Department of Botany

Course Outcome, Program Outcome and Program Specific Outcome, 2019-20

Course Outcome

Under CBCS

HONOURS

SEMESTER- I

CC1

THEORETICAL- PHYCOLOGY AND MICROBIOLOGY

PHYCOLOGY

CO1. General account: This course aims at acquainting students about the general organization of algal thallus as well as cytological details of the constituent cells. It also gives an idea regarding the different life cycle patterns prevalent among different groups of algae. Scope for developing awareness among the students about the remarkable contributions made by great phycologists has also been provisioned for.

CO2. Classification: Students are exposed to the different forms of classification proposed by renowned workers and are made aware about the basis behind them. Detailed information about the characteristic features of different major algal groups has also been provisioned for in this section. Students are also made aware regarding the ecological and economic implications of different groups of algae.

CO3. Life History: Scope for students to learn in details about the life-cycle pattern of selected member representatives of major algal groups has been provided for. Members have been carefully selected to give the readers a clear idea regarding the evolutionary pathway among algae.

MICROBIOLOGY

Virus:

CO1. Students are informed in details regarding the discovery, types, transmission and translocation of Plant viruses.

CO2. Provision for students to learn about physicochemical characteristics and Multiplication of well-known virus like TMV, T4 and Lambda phage has been made.

CO3. Students have the scope to learn about Viroids and Prions.

Bacteria:

CO1. Students get to learn about the discovery of Bacteria and its distinction from Archaea.

CO2. Students learn about the characteristics of some major groups of Bacteria.

CO3. They learn about the Bacterial growth curve and generation time in details.

CO4. Students get a detailed picture regarding the ultrastructure of a Bacterial cell and learn the basis of differentiation between Gram +ve & Gram – ve bacteria.
CO5. They have a thorough insight regarding Bacterial genome and plasmid, 2. Endospore - formation, structure and function, .Genetic Recombination (a) Transformation, Conjugation and Transduction.

PRACTICAL- PHYCOLOGY AND MICROBIOLOGY

ALGAE

CO1. Students get a first-hand experience of working-out major algal genera with reproductive structures accompanied by drawing under drawing prism with magnification.
CO2. Students get scope to study permanent slides and macroscopic specimens of algae belonging to different groups.

MICROBIOLOGY

CO1. Students have a first-hand experience of preparation of different bacterial media, slants and pouring of petri-plates.
CO2. They learn the techniques involved in sub-culturing of bacteria.
CO3. They have a hands-on training of staining and observing bacterial cell including Gram staining.

FIELD WORK

CO1. Scope has been provided for gaining first-hand experience in observation of plant diversity and collection and preservation of algae from field.

CC 2

THEORETICAL- MYCOLOGY AND PHYTO-PATHOLOGY

MYCOLOGY

CO1. General Account: Student gain general but detailed knowledge regarding the structural organization, sexuality, evolution of sex and life cycle patterns of fungi.
CO2. Classification: Students learn about a latest form of classification of fungi and knows about the salient characteristic features of major fungal groups.
CO3. Life history: Students get the opportunity to learn about the life-cycle patterns of some selected genera of fungi representing major groups.
CO4. Mycorrhiza: Students get to know about mycorrhiza, their types and roles in ecology and economy.
CO5. Lichen: Students learn about the types, reproduction and economic and ecological importance of lichens.

PHYTO-PATHOLOGY

CO1. Terms and Definitions: Students learn about the definitions and terminologies used in the study of plant diseases.
CO2. Host – Parasite Interaction: Students learn in details about the bio-chemical as well as mechanical procedures that play important role in host-parasite interaction during infection i.e. Pre-penetration, Penetration and Post-penetration.

CO3. They learn about the different methods used in Plant Disease Management.
CO4. Students gain detailed knowledge regarding symptoms , causal organism, disease cycle and control measures of carefully selected plant-diseases that have a deep-impact in the agricultural economy of our country.

PRACTICAL- MYCOLOGY AND PHYTO-PATHOLOGY

MYCOLOGY
CO1. Students have scope for gaining hands on experience on work out of selected fungal genera along with methodology for measurement of reproductive structures.
CO2. They will study some carefully selected genera from permanent slides.
CO3. Students will have access to fruit body of some fungi and lichens for gaining experience in morphological study.
PHYTO- PATHOLOGY
CO1. Student have provision for gaining hands-on training in preparation of fungal media, sterilization process, isolation of pathogen from diseased leaf, inoculation of fruit and subculturing.
CO2. They will gin training in procedures for identification of fungal diseases of plants that are of considerable economic importance.
FIELD WORK
CO1. Students will have the privilege of participating in field study involving study and collection of macro fungi.

Contact hours: 8hrs/week Practical: 8hrs/week

SEMESTER- II
CC 3

THEORETICAL- PLANT ANATOMY

ANATOMY
CO1. Cell wall: Students will gain detailed knowledge regarding ultrastructure of plant cell, tissue and organs, concept of Apoplast and Symplast, growth and thickening of cell wall etc.
CO2. They will have elaborate concept regarding stomata types, stellar types, stellar evolution, leaf-trace and leaf-gap.
CO3. Students will gain detailed idea about primary structure of leaf, stem and root of both monocot and dicot.
CO4. They will be acquainted with normal and anomalous secondary growth occurring in some carefully selected plant genus.
CO5. In-depth idea regarding mechanical tissues and the Principles governing their distribution in plants will be imparted to the students.
CO6. Students will be exposed to concepts regarding Developmental Anatomy involving organisation of shoot and root apex, plastochrone etc.

CO7. Ecological Anatomy: Students will gain in depth knowledge regarding the adaptive anatomical features of hydrophytes and xerophytes.
CO8. Students will be made aware about the scope and application of plant anatomy in the areas of systematics, forensics and pharmacognosy.

PRACTICAL- PLANT ANATOMY

PLANT ANATOMY

CO1. Students will have first-hand experience in microscopic studies on types of stomata, sclereids, raphides (Colocasia), cystolith (Ficus leaf) starch grains, aleurone grains, laticiferous ducts, oil glands.
CO2. They will study anatomical details of root, stem and leaf (both dicot and monocot) through permanent slides/ temporary stained mounts.
CO3. Students will have scope for in-depth study of anomalous secondary structure in stem and root of selected genera.
CO4. They will undertake study of adaptive anatomical features of hydrophytes and xerophytes.

CC 4

THEORETICAL- ARCHAEGONIATE

BRYOPHYTES

CO1. General Account : Students are exposed to detailed concept regarding general characteristics, adaptations and classification of Bryophytes.
CO2. Students will have in-depth idea about the life history of carefully selected genera.
CO3. Phylogeny: Students will gain detailed knowledge regarding unifying features of archaegoniates, transition to land habit, origin of Alternation of Generations, evolution of Sporophytes and origin of Bryophytes.
CO4. Importance: The learners will know about the in import role that bryophytes play in plant succession, pollution monitoring and learn about their economic and ecologic importance.

PTERIDOPHYTES

CO1. General Account: Students receive a detailed idea regarding colonisation and rise of early land plants, classification of vascular plants particularly Pteridophytes along with diagnostic characters and examples.
CO2. Life History: Students will get a detailed description of the life history of carefully selected bryophyte genera.
CO3. Learners will have in-depth concept about the Telome concept and its significance in the origin of different groups of Pteridophytes. They will also know about heterospory and origin of seed habit in Pteridophytes.
CO4. Students will learn about the economic importance of Pteridophytes as food, medicine and bio-fertilizer.

GYMNOSPERMS

CO1. Classification: Students will gain detailed idea regarding the classification of Gymnosperms along with diagnostic characters and examples.

