Shiksha Mandal's

Jankidevi Bajaj College of Science, Wardha.

(Autonomous)

NAAC (UGC) Reaccredited 'A' Institution
(A Linguistic Minority College)
COLLEGE WITH POTENTIAL FOR EXCELLENCE
Star College Status by DBT Govt. of India

M.Sc. Botany Syllabus
Semester pattern with Choice Based Credits System

(2017-2018)

Department of Botany

Jankidevi Bajaj College of Science, Wardha.

JANKIDEVI BAJAJ COLLEGE OF SCIENCE, WARDHA

Two Year Post Graduate Course (M. Sc.)

SEMESTER PATTERN SYLLABUS (Proposed Under Autonomy)

SUBJECT – BOTANY (Distribution of Units)

Semester	Paper	Existing Syllabus			Proposed Syllabus		
		Unit No	Content of Unit	Alloted Hours	Unit No	Content of Unit	Alloted Hours
Semester I	Paper I	I-IV	Prokaryotes & Viruses, Phycology, Mycology and Plant Pathology	60	I-III	Prokaryotes & Viruses, Phycology, Mycology and Plant Pathology	48
					IV	Microscopy & Centrifugation	12
	Paper II	I-IV	Bryophytes, Pteridophytes	60	I-III	Bryophytes, Pteridophytes	48
					IV	Plant Microtechniques	12
	Paper III	I-IV	Paleobotany, Gymnosperms	60	I-III	Paleobotany, Gymnosperms	48
					IV	Instrumentation (Spectrophotometery & Chromatography)	12
	Paper IV	I-IV	Cytology, Genetics	60	I-III	Cytology, Genetics	48
					IV	Methods To Study Cell / Tissue Structure	12
Semester II	Paper V	I-IV	Plant Physiology, Biochemistry	60	I-III	Plant Physiology, Biochemistry	48
					IV	Analytical Pharmacognosy	12
	Paper VI	I-IV	Plant Development, Reproduction	60	I-III	Plant Development, Reproduction	48
					IV	Phytochemistry	12
	Paper VII	I-IV	Cell, Molecular Biology- I	60	I-III	Cell, Molecular Biology- I	48
					IV	Data Collection, documentation & photography	12
	Paper VIII	I-IV	Angiosperms-I, Ethnobotany	60	I-III	Angiosperms-I, Ethnobotany	48
					IV	Scientific Writing and Its Presentation	12
Semester	Paper IX	I-IV	Plant Ecology, Conservation	60	I-III	Plant Ecology, Conservation Biology	48

III			Biology		IV	Herbal Cosmetics & Medicines	12
	Paper X	I-IV	Angiosperms-II	60	I-III	Angiosperms-II	48
					IV	Plant Nursery Management	12
	Special Paper XI	I-IV	Molecular Biology & Plant Biotechnology	60	I-IV	Molecular Biology & Plant Biotechnology	60
	Special Paper XI	I-IV	Mycology & Plant Pathology	60	I-IV	Mycology & Plant Pathology	60
	Paper XII	I-IV	Aesthetic Botany	60	I-IV	Aesthetic Botany	60
Semester IV	Paper XIII	I-IV	Cell and Molecular Biology-II	60	I-IV	Cell and Molecular Biology-II	60
	Paper XIV	I-IV	Plant Biotechnology & Plant Breeding	60	I-IV	Plant Biotechnology & Plant Breeding	60
	Special Paper XV	I-IV	Molecular Biology & Plant Biotechnology	60	I-IV	Molecular Biology & Plant Biotechnology	60
	Special Paper XV	I-III	Mycology & Plant Pathology	60	I-III	Mycology & Plant Pathology	60
	Paper XVI	I-IV	Plant Resources	60	I-IV	Plant Resources	60

