trophic organization**: basic source of energy, Models of energy flow, autotrophy, heterotrophy; symbiosis,	1-8 9-16 17-29	SEPTEMBER	P.D

		commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop. **Population ecology:** Characteristics and Dynamics .Ecological Speciation 4. **Plant communities:** Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts. 5. **Ecosystems:** Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids. **Functional aspects of ecosystem:** Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.	30-42 43-50		
	Phytogeography	1. Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.	51-55		P.D
	Plant Biodiversity	1. Biodiversity and Conservation: Biodiversity – definition, scope, types (genetic,	56-60	OCTOBER	P.D

		species and ecosystem), importance and threats; Threatened plants (IUCN Categories); knowledge on Red Data Book; Hotspots. 2. *In situ* and *ex situ* conservation strategies for rare and endangered plants with emphasis on National parks, Sanctuaries and Biosphere reserves, seed banks, cryopreservation in India.			
DC 6: PAPER 12: Practical	**Plant Ecology and Phytogeography**	Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibondcomparator and pH paper) 1. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 2. Determination of dissolved oxygen and dissolved carbon dioxide of water samples from polluted andunpolluted sources. 3. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats. 4. Study of morphological adaptations of hydrophytes and xerophytes (four each). a. Hydrophyte: *Eichhornia, Nymphaea, Hydrilla, Pistia, Ludwigia adscandens.* b. Xerophyte: *Nerium, Casuarina, Opuntia, Euphorbia tirucauli.* 5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, byspecies area curve method (species to be	1-10	OCTOBRER	P.D

		listed). 6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison withRaunkiaer's frequency distribution law. 7. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.			
DC 7. PAPER 13: Economic botany (Theory)	**Economic botany**	**1. Origin of Cultivated Plants:** Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity. **2. Cereals:** Wheat and Rice (origin, morphology, processing & uses); Brief account of millets. **3. Legumes:** Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance toman and ecosystem. **4. Sources of sugars and starches:** Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses. **5. Spices:** Listing of important spices, their	1-10 11-18 19-27 28-36 37-42	NOVEMBER	S.S

		family and part used. Economic importance with specialreference to fennel, saffron, clove and black pepper. **6. Beverages:** Tea, Coffee (morphology, processing & uses) **7. Sources of oils and fats:** General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses. **8. Natural Rubber:** Para-rubber: tapping, processing and uses. ***9.*** **Drug-yielding plants:** Therapeutic and habit-forming drugs with special reference to C*inchona, Digitalis* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards). **10. Timber plants:** General account with special reference to teak and pine. **11. Fibers:** Classification based on the origin of fibers; Cotton and Jute (morphology, extraction and uses)	43-51 53-55 56 57 58-59 60		

DC 7: PAPER 14: Practical		1. **Cereals**: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests: Qualitative: Ca, Mg, Fe and S); Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests). 2. **Legumes**: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests: : Qualitative: Ca, Mg, Fe and S). 3. **Sources of sugars and starches**: Sugarcane (habit sketch; cane juice-micro-chemical tests: Qualitative: Ca, Mg, Fe and S), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains). 4. **Spices:** Black pepper, Fennel and Clove (habit and sections). 5. **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans). 6. **Sources of oils and fats**: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds. *7.* **Essential oil-yielding plants**: Habit sketch of *Rosa, Vetiveria, Santalum* and *Eucalyptus* (specimens/photographs). *8.* **Drug-yielding plants**: Specimens of *Digitalis, Papaver* and *Cannabis.* 9. **Woods:** *Tectona, Pinus*: Specimen, (Types of section of wood specimen) 10. **Fiber-yielding plants**: Cotton (specimen, whole	1-10	NOVEMBER	S.S

		mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).			