CO2. Progymnosperms : They will learn in details about progymnosperms and their phylogenetic importance.
CO3. Life History : Students will have detailed knowledge about the life-cycle of carefully selected gymnosperm genera.
CO4. Students will learn the economic Importance of gymnosperms in details.

PRACTICAL- ARCHAEGONIATE

BRYOPHYTES
CO1. Students will have a first-hand experience regarding the morphological study of the plant body of selected bryophyte genera.
CO2. Students will have access to study reproductive structures of some bryophyte genera from permanent slides.

PTERIDOPHYTES
CO1. Students will have a first-hand experience regarding the morphological study of the plant body of selected pteridophyte genera.
CO2. They will have the opportunity to work out and learn in details about the reproductive structures of selected pteridophyte genera.
CO3. Students will have access to study reproductive structures of some pteridophyte genera from permanent slides.

GYMNOSPERMS
CO1. Students will have a first-hand experience regarding the morphological study of the plant body of selected gymnosperm genera.
CO2. Students will have access to study reproductive structures of some gymnosperm genera from permanent slides.

FIELD STUDY
Students will have the opportunity to familiarize themselves with the natural habitats of these groups of plants and develop concept about it.

Contact hours: 8hrs/week Practical: 8hrs/week

SEMESTER- III
CC 5

THEORETICAL- PALAEOBOTANY AND PALYNOLOGY

CO1. Students will gain detailed knowledge regarding Geological time scale with dominant plant groups through ages.
CO2. Plant Fossil: They will have elaborate concept regarding Body fossil (Micro- and Megafossils), Trace fossil, Chemical fossil, Index fossil; Different modes of preservation (Schopf, 1975); Conditions favouring fossilization; Nomenclature and Reconstruction; Principle of fossil dating and Importance of fossil study.
CO3. Fossil Pteridophytes: Students will gain detailed idea about Structural features, Geological distribution and Evolutionary significance of *Rhynia*, *Lepidodendron* (Reconstructed), *Calamites* (Reconstructed).

CO4. Fossil Gymnosperm: Students will gain detailed idea about structural features and Geological distribution of reconstructed genera: *Lyginopteris*, *Williamsonia*, *Cordaites*.
CO5. Indian Gondwana System: In-depth idea regarding Three fold division with major megafossil assemblages will be imparted to the students.
CO6. Palynology: Students will be exposed to concepts regarding Spore and Pollen; Pollen aperture types; NPC classification (Erdtman); Pollen wall- Sporopollenin, Stratification and Ornamentation (sculpturing).
CO7. Applied Palynology: Students will gain in depth knowledge regarding the Basic concepts of Palaeopalynology, Aeropalynology, Forensic palynology and Melissopalynology.

PRACTICAL- PALAEOBOTANY AND PALYNOLOGY

CO1. Students will have experience in Morphological study: *Ptilophyllum* and *Glossopteris* leaf fossils.
CO2. They will study from permanent slides: T.S. of stem of *Rhynia*, *Lepidodendron*, *Calamites*, *Lyginopteris*, *Cordaites*.
CO3. Students will have scope for in-depth study of Pollen types (colpate, porate and colporate) from permanent slides. Slides will be prepared from specimens: Colpate (*Leonurus sibiricus/ Brassica* sp.), Porate (*Hibiscus rosa-sinensis*), Colporate (*Cassia sophera/ C. tora*).
CO4. Classroom Preparation: They will undertake prepation of Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.

CC 6

THEORETICAL- REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

Morphology of angiosperms
CO1. Students will learn about Inflorescence types with examples.
CO2. Students will have in-depth idea about Flower, induction of flowering, flower development- genetic and molecular aspects.
CO3. They will know about Fruits and seeds - types with examples.
Embryology
CO1. Pre-fertilisation changes: Students will have an indepth understanding about Microsporogenesis and Microgametogenesis, Megasporogenesis and Megagametogenesis (monosporic, bisporic and tetrasporic).
Fertilization
CO1. Students receive a detailed idea regarding Pollen germination, Pollen tube- growth, entry into ovule and discharge, Double fertilization.
Post Fertilization Changes
CO1. Classification: Students will gain detailed idea regarding Embryogenesis in Capsella, Development of Endosperm (3 types).
Apomixis and Polyembryony
CO1. Students receive a detailed idea regarding Apomixis- Apospory and Apogamy, Polyembryony- different types.

PRACTICAL- ARCHAEGONIATE

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

CO1. Students will have a first-hand experience regarding the Inflorescence types- study from fresh/ preserved specimens.

CO2. Students will have access to study Flowers- study of different types from fresh/ preserved specimens.

CO3. Students will have access to study Fruits- study from different types from fresh/preserved specimens.

CO4. Students will have a first-hand experience regarding Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous).

FIELD STUDY

CO1. Students will have the opportunity to familiarize themselves with the reproductive parts and modes of reproduction in different plants and develop concept about it.

CO2. They will undertake a project supported along with photographs taken during field study to be submitted giving
comprehensive idea about different types of inflorescence, flowers and fruits.

Contact hours: 8hrs/week Practical: 8hrs/week

CC7

THEORETICAL- PLANT SYSTEMATICS

Taxonomy of Angiosperms

CO1. Introduction: Students have a indepth concept about components of Systematic, Nomenclature, Identification, Classification; Taxonomy and its phases - Pioneer, Consolidation, Biosystematic and Encyclopaedic; alpha- and omega- taxonomy.

CO2. Nomenclature: They gain knowledge regarding Type method, Publication, Rank of taxa, Rules of priority, Retention and rejection of names, Author Citation, Effective and valid publication, Elementary knowledge of ICN- Principles.

CO3. Systems of classification: Students have a broad outline of Bentham & Hooker (1862-1883), Cronquist (1988), Takhatajan (1991) - system of classification with merits and demerits. Brief reference of angiosperm phylogeny group (APG III) classification; Systematics in Practice: Herbaria and Botanical Gardens – their role in teaching and research;
important Herbaria and Botanical Gardens of India and world (3 each); Dichotomous keys –indented and bracketed.

CO$. Phenetics and Cladistics: Students gain brief idea on Phenetics, Numerical taxonomy- methods and significance; Cladistics- construction of dendrogram and primary analysis; Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy.

CO6. Data sources in Taxonomy: Students learn about supportive evidences from Phytochemistry, Cytology, Palynology and Molecular biology data (Protein and Nucleic acid homology).
CO7. Students gain detailed concept regarding diagnostic features, Systematic position (Bentham & Hooker and Cronquist), Economically important plants (parts used and uses) of the following families:
Monocotyledons: Alismataceae, Gramineae (Poaceae), Cyperaceae, Palmae (Arecaceae), Liliaceae, Musaceae, Zingiberaceae, Cannaceae, Orchidaceae.
6.2. Dicotyledons: Nymphaeaceae, Magnoliaceae, Leguminosae (subfamilies), Polygonaceae, Euphorbiaceae, Malvaceae, Umbelliferae (Apiaceae), Labiatae (Lamiaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Compositae (Asteraceae).

PRACTICAL- PLANT SYSTEMATICS

Angiosperms

CO1. Students gain hands on training in plant work out, description, preparation of floral formula and floral diagram, identification up to genus with the help of suitable literature of wild plants and systematic position according to Bentham & Hooker's system of classification from the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.
CO2. The gain skill in Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided).

Field Work

CO1. Students will have the opportunity to participate in at least three excursions including one excursion to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and Central National Herbarium (CNH).

FIELD RECORDS

CO1. Students will learn the procedures of writing Field Note Book with field notes on the plants of the area of excursion and workout on Angiosperms; Spot Identification; keeping of Lab records and Field Records (Field note book, herbarium specimens, voucher specimen book etc.).