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II	Paper V	I-III	Plant Physiology, Biochemistry	48
		IV	Analytical Pharmacognosy	12
	Paper VI	I-III	Plant Development, Reproduction	48
		IV	Phytochemistry	12
	Paper VII	I-III	Cell, Molecular Biology- I	48
		IV	Data Collection-photography	12
	Paper VIII	I-III	Angiosperms-I, Ethnobotany	48
		IV	Scientific Writing And Its Presentation	12
III	Paper IX	I-III	Plant Ecology, Conservation Biology	48
		IV	Herbal Cosmetics & Medicines	12
	Paper X	I-III	Angiosperms-II	48
		IV	Plant Nursery Management	12
	Special Paper -XI	I-IV	Molecular Biology & Plant Biotechnology -I	60
	Special Paper XI	I-IV	Mycology & Plant Pathology - I	60
	Paper XII	I-IV	Aesthetic Botany	60
IV	Paper XIII	I-IV	Cell and Molecular Biology-II	60
	Paper XIV	I-IV	Plant Biotechnology & Plant Breeding	60
	Special Paper XV	I-IV	Molecular Biology & Plant Biotechnology - II	60
	Special Paper XV	I-III	Mycology & Plant Pathology – II	60
	Paper XVI	I-IV	Plant Resources	60

Semester I

Paper I: Microbiology, Algae, Fungi, Microscopy & Centrifugation

Module I: Prokaryotes and viruses

General Microbiology: History- Contributions made by Koch's Postulates

Bacteria: Structure, morphology, reproduction. Viruses: General account; Morphology and ultrastructure of TMV, Bacteriophage; Archaebacteria and bacteria: General account; ultrastructure, nutrition and reproduction, biology and economic importance; Cyanobacteria: *Microcystis, Lyngbya, Nostoc, Gloeotrichia.*

Module II: Phycology,Lichen and Mycorrhiza

Classification of Algae up to Orders, according to the system proposed by APG, Algae in diversified habitats (terrestrial, freshwater, marine), thallus organization: origin and evolution, fossile algae, study of the life cycle of following: *Volvox, Ulothrix, Gracillaria* and *Padina.* Techniques of culturing algae biofertilizers, alage causing biological hazards. Lichen: Role of Lichen in biomonitoring type morphology and reproduction. Mycorrhiza: Type, distribution and significance with reference to agriculture and forestry;

Module III: Mycology

General account: APG Classification of Fungi,

Physiology of Fungi (with reference to biotrophs, hemibiotrophs symbionts) fungal Cytology.

Heterothallism, heterokaryosis, Praasexual cycle; General account of spore bearing organs and their arrangements in various groups of fungi, spore release and dispersal, study of following types *Penicillium, Plasmodiophora, Pernospora, Cunninghamella, Phyllactinia, Chaetomium, ;* Study of the following diseases with reference to symptoms, causal organism and disease cycle. Pady blast, Wheat rust, Smut of Jowar, black arm of cotton, red rot of sugarcane, citrus canker, potatoblight. Deuteromycetes: *Helminthosporium, , Colletotrichum.*

Module IV: Microscopy & Centrifugation

Microscopy and microscopic techniques: light-bright field and dark field, phase contrast, flurenscence, electron, confocal microscopy. Micrometery; Making solution: Moles and Molarity and Molarity, Stock solution and dilution, pH measurements and preparation buffers. Centrifugation techniques: principle and applications, sedimentation coefficient and Diffusion coefficient and zonal and differential centrifugation, high speed centrifuges, rotors, ultracentrifugation, density gradient, centrifugation

Practicals-

Classification and type study of the following classes:

Prochlorophyta: *Prochloron*, Chlorophyta: *Pandorina, Eudorina, Stigeoclonium, Ulva, Chlorella*, Scenedesmus, Caulerpa, Valonia, Acetabularia; Phaeophyta: *Spacelaria, Padina, Turbinaria*; Rhodophyta: *Nemalion, Gelidium, Gracilaria, Corallina, Polysiphonia*; Euglenophyta: *Euglena*, *Phacus*; Bacillariophyta: *Cyclotella, Synedra, Cymbella, Navicula, Gomphonema*.

Morphological Studies of Fungi (any 15 of the following)

Stemonities, Perenospora, Phytopthora, Albugo, Mucor, Rhizopus, Yeast, Aspergillus, Penicillium, Chaetomium, Taphrina, Peziza, Erisyphe, Phyllactenia, Uncinula, Melamosora,

Uromyces, Drechslera,Ravenallia, Ustilago, Polyporus, Morchella, Cyathus, Alternaria, Helminthosporium, Curvularia, Colletotrichum, Phoma, Plasmodiophora, Cercospora, Fusarium, Claviceps.