Discipline Core (DC)

YEAR 2: SEMESTER IV

DC 8: PAPER 15: Cell biology and Plant Breeding (Theory)	**Cell biology**	1. **The cell:** Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory). 2. **Cell wall and plasma membrane:** Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid, mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis. 3. **Cell organelles: Nucleus:** Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. 4. **Chloroplast, mitochondria and peroxisomes:** Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. 5. **Cytoskeleton:** Role and structure of microtubules, microfilaments and intermediary filament.. 6. **Endomembrane system:** Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the	1-8 9-17 18-27 28-36 37-40 41-45	S.S

		ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes. **Cell division:** Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role, of protein kinases	46-50	
	Plant Breeding	1. Concept of plant breeding; Significance and role in crop improvement. 2. Types of variety selection – mass selection, pure line selection, clonal selection, bulk and pedigreeselection and hybridization. 3. Heterosis and Hybrid vigour; Male sterility in plants- types and application.	51-53 54-57 58-60	S.S
DC8: PAPER 16: Practical		1. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo*/Crinum 2. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains). 3. Study of cell and its organelles with the help of electron micrographs. 4. Chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparationof permanent slides. Study of Mitotic Chromosomes. *5.* Metaphase chromosome preparation, free hand drawing, determination of 2n number and comment on chromosome morphology of *Allium cepa.* *6.* Determination of mitotic index in pre-fixed root tips of *Allium cepa.*	1-10	S.S

		7. Identification from permanent slides : Mitosis – (i) normal stages, (ii) abnormal stages- early separation,late separation, multipolarity , sticky bridge, laggard, fragmentation, (ii) pollen mitosis. Emasculation of flower: Demonstration		
DC 9: PAPER 17: Genetics and Biostatistics (Theory)	**Genetics**	1. **Mendelian genetics and its extension**: Mendelism: Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits. 2. **Linkage, crossing over and chromosome mapping:** Linkage and crossing over- Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage. 3. **Extrachromosomal Inheritance**: Basic concepts with examples in chloroplast and mitochondria 4. **Variation in chromosome number and structure:** Deletion, Duplication, Inversion, Translocation, 5. Position effect, Euploidy and Aneuploidy 6. **Gene mutations:** Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Baseanalogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation.DNA repair	1-7 8-17 18-23 24-31 32-33 34-37	S.S

		mechanisms. 7. **Fine structure of gene:** Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus. 8. Operon concept : Lac Operon and Trp-Operon 9. **Population and Evolutionary Genetics:** Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.	38-45 46-47 48-50	
	Biostatistics	1. Introduction to Biostatistics: Characteristics, Usefulness and Limitation, Types of Data. 2. Sampling methods-concept of sampling of population, measures of central tendency and dispersal: determination of mean, mode, median, variance, standard deviation and standard error. 3. Rules of probability (Addition and Multiplication theorem), Null-hypothesis, Tests of significance: chi-square test, t-test (student and paired t-test). 4. Correlation and Regression.	51-53 54-55 56-58 59-60	S.S

DC 9: PAPER 18: Practical		1. Introduction to chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smearpreparation. 2. Preparation of permanent slides Study of meiotic chromosome: Smear preparation of meiotic cells,identification of different stages and free hand drawing from flower buds: *Allium cepa*. 3. Identification from permanent slides : Meiosis – (i) normal stages (ii) abnormal stages – laggard, anaphase bridge, ring chromosome (*Rhoeo discolor*) 4. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square. 5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4). 6. Univariate analysis of statistical data: Statistical tables, mean mode, median, standard deviation, andstandard error (using seedling population/leaflet size).	1-10	S.S
DC 10: PAPER 19: Reproductive Biology of Angiosperms (Theory)	**Reproductive Biology of Angiosperms**	1. **Introduction:** History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P.Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope. 2. **Reproductive development:** Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.	1-10 11-20	D.S

		3. **Anther and pollen biology:** Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; **Palynology and scope** (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia. 4. **Ovule:** Structure; Types; Special structures– endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac. 5. **Pollination and fertilization:** Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization. 6. **Self incompatibility:** Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination. **Embryo, Endosperm and Seed:** Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions;	21-30 31-40 41-50 51-60	

		Embryo-endosperm relationship Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms.		
DC 10: PAPER 20: Practical		1. Slides/Micrographs of Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, sporetetrads, uninucleate, bicelled and dehisced anther stages and Male Germ Unit. 2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph). 3. Pollen viability: Tetrazolium test, Germination: Calculation of percentage germination in differentmedia using hanging drop method. 4. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (Permanent	1-10	D.S

		slides/specimens/photographs, Micrographs). 5. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus. 6. Intra-ovarian pollination; Test tube pollination through photographs. (Cucumber seed) 7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria. 8. Embryogenesis: Study of development of dicot embryo through permanent slides; Dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.		