SEMESTER IV

CC-8

THEORETICAL-PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION

Plant Geography

CO1. Phytogeographical regions: Students get to learn about the Phytogeographical regions of India (Chatterjee 1960); Dominant flora of Eastern Himalaya, Western Himalaya and Sunderban.

CO2. Endemism: They gain detailed concept regarding Endemic types and Factors; Age & Area hypothesis and Epibiotic theory; Endemism in Indian flora.

Ecology

CO1. Preliminary idea: Students will have preliminary idea about Habitat and Niche, Ecotone and edge–effect, Microclimate, Ecads, ecotype and ecoclines, Carrying capacity.

CO2. Community ecology: They will develop idea about Community-Characteristics and diversity, Ecological succession –Primary and secondary, Seral stages (with reference to Hydrosere), autogenic and allogenic succession.

CO3. They will learn about Plant indicators (metallophytes); Phytoremediation.

CO4. Conservation of Biodiversity: Students will develop elaborate concepts regarding Level of Biodiversity: genetic, species & ecosystem diversity, Biodiversity hot spots- criteria, Indian hotspots, In- situ and ex-situ conservation, Seed-banks, Cryopreservation.

Evolution

CO1. Introduction: Students will learn about the Theories of evolution: Natural selection, Group selection, Neutral theory of molecular evolution, Phyletic gradualism, Punctuated equilibrium and Stasis

CO2. Brief idea on: They will have elaborate idea about stabilizing, directional, disruptive and sexual selection; Speciation: Sympatric and allopatric speciation; Coevolution, Adaptive radiation, Reproductive isolation.

CO3. Students will come to know about simplified phylogeny of bacteria, algae, fungi, bryophyte, pteridophyte and gymnosperm, Phylogenetic tree.

PRACTICAL- PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION

Plant Geography

CO1. Students will have the scope of gaining first-hand knowledge about vegetation study through Field visit- at least one long excursion at different phytogeographical region of India.

CO2. They will undertake study of local flora and submission of a project report highlighting phytogeographical characteristics of the region.

Ecology

CO1. Students will learn the procedure of study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion/ field visit).

CO2. Students will have the scope to study comparative anatomical studies of leaves form polluted and less polluted areas.

CO3. They will learn about measurement of dissolved O2 by azide modification of Winkler's method.

CO4. They will learn to compare free CO2 from different sources.

CO5. Students will maintain Field Records (Field note book of phytogeographical study and ecological study)

CC- 9

THEORETICAL- ECONOMIC BOTANY

CO1. Origin of cultivated crops: Students will learn the concepts of centre 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.
CO2. Cereals: They will know the origin, morphology, processing and uses of Rice and wheat.
CO3. Legumes: They will come to know the origin, morphology and uses of gram and mung bean. Importance to man and environment.
CO4. Sugar and starches: Students will gain knowledge regarding the morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato- morphology, propagation and uses.
CO5. Spices: They will be able to list important spices, their family and part used.
CO6. Beverages: Students will learn about the morphology, processing and uses of Tea.
CO7. Oil and fats: Students will learn about the general description, classification, extraction, their uses and health implications of mustard, soybean, coconut (Botanical name, family and uses). Essential oils- general account, extraction methods, comparison with fatty oils and their uses.
CO8. Drug-yielding plants: They will have in-depth knowledge regarding the therapeutic and habit forming drugs with special reference to Cinchona, Digitalis, Papavar, Cannabis and Tobacco (morphology, processing, uses and health hazards).
CO9. Timber: They will have a general account with special reference to Sal and Teak.
CO10. Fibers: Students will learn the morphology, extraction and uses Cotton and Jute.

PRACTICAL- ECONOMIC BOTANY

Economic Botany
CO1. Cereals: Students will have general idea about Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests)
CO2. Legume: They will have detailed knowledge about Soybean, ground nut (habit, fruit, seed structure, micro-chemical tests)
CO3. Source of sugars and starches: Students will have general idea about Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch grains, micro-chemical tests.
CO4. Students will have detailed idea about Tea- tea leaves, tests for tannin

CO5. Students will have detailed idea about Mustard- plant specimen, seeds, tests for fat in crushed seeds
CO6. They will be able to make habit sketch of Digitalis, Papaver and Cannabis.
CO7. They will be able to make Sal, Teak- section of young stem.
CO8. They will be able to make Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fibre following maceration technique.

CC-10
THEORETICAL- GENETICS
CO1. Introduction: Students will develop concept about Mendelian genetics and its extension.
CO2. They will learn in details about Linkage, Crossing over and Gene Mapping: Complete and incomplete linkage (example), linked gene does not assort independently (example), linkage group, Crossing over, crossing over produces recombination (example), detection of crossing over (McClintock's experiment), and Molecular mechanism of crossing over (Holliday model), 2.4. Gene mapping with three point test cross, detection of middle gene in three point test cross, calculation of recombination frequencies, 2.5. Co-efficient of coincidence.
CO3. They will have the opportunity of a field visit desirable to give an idea about cultivation of any crop (viz. rice, jute, mustard, tea, potato)
CO4. They will keep field record of the visit, properly authenticated by escorting teacher. interference, mapping function, Problems on gene mapping, Molecular mapping – ISH, FISH (brief idea).
CO5. Students will learn in details regarding Epistasis and Polygenic inheritance in plants.
CO6. Aneuploidy and Polyploidy: They will know about the types, examples, meiotic behaviour and importance of: Aneuploidy, Polyploidy, Speciation and evolution through polyploidy.
CO7. Chromosomal aberration: They will know about the types and meiotic behaviour of: Deletion, Duplication, Translocation, and Inversion.
CO8. Mutation : Students will have in-depth concept regarding Point mutation-Transition, Transversion and Frame shift mutation, Molecular mechanisms (tautomerisation, alkylation, deamination, base analogue incorporation, dimerisation), DNA repair (brief idea).
CO9. Students will learn in details about the structural organisation of Gene: One Gene–one polypeptide concept, Split gene, Overlapping gene, Repetitive DNA tandem and interspersed, Transposon (Ac-Ds system), Homoeotic gene in plants (ABCE Quartet model of flowering).

PRACTICAL- GENETICS

Genetics

CO1. Introduction to chromosome preparation: Students will have hands on training in pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides.

CO2. They will learn determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of Allium cepa.

CO3. Study of mitotic chromosome: They will learn the skills of metaphase chromosome preparation, free hand drawing under high power objective, drawing with drawing prism under oil immersion lens, determination of 2n number, and comment on chromosome morphology of the following specimens from root tips: *Allium cepa, Aloe vera, Lens esculenta.*

CO4. They will study chromosomal aberrations developed due to exposure to any two pollutants/ pesticides etc.

CO5. Study of meiotic chromosome: The will undertake smear preparation of meiotic cells, identification of different stages and free hand drawing of the following specimens from flower buds: *Allium cepa* and *Setcreasea* sp.

CO6. Identification from permanent slides : Students will gain skill in Meiosis – (i) normal stages (ii) abnormal stages – laggard, anaphase bridge, ring chromosome (*Rhoeo discolor*); Mitosis – (i) normal stages, (ii) abnormal stages early separation, late separation, multipolarity, sticky bridge, laggard, fragmentation, (ii) pollen
mitosis.

SEC-A: SKILL ENHANCEMENT COURSE

THEORETICAL- APPLIED PHYCOLOGY, MYCOLOGY AND MICROBIOLOGY

Applied Phycology

CO1. Students will learn about Algae as food and source of phycocolloid (Agar-agar, Algin, Carrageenan), 2. Diatomite, 3. Algal toxin, 4. Algal Biotechnology – potential of microalgae for SCP, β-carotene, Biodiesel, bioplastics from algae.