Symptomology of some diseased plants (any 7 of the following).

White rust of Crucifers, Downy mildew, powdery mildew, Rusts, Smuts, Ergot, Groundnut leaf spot (Tikka disease), False smut of paddy, red rot of Sugarcane, Wilt disease, Citrus canker, Angular leaf spot of cotton, Potato blight, Leaf mosaic of bhindi/ papaya, Leaf curl of tomato/Potato/Papaya, Little leaf of brinjal.

Identification of Fungal cultures (Any 5)

Rhizopus, Mucor, Aspergillus, Penicillum, Drechslera, Curvularia. Phoma, Colletotrichum, Alternaria, Helminthosporium.

Field study: For collection and studying fungal flora

To prepare different laboratory stains.

To study different staining equipments.

To study procedure for staining different plant materials.

Semester I
Paper II: Bryophytes, Pteridophytes & Plant Microtechniques

Module I: Bryophytes

General characters, distribution, APG classification, ecology of Bryophytes, fossil history of bryophytes, cytology of bryophytes, regeneration in bryophytes, evolution of sporophyte- Retrogressive and Progressive theory.

General account of- Hepaticopsida: Sphaerocarpels, Takakiales; Anthocerotopsida: Anthocerotales; Bryopsida: Sphagnales, Polytrichales.

Module II: Pteridophytes

General characters, APG classification, distribution, classification, evolution of stele, Psilopsida Salient features of Psilophytales, *Rhynia*, Lycopsida Salient features of Lepidodendrales, Sphenopsida,

Module III: Pteridophytes contd…

Salient features of Calamitates, *Calamites, Annularia, Calamostachys*.

Study of life cycles of *Lycopodium, Osmunda, Marsilea, Ophiolglossum, Azolla*, Cultivation and maintainance of ornamental ferns & Life cycle of *Gleichenia, Dryopteris*.

Module IV : Plant Microtechniques

Staining procedures, classification and chemistry of stains. Reactive 32 dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags) . Cytogenetic techniques with squashed plant materials.

Practicals:-

Bryophytes:

Study of morphological and reproductive characters of representative members mentioned in the syllabus using section preparations, dissections and sections. Preparation of permanent slides is necessary.

Study of bryophytes in their natural habitats.

Botanical excursion outside the state is compulsory to study the bryophytes

Pteridophytes:

Study of fossil forms (specimens and permanent micropreparations).

Study of living forms: Morphological, anatomical and reproductive characters of the forms mentioned in the syllabus. Anatomical characters to be studied either by taking free hand sections (t.s./l.s.) and by observing the permanent micropreparations. Preparations of permanent slides are essential. To prepare different laboratory stains. To study different staining equipments. To study procedure for staining different plant materials.

Semester I

Paper III: Paleobotany, Gymnosperms, Spectrophotometery & Chromatography

Module I: Paleobotany

Introduction; Plant fossils- Preservation, preparation, age determination, geological time scale; Fossil record- systematics, reconstruction and nomenclature; Applied aspects of paleobotany. General account; distribution (living, Fossil); origin; APG systems of classification; economic importance.

Module II: Gymnosperms

Comparative morphology and evolutionary tendencies of:
Cordaitales, Caytoniales, Glossopteridales,
1. Pteridospermales- Lyginoptridaceae (*Calymotheca hoeninghausii, Hetarngium, Spherostoma*); Medullosaceae (*Medullosa, Trignocarpus*).
2. Cycadales- Cycadaceae; Fossil history (*Baenia, Nilssonia, Androstrobus*)
3. Cycadeoidales- Williamsoniaceae, Cycadoeoidaceae

Module III: **Gymnosperms contd…**

General account and relationships of- Pentoxylales, Gnetales, Ephedrales, Ginkgoales (*Ginkgo, Baiera, Trichopitys*); Coniferales (General characters, Embryogeny and phylogeny, evolution of ovuliferous scales, phylogeny)