Discipline Core (DC)

YEAR 3: SEMESTER V

DC 11. PAPER 21: Plant Physiology (Theory)	**Plant Physiology**	1. **Plant-water relations:** Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement. Soil-Plant-Atmosphere continuum concept, Cavitation and ambolism. 2. **Mineral nutrition:** Essential and beneficial elements, macro and micronutrients, mineral deficiency symptoms, roles of essential elements, chelating agents. **Nutrient Uptake:** Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems,proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.	1-8 9-18	D.S

		3. **Translocation in the phloem:** Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship. 4. **Transpiration:** **Stomata** - micellation of guard cell; Role of CO2, K+ - ion, blue light & abscisic acid in stomatal movement; Anti-transpirant. 5. **Plant growth regulators:** Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid. 6. **Physiology of flowering:** Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy; **Phytochrome, crytochromes and phototropins:** Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.	19-26 27-33 34-41 42-54	

		7. **Seed Dormancy:** Types, causes and methods of breaking seed dormancy.	55-60	
DC-11: PAPER 22: Practical		1. Determination of stomatal frequency and rate of transpiration per stomata per hour. 2. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyteand xerophyte. 3. Measurement of oxygen uptake by respiring tissue (per gram / hr.) by germinating seeds. 4. Measurement of osmotic pressure in the leaf cells of *Rhoeo discolor* by plasmolytic method. 5. Determination of water potential / Osmotic pressure of given tissue (potato tuber) by weight method. 6. Determination of R.Q. of germinating seeds by Ganong' respirometer or respiroscope. 7. Effect of detergent (SDS) on the permeability of plasma membranes.	1-10	D.S

		8. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA Bioassay).		
DC 12: PAPER 23: Plant Metabolism (Theory)	**Plant Metabolism**	1. **Concept of Metabolism in plants**: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes). 2. **Carbon assimilation**: Historical background, photosynthetic pigments: Structure of chlorophyll a & b, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration,C4 pathways; efficiency of C3 & C4 plants on crop productivity; CAM and its ecological significance. Crassulacean acid metabolism; Factors affecting CO_2 reduction. 3. **Carbohydrate metabolism**: Synthesis and catabolism of sucrose and starch. 4. **Carbon Oxidation**: Glycolysis and its significance, fate of pyruvate, oxidative pentose phosphate	1-9 10-17 18-24 25-30	D.S

		pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration. 5. **ATP-Synthesis**: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers. 6. **Lipid metabolism:** Synthesis and breakdown of triglycerides, *β*-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, *α* oxidation. 7. **Nitrogen metabolism:** Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.	31-40 41-47 48-55	

		8. **Mechanisms of signal transduction:** Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.	59-60	
DC 12: PAPER 24: Practical		1. Chemical separation of photosynthetic pigments by paper chromatography. 2. Experimental demonstration of Hill's reaction. 3. Demonstration of absorption spectrum of photosynthetic pigments. 4. To study the effect of light quality on the rate of photosynthesis. 5. Effect of carbon dioxide on the rate of photosynthesis. (varying HCO- 3 concentration usingbicarbonate in an aquatic plant to find out the optimum and toxic concentration) 6. To compare the rate of respiration in different parts of a plant (Flower, leaf, buds etc) 7. Determination of R.Q. of germinating seeds by Ganong' respirometer or respiroscope. 8. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids duringgermination.	1-10	D.S

Discipline Core (DC)

YEAR 3: SEMESTER VI

DC 13: PAPER 25: Biomolecules (Biochemistry) (Theory)	**Biochemistry**	**1. Biomolecules:** Types and significance of chemical bonds (Covalent, non-covalent & hydrogen bonds, van der Waals interactions); Structure and properties of water; pH and buffers. **2. Carbohydrates:** Nomenclature and classification; Monosaccharides ; Disaccharides; Oligosaccharides and polysaccharides. **3. Lipids:** Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; saturated and unsaturated fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides. **4. Proteins:** Structure of amino acids and classification; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins. **5. Nucleic acids:** Structure of nitrogenous bases;	1-10 11-18 19-26 27-32 33-41	P.D

		Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA. **6. Bioenergenetics:** Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule. **7. Enzymes:** Definition**,** Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group;Classification of enzymes; Features of active site, substrate specificity, mechanism of action(activation energy, lock and key hypothesis, induced - fit theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.	42-48 49-60	
DC 13: PAPER 26: Practical		1. Detection of nature of carbohydrate- glucose, fructose and starch from laboratory samples. 2. Estimation of amino-nitrogen in an amino acid (glycine) by formol titration method. 3. Estimation of glucose by Benedict's quantitative reagent. 4. Estimation of titrable	1-10	P.D

		acidity from lemon. 5. Estimation of catalase activity in plant samples. 6. Estimation of urease activity in plant samples. 7. Colorimetric estimation of protein using Folin-Ciocalteu phenol reagent.		
DC 14: PAPER 27: Plant Biotechnology (Theory)	**Plant Biotechnology**	1. **Plant Tissue Culture** Historical perspective; Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Composition of tissue culture media; Nutrient and hormone requirements (role of vitamins and hormones). 2. Micropropagation: methods and stages, advantages, disadvantages and application, organogenesis and embryogenesis (zygotic and somatic, induction of somatic embryogenesis, role of plant growth regulators, application – synthetic seeds); callus culture; application of plant tissue culture in agriculture and forestry. 3. Protoplast isolation, culture and fusion; Application of	1-10 11-18 19-26	P.D

			Tissue culture applications (micropropagation, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation). 4. **Recombinant DNA technology :** Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC). 5. **Gene Cloning:** Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediatedgene cloning; Gene Construct; construction of genomic and cDNA libraries, screeningDNA libraries to obtain gene of interest by	27-32 33-41	

			genetic selection; complementation, colonyhybridization; PCR 6. **Methods of gene transfer:** Brief idea about different methods of gene transfer,*Agrobacterium*- mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP). 7. **Applications of Biotechnology:** Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase,); Gentically Engineered	42-48 49-60	

		Products–Human Growth Hormone; Humulin; Biosafety concerns.		
DC 14: PAPER 28: Practical		Preparation of MS medium.(Demonstration) *In vitro* sterilization and inoculation methods using leaf and nodal explants Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis &artificial seeds Study of methods of gene: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. Study of steps of genetic engineering for production of Bt cotton and Golden rice. Isolation of protoplasts (Demonstration)/visuals Construction of restriction map of circular and linear DNA from the data provided. Isolation of Plant DNA Gel Electrophoresis of plant Genomic DNA	1-10	P.D

DISCIPLINE PLINE SPECIFIC ELECTIVE (DSE)

DSE1	**Analytical Techniques in Plant Sciences THEORY**	1. **Imaging and related techniques:** Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Applications of fluorescence microscopy: Principle of Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching. 2. **Cell fractionation:** Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$ gradient, analytical centrifugation, ultracentrifugation, marker enzymes. 3. **Radioisotopes:** Definition, Use in biological research, auto-radiography, pulse chase experiment. 4. **Spectrophotometry:** Principle and its application in biological research. 5. **Chromatography:** Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography. 6. **Characterization of proteins and nucleic acids:** Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS PAGE 7. **Biostatistics:** Statistics, data, population, samples, parameters; Representation of		

		Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.		
	Practical	1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing,PCR **through photographs**. 2. Demonstration of ELISA. 3. To separate amino acids by thin layer chromatography. 4. To estimate protein concentration through Lowry's methods. 5. To separate proteins using SDS PAGE. 6. To separation DNA (marker) using PAGE. 7. Study of different microscopic techniques using photographs/micrographs (Negative staining, positive staining, fluorescence and FISH). 8. Preparation of permanent slides (double staining).		
DSE2	**BIOINFORMATICS THEORY**	1. **Introduction to Bioinformatics:** Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics. 2. **Databases in Bioinformatics:** Introduction, Biological Databases, Classification format of Biological		

		Databases, Biological Database Retrieval System. 3. **Biological Sequence Databases:** National Center for Biotechnology Information (NCBI): Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank). Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features. 4. **Sequence Alignments:** Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM). 5. **Molecular Phylogeny:** Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of		

		Molecular Phylogenetic Prediction. 6. Applications of Bioinformatics in various fields.		
	Practical	1. Nucleic acid and protein databases. 2. Sequence retrieval from databases in *fasta format* (NCBI) 3. Sequence alignment. (Using Mega 4 bioinformative tool) 4. Sequence homology and Gene annotation. CLUSTAL-W Construction of phylogenetic tree.(Neighbor joining, Bootstraps		