Applied Mycology

CO1. They will learn the use of Fungi as food, 2. Cheese and Ethanol-Industrial production (brief outline), 3. Fungal sources and uses of Enzyme (Cellulase), Amino acid (Tryptophan), Vitamin (Riboflavin), Antibiotic (Griseofulvin), Pharmaceuticals (Cyclosporin-A). 4. Aflatoxin.

Applied Microbiology

CO1. Students will gain knowledge regarding Industrial Production of Vinegar and Streptomycin (brief outline).

CO2. They will learn the Microbial sources and uses of Enzyme (Amylase, Protease), Amino acid (Glutamic acid, Lysine), Polysaccharides (Dextran).
CO3. They will be acquainted about the use of microbes as Biofertilizer and Biopesticides, 3.4. Use of microbes in mineral processing.

THEORETICAL- BIOFERTILIZERS

CO1. Students will learn the general account about the microbes used as biofertilizers- *Rhizobium*- isolation, identification, mass multiplication, carrier based inoculants, actinorrhizal symbiosis.

CO2. They will learn in details about *Azospirillum*: isolation and mass multiplication- carrier based inoculants, associative effect of different microorganisms.

CO3. They will learn in details about *Azotobacter*: classification, characteristics- crop response to *Azotobacter* inoculants, maintenance and mass multiplication.

CO4. They will learn in details about Cyanobacteria (Blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation. Factors affecting growth, blue green algae and *Azolla* in rice cultivation.

CO5. Students will learn in details about Mycorrhizal association, types of mycorrhizal association, phosphorus nutrition, growth and yield- colonisation of VAM – isolation and inoculum production of VAM and its influence on growth and yield of crop plants.

CO6. Organic farming- green manuring and organic fertilizers, recycling of biodegradable municipal, agricultural and industrial wastes- biocompost making methods, types and methods of vermicomposting- field application.

GENERAL

SEMESTER I

CC 1

THEORETICAL- PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY)

CO1. Students will be Introduced to different plant groups.

CO2. Phycology: This course aims at acquainting students about the diagnostic characters and examples of selected groups of algae, they also learn about the classification and life-cycle of some algae in details. The students also develop concept about role of algae in the environment, agriculture, biotechnology and industry.

CO3. Mycology: This course aims at acquainting students about the diagnostic characters and examples of selected groups of fungi, they also learn about the classification and life-cycle of some fungi in details. The students also develop concept about role of fungi, mycorrhiza and lichens in the environment, agriculture, biotechnology and industry.

CO4. Phytopathology: Students get to learn about different terminologies and concepts prevalent in plant-disease study. They learn in details about the **s**ymptoms, causal organism, disease cycle and control measures of selected plant diseases.

CO5. Bryophytes: Students gain indepth concept about unifying features of archaegoniates and transition to land habit, amphibian nature of bryophytes, diagnostic characters and examples of major groups of bryophytes. They also

learn in details about the life histories of selected genera of bryophytes. The also gain concept regarding the ecologic and economic importance of the group.
CO6. Anatomy: Students get to know in etails regarding the anatomical details of stomata, root, stem and leaf of monocots and dicots. They also have the scope to learn about different stelar types, their evolution and mode of secondary growth (both normal and anomalous) in selected plant genera.

PRACTICAL- PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY)

CO1. Work out: Students have hands-on experience in microscopic preparation, drawing and labeling of selected algal and fungal genera.
CO2. Anatomical studies: They have the exposure to undertake anatomical study with stem, root and leaf of selected plant genera.
CO3. They learn to identify different cryptogamic and plant disease specimens using observable characteristics.
CO4. Students are provided with scope to participate in local excursion where they can develop an in situ concept about plant diversity, habitat of algae and fungi etc.

Contact hours: 14hrs/week Practical: 10hrs/week

SEMESTER II
CC 2

THEORETICAL- PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY)

Pteridophytes
CO1. Students gain detailed knowledge regarding major pteridophyte groups.
CO2. They also get to know in details regarding the life-history of selected pteridophyte genera.
CO3. They learn about the economic importance of pteridophytes.
Gymnosperms
CO1. Students gain detailed knowledge regarding major gymnosperm groups.
CO2. They also get to know in details regarding the life-history of selected gymnosperm genera.
CO3. They learn about the economic importance of gymnosperms.
Paleobotany & Palynology
CO1. Students have scope to learn in details regarding fossil, fossilization process, factors of fossilization and importance of fossil study.
CO2. They have a clear concept regarding the Geological time scale.
CO3. They gather useful concepts regarding palynology and its applications.
Angiosperm Morphology
CO1. Students learn in details regarding different types of inflorescence, flowers, fruits and seeds with examples.

Taxonomy of Angiosperms

CO1. Student get scope to develop in-depth concept regarding Artificial, Natural and Phylogenetic systems of c1assificaiton with example.

CO2. They get to learn about the diagnostic features of very carefully selected angiosperm families.

PRACTICAL- PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY)

CO1. Students get the opportunity to dissect, draw and label, describe angiospermic plants from selected families. They also learn about floral parts, floral formula and floral diagram in details.

CO2. They get the scope to develop skill in identification of the plants.

CO3. Students learn to identify citing reasons pteridophyte, gymnosperm and various morphological and anatomical specimens (both macro- and

CO4. They learn to spot identify a number of selected Angiospermic plants belonging to different families.

CO5. Students have the opportunity to participate in field excursion to gain first-hand knowledge about the plants and plant-groups they hae studied in their class-room.

CO6. They learn the skills required to maintain field records and herbarium sheets of common Angiospermic weeds.

Contact hours: 5hrs/week Practical: 4hrs/week

SEMESTER III

CC-3

THEORETICAL- CELL BIOLOGY, GENETICS AND MICROBIOLOGY

CO1. Cell Biology and Genetics: Students will learn in details about the ultrastructure of nuclear envelope, nucleolus and their functions, Molecular organisation of metaphase chromosome (Nucleosome concept).

CO2. Chromosomal aberrations: They will know about deletion, duplication, inversion & translocation, Aneuploidy & Polyploidy-types, importance and role in evolution.

CO3. Central Dogma: Students will gain concept about Transcription and Translation.

CO4. Genetic Code- they will learn the properties.

CO5. Students will have elaborate idea about Linkage group and Genetic map (three-point test cross).

CO6. Mutation – They will have detailed understanding of Point mutation (tautomerisation; transition, transversion and frame shift), Mutagen-physical and chemical.

CO7. They will have a brief concept of Split gene, Transposons.

Microbes

CO1. Viruses- Students will know about the discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance.

CO2. Bacteria- They will know about the discovery, general characteristics and cell structure; reproduction- vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

PRACTICAL- CELL BIOLOGY, GENETICS AND MICROBIOLOGY

CO1. Cell Biology: Staining (Aceto-orcein) and squash preparation of onion root tip: study of mitotic stages. Determination of mitotic index (from onion root tip).

CO2. Microbiology: They will gain skill in the workout gram staining (curd/any natural source).

CO3. Identification with reasons: They will have the opportunity to observe Cytological slides of different mitotic and meiotic stages. Different forms of bacteria (Coccus, Bacillus, Spiral).

CO4. Laboratory Records: Students will learn how to maintain laboratory note books (regularly signed) and slides**.**

SEMESTER IV

CC-4

THEORETICAL- PLANT PHYSIOLOGY AND METABOLISM

CO1. Proteins: Students will gain detailed concept on primary, secondary and tertiary structure, Nucleic acid- DNA structure, RNA types, Enzyme- Classifications with examples (IUBMB), Mechanism of action.