Module IV: **Instrumentation (Spectrophotometery & Chromatography)**

Spectrophotometry Principle and its application in biological research. Chromatography Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Laboratory exercise-

Comparative Study of vegetative and reproductive parts of: *Cycas, Zamia, Cedrus*, *Abies, Pinus, Cupressus, Cryptomeria, Taxodium, Podocarpus, Agathis, Thuja, Gnetum*, *Ephedra, Juniperus*, *Cephalotaxus, Taxus*. Permanent micropreparatious to be submitted by the students.
Ginkgo: Morphology to be studied from Museum specimens & anatomy from permanent slides only.
Study of important fossil gymnosperms from material and permanent slides.
Visit to palaeobotanical Institutes, localities and collection of specimens.
Field visits to ecologically different localities to study living gymnosperms.
To study Beer-Lambert's law for spectrophotometry
To separate chlorophyll pigments by paper chromatography
To measure chlorophyll by spectrophotometer
To measure anthocyanin by spectrophotom

Semester I

Paper IV: Cytology, Genetics & Methods To Study Cell / Tissue Structure

Module I

Mendel‟s laws of inheritance; penetrance, expressivity, multiple alleles and isoalleles (example Corn, Drosophila and *Nicotiana*), gene interactions (non-epistatic and epistatic), Modifiers, suppressors and pleiotrpic genes; multigene families (globin, immunoglobin genes);

Extrachromosomal inheritance: Inheritance of mitochondria and chloroplast genes, maternal inheritance and its effect.

Chromatin organization: rRNA genes, euchromatin and heterochromatin;; C-value paradox, Cot curve and its significance;

Module II

Karyotype analysis and evolution, banding patterns specialized types of chromosomes: polytene, lampbrush, B-chromosome, sex chromosome; molecular basis of chromosome pairing.Origin, breeding behaviour of duplications, deficiency, inversion and translocation heterozygotes; effect of aneuploidy on plants; transmission of trisomics and monosomics and their use in chromosome mapping; complex translocation heterozygotes, translocation tester sets; Robertsonian translocation.

Population genetics: HardyWeinberg equilibrium,factor affecting Hardy Weinberg Equilibrium

Module III

Mutations: Molecular basis of gene mutations; transposable genetic elements; site directed mutagenesis- definition, applications and PCR based oligonucleotide mutagenesis; role of mutations in crop improvement; induction of polyploidy.

Plant Genetic Resources: Importance of genetic diversity in crop improvement, and its erosion.Epigenetics: Introduction; histone code; base modification; paramutations in maize; Callipygh sheep; Epigenetics and Lamarckism; Epigenome and epigenomics (Introduction).

Module IV: Methods to study cell / Tissue Structure

Whole mounts, peel mounts, squash preparations-mitotic and meiotic chromosomes, staining of chromosomes, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin sections.

Practicals

1. To study cell division (mitosis and meiosis) in the given material.
2. To study the effect of mutagen treatment on germination and seedling height.
3. To study effect of mutagen on the rate of cell division.
4. To study effect of mutagen on genetic material by scoring the chromosomal aberrations.
5. To study the translocation heterozygote in *Rheo discolor* or any other suitable material.
6. To study polytene chromosomes in *Chironomas* larvae.
7. To solve the given problems on interaction of genes (at least five).

8. To study the karyotype of given organism.
9. To study the chiasma frequency in the given material.
10. To solve the given problem on population genetics (at least three).
11. To study methods of fixation, preservation and clearing
12. To study the methods of paraffin and plastic infiltration.
13. To study maceration and sectioning of infiltrated materials.