CO2. Transport in plants: They will learn the mechanism behind Ascent of sap and Xylem cavitation, Phloem transport and source-sink relation.

CO3. Transpiration: They will learn the mechanism of stomatal movement, significance.

CO4. Photosynthesis: Students will learn in details about the Pigments, Action spectra and Enhancement effect, Electron transport system and Photophosphorylation, C3 and C4 photosynthesis, CAM- Reaction and Significance.

CO5. Respiration: They will learn in details about Glycolysis & Krebs cycle—Reactions and Significance, ETS and oxidative phosphorylation.

CO6. Nitrogen metabolism: They will know about biological dinitrogen fixation, Amino acid synthesis (reductive amination and transamination).

CO7. Plant Growth regulators: They will learn in details about Physiological roles of Auxin, Gibberellin, Cytokinin, Ethylene, ABA.

CO8. Photoperiodism: Students will come to know about plant types, Role of phytochrome and GA in flowering) and Vernalization.

CO9. Students will have a brief idea about Senescence.

PRACTICAL- PLANT PHYSIOLOGY AND METABOLISM

Plant Physiology:

CO1. Students will have hands on experience regarding **e**xperiment on Plasmolysis.

CO2. Students will have hands on experience regarding **m**easurement of leaf area (graphical method) and determination of transpiration rate per unit area by weighing method.

CO3. Students will have hands on experience regarding **i**mbibition of water by dry seeds - proteinaceous and fatty seeds.

CO4. Students will undertake experimental setups on evolution of O2 during photosynthesis (using graduated tube).

CO5. Students will undertake experimental setups on evolution of CO2 during aerobic respiration and measurement of volume.

SEC A

PLANT BREEDING AND BIOMETRY

CO1. Plant breeding: Students will have idea on **i**ntroduction and objective, Techniques of hybridisation.

CO2. Mass and Pure line selection: They will come to know about the Procedure, Advantages and limitations.

CO3. Students will learn about Heterosis and hybrid seed production.

CO4. They will come to know about the **r**ole of mutation, polyploidy, distant hybridization and role of biotechnology in crop improvement.

CO5. Biometry: Students will develop concept on Measures of central tendency (Mean, Median and Mode), Standard error and standard deviation, Test of significance: Chi-square test for goodness of fit.

BIOFERTILIZERS

CO1. Biofertilizers: Students will learn the **g**eneral account about microbes used as biofertilisers; Rhizobiumidentification, mass multiplication. Actinorrhizal symbiosis.

CO2. They will gain knowledge regarding *Azospirillum*- identification, mass multiplication, associative effect of different microorganisms. *Azotobacter* and crop response to *Azotobacter* inoculums.

CO3. They will learn in details about *Cyanobacteria, Azolla, Anabaena* and *Azolla* association, blue green algae and *Azolla* in rice cultivation.

CO4. They will gain idea about Mycorrhizal association: Types of Mycorrhizal association- Brief idea, Its influence on growth and yield of crop plants.

CO5. Organic farming: Students will gain knowledge about **g**reen manuring and organic fertilizers, Biocompost and vermicompost- making methods and field applications. Recycling of biodegradable municipal, industrial and agricultural wastes.

Under 1+1+1 System

PART II

HONOURS

PAPER III

THEORETICAL- Pteridophytes, Gymnosperms, Ecology and Plant Geography, Anatomy

PTERIDOPHYTES

1.General account of Pteridophytes.

CO1. Understanding the general characters, structure, reproduction, life cycle pattern.

1.1.Colonisation and rise of early land plants.

CO1. Understanding the origin of sporophyte land plants, and their colonization.

1.2.Classification of Vascular Plants by Gifford and Foster (1989) up to division (Rhyinophyta to Filicophyta) with diagnostic characters and examples.

CO1. Understanding the arrangements of vascular plants in taxonomic groups according Gifford and Foster from Rhyinophyta to Filicophyta with their diagnostic characters with examples.

2. Life history.

CO1. Undestanding about occurrence ,distribution and life cycle pattern about different genera of pteridophytes.

Sporophyte structure, Reproduction and Gametophyte structure in 2.1Psilotum.2.2 Selaginella 2.3 Equisetum 2.4 Dryopteris.

CO1. Understanding the structure of both phases sporophytic and gametophytic and reproduction in genus Psilotum,.Selaginella,Equisetum and Dryopteris.

3. Fossil Pteridophytes.

CO1. Undestanding about the origin, classification, structure of fossil pteridophytes.

Structural features, Geological distribution and Evolutionary significance of 3.1 Rhynia.3.2 Lepidodendron.3.3 Calamites.

CO1. Understanding the morphological, anatomical features their distribution and evolutionary significance of Rhynia, Lepidodendron, and Calamites.

4. Telome concept and its significance in the origin of different groups of Pteridophytes.

CO1. Understanding the theory that the megaphylls of ferns and seed plants evolved by the modification of the terminal branches of stems and their significance in different genera of pteridophytes.

5. Hetrospory and Origin of seed habit.

CO1. Understanding the production of two or more type of spores in a single plant and Origin of seeds and seed habit in vascular plants from hetrospory.

6. Economic importance as food, medicine and Agriculture.

CO1. Undestanding economic use of pteridophytes as food medicine and in agriculture.

GYMNOSPERMS.

1 .Classification of vascular plants by Gifford and Foster (1989) up to division (progymnospermophyta to Gnetophyta) with diagnostic characters and examples.

CO1. Understanding the classification from earlier woody plants to advanced group of gymnosperms by Gifford and Foster, with their general characters like habit, occurrence, structure with examples.

2. Progymnosperms.

CO1. Understanding about earlier woody plants.

2.1. Diagnostics Characters of the group 2.2.Vegetative and Reproductive features of Archeopteris.2.3. Phylogenetic importance.

CO1. Understanding the important characters of progymnosperms morphological, anatomical and reproductive characters of Archeopteris.And their evolutionary importance.

3. Life History.

CO1. Understanding the occurrence, distribution, life cycle pattern in gymnosperms.

Distribution in India, vegetative and reproductive structure, Development of gametophyte and Embryogeny in 3.1 Cycas.3.2 Pinus.3.3 Gnetum.

CO1. Understaning the distribution of genus Cycas, Pinus and Pnetum in India their vegetative and reproductive structure of sporophyte and gametophytes development.

4. Fossil Gymnosperms.

CO1. Understanding general account of fossil gymnosperms.

Structural features and Geological distribution of reconstructed genera: 4.1 Lyginopteris.4.2 Williamsonia.4.3 Cordaites.

CO1. Understanding the distribution of Lyginopteris, Williamsonia, and Cordaites according to geological time scale, and their structure.

5. Economic Importance with reference to wood, Resins, Essential oils and Drugs.

CO1. Understanding the economic importance of gymnosperms relating wood used as furnitures, essential oils and drugs.

ECOLOGY

1. Preliminary idea on:

CO1. Understanding the primary ideas on ecosystem.

1.1Habit and Niche, Ecotone and edge effect, 1.3 Microclimate, 1.4Ecads ecotypes and ecoclines, 1.5 Carrying capacity.

CO1. Undestanding ecological habit the specific area where organism inhabits, transitional areaof vegetation between two different plant communities, climate of very small area which differ from the surrounding, distinct form or race plant species occupying particular habitat.

2. Community ecology:

CO1. Understanding about different communities of ecosystem.

2.1. community-characteristics and diversity.

CO1. Understanding the diversification of different communities with characters.

2.2. Ecological Succession- Primary and secondary, seral stages, autogenic and allogenic succession

CO1. Understanding the process of change in species structure of ecological community, seral stages, and succession driven by biotic and abiotic components.

3.3.1. Plant indicators; 3.2 .Phytoremediation.

CO1. Understanding the indicator species respond closely to metal concentration and bioremediation of various plants to remove, transfer, and destroy the contaminants in soil and groundwater.

4. Conservation of Biodiversity.

CO1. Understanding the conservation of biodiversity.

4.1. Level of Biodiversity: genetic species and ecosystem diversity.

CO1. Understanding the three levels of biodiversity genetic, species and ecological.

4.2. Biodiversity hotspots-criteria, Indian hotspots

CO1. Understanding the criteria to qualify as a biodiversity hotspots and Indian hotspots.

4.3. In-situ and Ex-situ conservation, 4.4 Seed-banks, 4.5.Cryopreservation, 4.6 Geographic Information system and remote sensing (brief idea)

CO1. Understanding the conservation of plants species in their natural and outside the natural habitats store the seed to preserve genetic diversity and use of very low temperature to preserve the structure of living cell intact.

PLANT GEOGRAPHY

5: Phytogeographical regions:

CO1. Understanding the area of uniform climatic conditions and having distinct types of vegetation.

5.1. Phytogeographical regions of India (chatterjee 1960);5.2 Dominant flora of Eastern and Western Himalaya and Sunderban.

CO1. Understanding the different phytogeographical regions of India according to Chatterjee and knowing about dominant plants of Eastern western and Sunderban areas.

6. Endemism:

CO1. Understanding the ecological state of a species being unique to a particular habitat.

6.1. Endemism types and Factors; 6.2.Age and Area hypothesis Epibiotic theory; 6.3.Endemism in Indian flora.

CO1. Understanding different types of Endemism factors area hypothesis, different theory of Epibioticc and endemism in Indian plants.

ANATOMY

1. Cell wall

1.1. Ultrastructure and chemical constituents.

CO1. : Understanding fine detail structure of cell wall and its composition.

1.2Plasmodesmata ultra structure.

CO1. understanding about fine structure of cytoplasmic canal that passes through plant cell walls.

1.3.Concept of apoplast and symplast.

CO: Understanding the movement of water and solute through protoplasmic and nonprotoplasmic parts.

1.4. Growth and thickening of cell wall.

CO1. Understanding the modification of cell according to function they perform and parts like xylem phloem undergo heavy thickening of their walls.

2. STOMATA.

21. Types and 2.2 Ontogeny.

CO1. Understanding the different types and origination and development of stomata.

3. Ontogeny of 3.1 Trachea and 3.2 Sieve tube.

CO1. Understanding the origination and development of Xylem vessels and living part of phloem.

4. Stele. 4.1 Leaf trace and Leaf gap.4.2 stellar types and its evolution.

CO1. Understanding the extension of vascular tissue from stem into the leaf and space from which leaf grows and types of stele and its origin and evolution.

5. Secondary growth:

CO1. Understanding the increase in thickness of the plant parts due to the activity of vascular cambium and cork cambium.

5.1 .Normal (intrastelar and extrastelar).

CO1. Understanding the secondary growth in stelar region by vascular cambium and in cortex due to cork cambium.

5.2. Anomalous (stem of Bignonia, Boerhavia, Tecoma, Dracaena and root of Tinospora).

CO1. Understanding the abornormality of cambium tissue in different Genera.

6. Mechanical tissue and principles governing their distribution in Plants.

CO1. Understanding the principles regarding the construction of mechanical tissue and their distribution.

7. Developmental Anatomy:

CO1. Understanding the structural changes of an plant from initial stage to its maturity.

7.1. Organisation of shoot apex (Tunica-corpus) and root apex (Korper-Kappe).
CO1. Understanding the developmental and organisation of shoot and root apex based on the theories concerned on plane of cell division.
7.2. Plastochron.
CO1. Understanding the time interval between initiations of leaf growth between two consecutive nodes in a growing shoot apex.
8. Ecological Anatomy:
CO1 Understanding the anatomical adaptation by group of plants species under the stress condition.
Adaptive anatomical featuresof 8.1.Hydrophytes 8.2. Xerophytes.
CO1. Understanding the anatomical characters of plants living in dry condition and in water for the adaptation.

PAPER IVA
THEORETICAL- Morphology of Angiosperms, Taxonomy of Angiosperms
MORPHOLOGY OF ANGIOSPERMS
1. Inflorescence types with examples.
CO1. Understanding about the different types of arrangement of flower on floral axis.
2. Flower: Corolla- forms, aestivation; Stamen- types; Placentation-types; Ovule - structure and forms.
CO1. Describing and understanding different parts of flower including different whorls, types of placentation and ovule.
3. Fruit - types with examples.
CO1. Describing different types of fruits along with its classification according to different aspects.
TAXONOMY OF ANGIOSPERMS
1. Introduction :
1.1. Components of Systematics: Nomenclature, Identification, Classification; 1.2. Taxonomy and its phases -Pioneer, Consolidation , Biosystematic and Encyclopaedic ; alpha- and omega- taxomony .
CO1. Understanding about the conception of biosystematics in detail including basic knowledge of taxonomy.
2. Nomenclature :
Elementary knowledge of ICBN: Principles; Rank of taxa, Retention and rejection of names; Type method; Principleof priority; Effective and valid publication; Author Citation.
CO1. Knowing about the rules and regulation of botanical code along with nomenclatural type method.
3. Systems of classification :
Broad outline of Bentham & Hooker (1862-1883), Cronquist's (1988) system of classification with merits and demerits

CO1. Discussing the classification system of plants according to different authors and their merits and demerits.

4. Systematics in Practice :

4.1. Herbaria and Botanical Gardens – their role; important Indian Herbaria and Botanical Gardens; 4.2. Dichotomouskeys – indented and bracketed.

CO1. Study the methods of plant exploration, collection, preparation of herbarium and its identification by using different keys. Also know about the Herbaria and Botanical Garden.

5. Phenetics and Cladistics :

Brief idea on Phenetics, Numerical taxonomy; Cladistics; Monophyletic, polyphyletic and paraphyletic groups;Plesiomorphy and apomorphy.

CO1. Establishing the relationship among ancestral plants with its descendent by using different methods particularly Phenetics and Cladistics.

6. Data sources in Taxonomy:

Supportive evidences from : 6.1. Phytochemistry, 6.2. Cytology, 6.3. Anatomy.

CO1. Study of different data sources of taxonomy and its different supporting evidences.

7. Diagnostic features, Systematic position (Bentham & Hooker and Cronquist), Economically important plants (parts used and uses) of selected families.

CO1. Discussing Salient features of different Dicotyledons and Monocotyledons plant families and their importance.

PAPER IVB

PRACTICAL

1. Workout on Pteridophytes

CO1. Critically analyzing and understanding the important cellular structure of different pteridophytes and tracing the evolutionary lineage of this particular plant group and also correlating with other group of plants.

2. Workout on Angiosperms

CO1. Learning the process of plant dissection, illustration, description and diagnosis and also identifying the plant with the help of different floras including the procedure of handling the different types of keys.

3. Spot Identification

CO1. Examining critically the different plant parts particularly cellular structure and identify them through microscope or by naked eyes.

4. Identification with reasons (Pteridophyte - 1, Gymnosperms - 2, Palaeobotany/Palynology–1,)

CO1. Investigating critically the different microscopic or macroscopic plant parts or plant body and identify them using proper reason.

Contact hours: 5hrs/week Practical: 6hrs/week

PART-II

GENERAL

Paper-II

Theoretical-Module III: Anatomy, Cell Biology and Genetics.