SEMESTER I

PRACTICAL I

Time : 6 Hours		Full marks : 100
Q. 1	To identify the given Cyanobacterial material A.	10
Q.2	To identify two algal forms B, C, from the given mixture.	10
Q.3	To identify the given fungal culture D	10
Q. 4	To identify the given plant pathogen in the given material E.	10
Q. 5	To prepare a temporary microprepration of the given Bryophytic material F and identify it	10
Q. 6	Comment on the given spot G (Cyanobacteria/Bacteria), H (Algae), I (Fungi), J (Bryophyte) K. Microscopy & Centrifugation L. Plant Microtechniques	15
Q.7	Viva-voce	20
Q. 8	Practical Record and tour report	15

SEMESTER I
PRACTICAL II

Time : 6 Hours		Full Marks : 100
Q. 1	To prepare a double stained microprepration of the given Pteridophytic material A and identify it.	10
Q.2	To prepare a double stained microprepration of the given gymnospermic material B and identify it.	10
Q.3	Comment on the given fossil specimen C	10
Q. 4	One experiment from Cytology and Genetics D	10
Q. 5	Comment on the given spot- E. (Pteridophyte), F. (Gymnosperm), G. (Fossils), H (Cytology/Genetics) I. Spectrophotometry & Chromatography J. Cell/ Cell tissue structure	24
Q.6	Viva-voce	20
Q. 7	Practical Record and tour report	16

Semester II

Paper-V
Plant Physiology, Biochemistry and Analytical Pharmacognosy

Module-I The Scope of plant physiology

Photosynthesis: pigments, Light, light harvesting complex, Mechanism of electron transport, Photo protective mechanism, CO2 fixation, C3, C4 and CAM pathway, Photorespiration, the chemiosmatic-coupling hypothesis and ATP Synthesis,

Respiration:- introduction, ,Glycolysis, Citric acid cycle, oxidative pentose phosphate pathway, Plant mitochondrial electron transport and ATP synthesis (oxidative phosphorylation).

Module-II Plant hormones & Enzymes

Plant hormones:- biosynthesis, physiological effect and mechanism of action of hormones auxins, gibberellins and cytokinine

Sensory photobiology:- structure, function and mechanism of phytochromes, Photoperiodism and biological clock

Enzymes: Nomenclature and classification of Enzymes enzyme kinetics, Michaelis –Menten equation, mode and mechanism of Enzyme action (Regulation of Enzyme activity), Activators& Inhibitors of enzymes, properties of Enzymes, factors affecting Enzyme activity, isozymes.

Module-III Transport and Metabolism

Solute transport and photo-assimilate translocation:- uptake transport and translocation of water, ion, solutes and macromolecules from soil through cell, across membranes, through xylem and phloem , transpiration, mechanism of loading and unloading of photo –assimilates **Carbohydrate Metabolism:** Composition, structure and function of carbohydrates, synthesis of starch and Sucrose, catabolism (degradation) of starch and sucrose **Lipid Metabolism:** Composition, structure and function of lipids, fatty acid biosynthesis, membrane Storage lipids. **Protein metabolism:** Composition, structure (Ramchandra plot. secondary, tertiary and quaternary structure) and function of Proteins

Metabolism of amino acids: Composition, structure and function of amino acids, amino acid biosynthesis in Plants. **Nitrogen metabolism: N**itrate and ammonium assimilation

Module –IV Analytical Pharmacognosy

Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

Practicals-

1. To study the effect of time and enzyme concentration on the rate of reaction of enzyme. (e.g. phosphatase, nitrate reductase).

2. To study the effect of substrate concentration on activity of enzyme and determination of its Km value.

3. Demonstration of the substrate inducibility of the enzyme nitrate reductase.

4. Determination of succinate dehydrogenase activity, its kinetics and sensitivity to inhibitors.

5. To determine the total carbohydrate content in the given sample

6. Estimation of Pectic Substances-gravitic method .

7. To prove Berr-Lambert.s law using a suitable solution.

8. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophyll and carotenoids.

9. To determine the chlorophyll a/ cholorophyll b ratio in C3 and C4 plants.

10. Isolation of intact chloroplasts and estimation of choloroplast proteins by spot protein assay.

11. Preparation of standard curve of protein (BSA) and estimation of protein content in extracts of plant material by Lowry‟s or Bradford‟s method.

12. Preparation of Leaf Protein Concentrates from green vegetables.

13. Determination of reducing sugars by Nelson – Somogyi Method.

14. To study different methods of identification of drug adultration.

15. To study the methods of biological testing of herbal drugs.

16. To study the screening tests for secondary metabolites.

Semester-II
Paper-VI
Plant Development, Reproduction and Phytochemistry

Module I: Plant development

Plant growth kinetics and patterns of growth.

Seedling growth: Tropisms; Photomorphogenesis of seedling; hormonal control of seedling growth & control.

Shoot Development: Organization of shoot apical meristem (SAM); cytological and molecular analysis of SAM; regulation of cell fate in meristem; tissue differentiation in the shoot.

Leaf growth and differentiation: Determination; phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata & trichomes) and mesophyll.

Root Development: Organization of root apical meristem (RAM); vascular tissue differentiation; lateral root hairs; root microbe interactions.

Phytohormones: Classification, chemical nature and their role in plant development.

Module II: Plant development and reproduction

Flower Development: Physiology of flowering, florigen concept and photoperiodism, Genetics of floral organ differentiation; homeotic mutants in *Arabidopsis* and *Antirrhinum*.

Pollination mechanisms and vectors. Types of pollination, dispersal agencies.

Male Gametophyte: Structure of anther, microsporogenesis, tapetum; pollen development and gene expression; male sterility; sperm dimorphism; pollen germination; pollen tube growth and guidance.

Female Gametophyte: Ovule types; megasporogenesis; organization of embryo sac; types of embryo sacs, structure of polygonum embryo sac cells.

Module III: Reproduction

Pollen-pistil interaction, self-incompatibility and fertilization; Structure of the pistil; pollen-stigma interactions, double fertilization; *in vitro* fertilization. Seed Development and fruit growth: Endosperm development; embryogenesis; ultrastructure and nuclear cytology; storage proteins of endosperm and embryo; polyembryony; apomixes; embryo. Fruit development and growth Latent life: Dormancy; Importance and types of dormancy; seed dormancy; overcoming seed dormancy;breaking of seed dormancy, bud dormancy. Senescence and Programmed Cell Death (PCD): Basic concepts; types of cell death, PCD in life cycle of plants; metabolic changes associated with senescence and its regulations; influence of hormones and environmental factors on senescence.

Module IV: Phytochemistry

Active principles and methods of their testing - identification and utilization of the medicinal herbs; Catharanthus roseus (cardiotonic), Withania somnifera (drugs acting on nervous system), Clerodendron phlomoides (anti-rheumatic) and Centella asiatica (memory booster).

Practicals- / Field Exercises **(Any 12)**

1. Tissue systems, meristem, vascular and cork cambium.
2. Internal structure of root, stem and leaf (dicot and monocot), advanced secondary growth in dicot stem and root.
3. Anomalies in primary and secondary structure of stem.
4. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla*.
5. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant such as *Coleus, Kalanchoe*, Tobacco.
6. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
7. Study of alternate and distichous, alternate and superposed, opposite and superposed; opposite and decussate leaf arrangement.
8. Examination of rosette plants (*Launaea, Mollugo, Raphanus, Hyoscyamus* etc.) and induction of bolting under natural conditions as well as by GA treatment.
9. Microscopic examination of vertical sections of leaves such as *Cleome, Nerium*, Maize and Wheat to understand the internal structure of leaf tissues and trichomes, glands etc. Also study the C3 and C4 leaf anatomy of plant.
10. Study of epidermal peels of leaves such as *Coccinia, Gaillardia, Tradescantia, Thunbergia*, etc. to study the development and final structure of stomata and prepare stomatal index. Demonstration ofthe effect of ABA on stomatal closure.
11. Study of whole roots in monocots and dicots. Examination of L.S. of root from permanent preparation to understand the organization of root apical meriste m and its derivatives. (use maize, aerial roots of banyan, *Pistia*, *Jussieua* etc.).
12. Origin of lateral roots.
13. Study of leguminous roots with different types of nodules.
14. Study of microsporogenesis and gametogenesis in sections of anthers.
15. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (Maize, Grasses, *Crotolaria, Tradescantia, Brassica, Petunia, Solanum melongena*, etc.)
16.Tests for pollen viability using stains and in vitro germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
17. Estimating percentage and average pollen tube length *in vitro*.
18.Role of transcription and translation inhibitors on pollen germination and pollen tube growth.
19.Pollen-pistil interaction, self-incompatibility, *in vitro* pollination.
20.Study of ovules in cleared preparations; study of monosporic, bisporic and tetrasporic types of embryo sac development through examination of permanent stained serial sections.
21.Field study of several types of flower with different pollination mechanisms (wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).
22.Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self compatible and obligate outcrossing systems.
23.Study of cleistogamous flowers and their adaptations.
24.Study of nuclear and cellular endosperm through dissections and staining.
25.Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (*Syzygium cumini*) etc. by dissections.
26.Study of seed dormancy and methods to break dormancy.
27.Identification and utilization of the medicinal herbs.
28.To study methods of testing different drugs.
29. To study the active principles of herbal drugs.