Module IV:Biochemistry and Plant Physiology, Economic Botany, Ecology.

1. Anatomy:

CO1. Classification of different types of stomata and understanding the detail cellular structure of different types of stele, roots, stems and leaves of monocots and dicots plant along with is anomalous secondary growth.

2. Cell Biology and Genetics:

CO1. Understanding the different cytological structure particularly nuclear envelope, nucleolus, chromosome and DNA. Understanding the mechanism of DNA replication, transcription and Translation and also the process of chromosomal abaration along with different types of cytological event related to Chromosome, DNA and gene.

3. Biochemistry and Plant Physiology:

CO1. Understanding the different macromolecular structure of different biochemical process of plant cell including structure of protein, enzyme. Also understanding the different physiological processes of plant and its effects. Besides knowing the structure and functions of different plant hormones.

4. Economic Botany:

CO1. Study of different economically important plants including their scientific names, families, partsused and importance.

5. Ecology:

CO1. Understanding about the ecological system including its different factors. Also knowing about the biodiversity and its conservation and Phytoremediation.

Paper-III

Practical

Module V

1. Cryptogams:

CO1. Understanding the vegetative and reproductive structure bythe process of microscopic slide preparation, drawing and labeling, description and identification of them.

2. Angiosperms:

CO1. Learning the process of plant dissection, illustration, description and diagnosis and also identifying the plants.

3. Identificaiton with reasons:

CO1. Examining critically the different plant parts particularly cellular structure and identify them through microscope or by naked eyes.

4. Spot identification

CO1. Examining critically and identifying the different plants and its family by their diagnostic characters.

Module VI

1. Plant Physiology:
CO1. Examining the different physiological processes of plants.
2. Anatomy:
CO1. Critically analyzing and understanding the important cellular structure of different plant parts and identifying them by their diagnostic characters.
3. Cell Biology:
CO1. Knowing the process of preparation of squash and study of mitotic stages and determination of mitotic index.
4. Identificaiton with reasons:
CO1. Examining the different mitotic and meiotic stages by using its critical characters.

Contact hours: 5hrs/week Practical: 6hrs/week

PART III
HONOURS

PAPER V (THEORETICAL)
BIOCHEMISTRY
CO1. Biochemical Foundations:
Students will get an idea about various types of bonds, pH,Buffer solution, structure and properties of water.
CO2. Molecules of life
Study about nucleic acids, B and ZDNA, RNA, Nucleotides and nucleosides, biochemistry of proteins, carbohydrates and lipids.

CO3. Energy flow and enzymology :
To understand Bioenergetics-Thermodynamic principles, Biological redox reactions, Enzymes – classification and nomenclature enzyme action and Enzyme kinetics

CO 4. Cell membrane and Biosignalling :.
Study about Membrane chemistry, transport , Signal transduction pathway and second messenger concept - G-protein and Ca2+ as messenger.

CO 5. Phosphorylation :
Gives an overview of ATP synthesis (Chemiosmotic theory)and differences between oxidative and photophosphorylation

PHARMACOGNOSY
CO1. Gives a. general account of Pharmacognosy and its importance in modern medicine, Crude drugs, Classification of drugs, Drug evaluation
CO2. Secondary metabolites :
Definition of secondary metabolites, basic metabolic pathways with secondary metabolite biosynthesis Major types– with examples.
CO 3. Pharmacologically active constituents :

To study about Source plants, parts used and uses of some secondary metabolites.

PLANT PHYSIOLOGY

CO1. Plant-water relations:

To examine the Concept of water potential, Soil-plant-Atmosphere continuum concept, Transpiration and stomatal physiology.

CO2. Organic translocation

To focus about phloem transport and various hypothesis about Organic Translocation and its critical evaluation.

CO3. Photosynthesis :

The students will understand about the photosynthetic pigments ,importance, components, process and stages of photosynthesis with details of various pathways C3, C4,and CAM and their differences with stoichiometry and their ecological significance and photorespiration .

CO4. Respiration:

To evaluate the respiration process, various phases, regulatory steps ,site of respiration, types of respiration mitochondrial ETS and stoichiometry of glucose oxidation(aerobic)..

CO5. Nitrogen Metabolism :

Students will be given an idea of Assimilation of nitrate by plants, Biochemistry of dinitrogen fixation in Rhizobium, and General principle of amino acid biosynthesis (including GS and GOGAT enzyme system).

CO6. Plant Growth Regulators :

To assess and describe about Physiological roles of (Growth regulators) Auxin, Gibberellin, Cytokinin, Abscisic acid, Ethylene ,Chemical nature –IAA, GA3,Kinetin, Biosynthesis and bioassay of IAA, Mode of action of IAA, Brassinosteroids and Polyamines as PGRs (brief idea).

CO7. Photomorphogenesis :

To know about the concept of photomorphogenesis Photoperiodism Phytochrome, Role of GA in flowering, Vernalisation Concept of biological clock and biorhythm .

CO8. Seed dormancy :

Students will study the Types; Causes and Methods of breaking seed dormancyBiochemistry of seed germination.

CO9. Physiology of Senescence and Ageing.

This topic will help the students understand briefly about plant senescence and ageing process.

CO10. Stress Physiology

The students will be made aware of Plant responses to Water stress, Temperature stress and Salt stress.

PAPER VI

1. CELL BIOLOGY

CO1. Origin and Evolution of Cells :
Students will get idea about origin of cells, and origin of (cp-and mt-DNA).
CO2. Nucleus and Chromosome :
An elaborative structure for students regarding detailed idea about nuclear structure and ribosomebiogenesis and chromosomal and DNA structure.
CO3. Cell cycle and its regulation :
A detailed idea about cell cycle mechanism in yeast and its checkpoints and its related mechanism of apoptosis

PLANT BREEDING & BIOMETRY
CO1. Plant Breeding:
An idea for students about Molecular Breeding (use of DNA markers in plant breeding), Mass selection and Pure line selection and Heterosis and hybrid seed production
CO2. Biometry:
An idea for students about biostatistical measures, biostatistical analysis methods, Test of significance: 't'- test; chi square test for goodness of fit, Probability and Measurement of gene frequency (Hardy-Weinberg equilibrium).

PLANT BIOTECHNOLOGY
CO1. Plant tissue culture –
An Introduction to Plant tissue culture method and the requirements for tissue culture
CO2. Callus culture:
A detailed idea for students about the process for callus culture and its maintenance.
CO3. Micro propagation:
The students will get an idea about Organogenesis (direct and indirect), Somatic embryogenesis, Artificial seed, and its significance.
CO4. Haploid Culture:
A detailed process for students about Anther and Pollen culture methods, and its significance .
CO5. Protoplast Culture:
A clear picture about the method of Protoplast isolation, culture, Protoplast fusion (somatic hybridization) and its Significance.
CO6. Plant Genetic Engineering:
A detailed idea about achievements of plant genetic engineering and outcome of technology that is production of transgenic crops.

GENETICS & MOLECULAR BIOLOGY
CO1. Linkage, Crossing over and Gene Mapping :
Detailed idea for students about of Detection of crossing over (McClintock's experiment), Molecular mechanism of crossing over (Holliday model) and the process of Gene mapping.
CO2. Epistasis and Polygenic inheritance in plants.

The students will get an idea about Aneuploidy and Polyploidy and its application on agriculture

CO4. Chromosomal aberration:

Students will be benefitted about the types and the application of meiotic behavior of Deletion, Duplication, Translocation and Inversion.

CO5. Mutation :

The students will get an idea about mutation and molecular mechanism of mutation types and DNA repair and its mechanism.

CO6. Structural organization of Gene :

A detailed idea for the students about structure and organization different types of gene for example Overlapping gene,Repetitive DNA-tandem and interspersed,Transposon (Ac-Ds system)and Homoeotic gene in plants (ABCmodel in Arabidopsis).

CO7. DNA Replication, Transcription and Translation (Prokaryotes & Eukaryotes):

An idea for students about the basic process of a living cell , the central dogma, its detailed process, enzymes involved and RNA processing.

CO8. Gene Regulation :

Students will get idea about concept of Lac-operon, and its Positive and negative control.

CO9. Genetic Code :

A structure about Properties-evidences & exceptions of genetic code

CO10. Recombinant DNA Technology

Detailed idea for students about DNA technology its applications .The enzymes involved in the process of DNA technology, marker genes, and formation of Genomic DNA and C- dna library are quiet beneficial for the students.

CO11. Bioinformatics: Brief concept on 11.1 Genomics, 11.2 Proteomics.

Paper VII
Practical

PLANT BIOCHEMISTRY

CO1. Students will get hands- on practical experience in Qualitative estimation of organic acids, carbohydrate and protein estimation from plant products, detect the nature of carbohydrate from laboratory samples and detect mineral nutrients from plant ash.

CO2. Students will also have practical experience in Quantitative estimation of amino nitrogen, glucose, TAN, enzyme activity(catalase and urease),and colorimetric estimation of protein.

PLANT PHYSIOLOGY

CO1. Students will be exposed and be able to carry out various plant physiological experiments themselves and learn about methodology of plant physiological experiments on Imbibition, measurement of osmotic pressure,

transpiration and evaporation, stomatal frequency, photosynthesis ,separation of plastidial pigments, respiration and about parameters like Q10.

ANATOMY

CO1. Students will gain an insight on anatomical features of plant cells, stomatal morphology through microscopic studies.

CO2. Students will learn about the anatomical features with special emphasis on Anamolous secondary growth of stem and root sections.

CO3. Study and note the adaptive anatomical features of Hydrophytes and Xerophytes.

PHARMACOGNOSY

CO1. Perform and learn about chemical tests on Tanin and Alkaloids.

CO2. Students will have hands-on experience on practical metholodology on powder microscopy using Zingiber and Holarrhena.

CO3. Perform and learn about Histochemical tests on Curcumin, Starch , and Alkaloid.

PAPER VIII

CELL BIOLOGY AND GENETICS

CO1. Detailed idea for students about the process of evaluation of mitotic index, idea about the stages of mitosis and meiosis, Study of mitotic chromosome : Metaphase chromosome preparation from from root tips: Allium cepa , Aloe vera , Lens esculenta. Identification from permanent slides gives detailed and clear idea about how and why the chromosomal abnormalities happen and how they look like.

BIOMETRY

CO1. It gives students an idea about the process of determination of goodness of fit in normal and modified mono-and dihybrid ratios by Chi-square analysis and on the nature of inheritance.

Contact hours: 11hrs/week Practical: 10hrs/week

PART-III
GENERAL
THEORETICAL

Paper-IVA

Module VII

Biofertilizer:

CO1. Detailed information about the sources , production and application of biofertilizer

Mushroom:

CO1. Students are benefitted with the idea about how the common edible mushrooms are cultivated and used as food.

Plant disease control:

CO1. Students get an idea about the common plant disease and their control measures both chemical and biological along with its quarantine methods

Plant Breeding:

CO1. An idea for students about Mass and Pure line selection, Heterosis and hybrid seed production .

Biometry:

CO1. Biometrical methods are studied by the students along with Measures of Central Tendency and Goodness of fit (Chisquaretest).

Plant tissue culture:

CO1. Detailed idea about study of artificial method of plant tissue culture along with micro propagation, Somatic embryogenesis, artificial seed and protoplast culture with its applications.

Pharmacognosy:

CO1. An elaborative idea about scope and importance of Secondary metabolites- alkaloids, terpenoids, phenolics and their functions, along with their organoleptic evaluation of crude drugs.

Paper IVB

Practical

Module VIII

CO1. Students will be acquainted with laboratory instruments and their working principle with practical knowledge of handling these instruments.

CO2. Students will learn about sterilization techniques by autoclaving.

CO3. Students will learn about preparation of PDA medium.

CO4. Students will have hands-on experience on Bacterial staining techniques with suitable staining methods from curd.

CO5. Students will be acquainted with common medicinal parts and their uses.

CO6. Determine the method of Goodness of Fit of normal Monohybrid ratios by Chi Square analysis.

CO7. Students will be taken to visit Medicinal Plant Garden and learn to prepare a field report.

Contact hours: 4hrs/week Practical: 6hrs/week

PROGRAMME OUTCOME

PO1. Students will be able to apprehend of the range of plant diversity spanning from simple algae to angiosperms through interim groups like fungi, bryophytes, pteridophytes and gymnosperms. Students are provided with the scope to understand the evolutionary events that lead to the origin of these

diverse forms. They also have the scope to ascertain the phylogenetic relationship between different groups of plants.

PO2. Students will learn in details about lower groups like prions, viroids, viruses and bacteria. They will gain knowledge regarding their economic and ecologic implications.

PO3. Students will be trained in skills required to plant diseases, causal organisms, and their life-cycle. They will be able to come up with appropriate suggestions to control those diseases.

PO4. They will learn in details about the anatomical features of plant.

PO5. Students will gain in-depth knowledge about palaeobotany, palynology and the ecologic and economic applications of these fields of study.

PO6. Students will be able to know in details about the reproductive biology of angiosperms, plant geography, ecology and evolution of plants.

PO7. Students will be made aware regarding the latest aspects of genetics, cell and molecular biology.

PO8. They will learn about the different topics and procedures of plant-physiology and biochemistry.

PO9. Students will get to know the ecologic and economic importance of studying Botany.

PROGRAMME SPECIFIC OUTCOME

PSO1. Students will learn in details about lower groups like prions, viroids, viruses and bacteria. They will gain knowledge regarding their economic and ecologic implications.

PSO2. Students will learn in details about algae, their organization, classification, characteristics, ecologic and economic importance etc.

PSO3. Students will learn in details about fungi, their organization, classification, characteristics, ecologic and economic importance etc.

PSO4. Students will learn in details about bryophytes, their organization, classification, characteristics, ecologic and economic importance etc.

PSO5. Students will learn in details about pteridophytes, their organization, classification, characteristics, ecologic and economic importance etc.

PSO6. Students will learn in details about gymnosperms, their organization, classification, characteristics, ecologic and economic importance etc.

PSO7. Students will learn in details about angiosperms, their organization, classification, characteristics, ecologic and economic importance etc.

PSO8. Students will develop skill in identifying plant diseases. Identify plant diseases and come up with appropriate measures to treat them.

PSO9. They will learn in details about the anatomical features of different plant parts and identify normal and anomalous tissue arrangement from sections of plant parts.

PSO10. Students will gain in-depth knowledge about geological time scale, fossils, fossilization process, past vegetation and past climate.

PSO11. They will learn in details about spores and pollens in details, their morphological features, classification and application in various fields.

PSO12. Students will be able to know in details about the reproductive biology of angiosperms.

PSO13. Students will gain in-depth knowledge about plant geography, ecology and evolution of plants.

PSO14. They will have a detailed idea regarding the economic scope offered by botany.

PSO15. Students will be made aware regarding the different aspects of genetics, procedures and applications.

PSO16. They will learn in extensive details about cell and molecular biology.

PSO17. They will learn about the different topics and procedures of plant-biochemistry and also know about their applications.

PSO18. Students will have elaborate knowledge about plant physiology and metabolism that will help them in better apprehension of the physiological activities of plants.