Semester II
Paper-VII
Cell, Molecular Biology- I & Data Collection, Documentation & Photography

Module I:

Cell wall: Structure; function; biogenesis and growth.

Plasma membrane: Membrane architecture (fluid mosaic model); sites for ATPases; membrane transport- ion carriers, channels, pumps and aquaporins; receptors; Plasmodesmata: Structure, role in movement of molecules and macromolecules; comparison with gap junction.

Module II:

Cell shape and motility: The cytoskeleton; organization and role of microfilaments, intermediate filaments and microtubules; motor movements, implications in cell division, flagellar & other movements; Nucleus: Ultrastructure, nuclear pores, nucleolus, DNA structure A, B and Z forms, replication in prokaryotic and eukaryotic cells, DNA replication proteins, damage and repair.

Module III:

Stress biology: Definition and classification of stress.

Biotic stress: Plant defence mechanism (passive and active); HR and SAR; modulation of plant metabolism in response to biotic stress: early and late response; production of ROS, induction of enzymes; PR proteins; R-genes.

Abiotic stress: Effect of water, temperature, salt and light stress on plants; developmental and physiological mechanisms protecting plants against environmental extremes.

Module IV: Data collection, documentation and Photography

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

Practicals-

1. To study salivary gland chromosomes of Chironomas and Drosophila.
2. To isolate mitochondria and determine the activity of its marker enzyme SDH.
3. To isolate bacterial and plant DNA and quantify them by spectrophotometric method.
4. To demonstrate the semi-permeability of the plasma membrane.
5. To study the activity of Na/K ATPase.
6. To demonstrate different components of cytoskeleton in the suitable material.
7. To perform flagellar staining.

8. Isolation of DNA and preparation of Cot-curve.

9. Demonstration of vital structure and functions of cell

10. To study the activity of PAL in the seedlings challenged with elicitors.

11. To study the induction of antioxidant enzymes in the seedlings challenged with elicitors.

12. To study the effect of water stress on the seedling growth and its chlorophyll content.

13. To study the effect of temperature stress on the seedling growth and its chlorophyll content.

14. To study the effect of salt stress on the seedling growth and its chlorophyll content.

15. To study tabulation & generation of graphs.

16. To know the imaging of tissue specimen and application of scale bars.

17. To study the art of field photography.

Semester II
Paper-VIII
Angiosperms-I, Ethnobotany & Scientific Writing and Its Presentation

Module I: Angiosperm Morphology

Angiosperm Morphology, structural units and floral symmetry, dicot and monocot flower; structure, diversity origin and evolution of stamen, carpels; placentation types and evolution. Floral adaptation to different pollinators

Module II: Angiosperm

Angiosperm Taxonomy: Relative merits and demerits of major systems of classifications. Taxonomic structure: taxonomic hierarchy, concept of taxa, concept of species, concept of genus and family; Taxonomic character: HETEROBATHMY, ANALYTIC versus synthetic character, qualitative versus quantitative characters.

Taxonomic tools: herbarium, floras, monographs, botanical gardens, biochemical and molecular techniques, computers and GIS.

Module III: Biosystematics & Ethnobotany

Biosystematics: The population concept phenotypic plasticity, biosystematic categories, methods of biosystematics studies. Numerical taxonomy: principles, aims and objectives, cladistics in taxonomy, polarity of characters, homology, homoplasy, monophyly, polyphily.

Plant nomenclature: Salient features of ICBN

Ethnobotany: Definition; scope and significance; Sacred groves and their role in conservation.

Module IV: Scientific Writing and Its Presentation

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Practicals-

1. To study the floral symmetry in various taxa.
2. To study and work o ut the differences in dicot and monocot flower.
3. To study the variation stamens and carpels.
4. To study placentation types in various taxa.
5. To study the floral adaptations for pollination.
6. To study anatomical features of various taxa.
7. To study embryological features of various taxa.
8. To study palynological features of various taxa.
9. To study cytological features of various taxa.
10. To prepare a cladogram on the basis of various morphological features of the species belonging to a genus.

11. To understand and prepare reference list (e.g. Research papers, Reference books, websites, Ph.D./M. Sc. Thesis & research reports)
12. To write and understand units, abbreviations and nomenclature used in scientific writing and prepare presentations in poster and power point template.
13. To prepare and scientific paper.

SEMESTER II

PRACTICAL III

Time : 6 Hours			Full marks : 100
Q. 1	To perform the given physiological experiment A and report the findings		10
Q. 2	To quantify the given metabolite in the given sample B		5
Q. 3	To study the cytohistological zonation in SAM of given material C		10
Q. 4	To perform the given exercise based on plant development D		10
Q. 5	Write a note on given stage of micro- or megasporogenesis E		10
Q. 6	Spotting: F (Physiology), G (Plant development), H (Reproduction)		20
	I (Analytical Pharmacognosy) J (Phytochemistry)		
Q. 7	Viva-voce		20
Q. 8	Practical Record		15

SEMESTER II

PRACTICAL IV

Time : 6 Hours		Full marks : 100
Q. 1	One experiment from paper VII A	15
Q. 2	One experiment from paper VII B	10
Q. 3	One experiment from paper VIII C	15
Q. 4	One experiment from paper VIII D	10
Q. 5	Spotting- E (paper VII), F(Paper VII), G(Paper VII), H(Paper VII) I(Data generation & Photography J(Scientific Writting & Presentation	15
Q. 6	Viva-voce	20
Q. 7	Practical Record and field diary	15

Semester III
Paper–IX
Plant Ecology, Conservation Biology and Herbal Cosmetics & Medicines

Module I:

Vegetation organization: Interspecific associations, concept of ecological niche; Vegetation development: Temporal changes (cyclic and non-cyclic); mechanism of ecological succession (relay floristics and initial floristic composition; facilitation, tolerance and inhibition models); Community function- Dynamics and succession, laboratory model, trends in succession, climax concept, General introduction to autecology.

Module II:

Ecosystem organization: Structure and functions; primary production (methods of measurement, global pattern, controlling factors); ecological efficiencies); litter fall and decomposition (mechanism, substrate quality and climatic factors); Nutrient budget in forest and aquatic ecosystem.

Ecosystem stability: Concept (resistance and resilence); Ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion; environmental impact assessment; ecosystem restoration; Ecological management: Concepts; sustainable development; sustainability indicators.

Module III:

IUCN- General account, categories, Commissions, role in conservation; Red Data Book

Protected areas- Sanctuaries, National parks, Biosphere reserves; Wetlands and Mangroves

Coral Reefs- Types, importance, artificial reefs, conservation measures; Botanical gardens, Seed Banks; *In-vitro* repositories; Cryobanks,

Module IV: Herbal Cosmetics & Medicines

Methods of Herbal extraction:- Maceration, digestion, Decoction, extracts and tinctures.

Herbal Preparations: Churna, Asava, Arishta Products & uses of Aloe, Amla, Adathoda, Neem, Rose Turmeric, Ginger.

Practicals- Based on Biostatistics-

1. Calculate mean, variance, standard deviation and coefficient of variation for comparing two means related to given ecological data.
2. Calculate mean, variance, and to use t-test for comparing two means related to given ecological data.
3. To find out association between important grassland species from the given data using chi-square test.
4. To find out relationship between two ecological variables using correlation analysis.
5. To perform the one-way ANOVA from the given data.

Based on Ecology

1. A trip to the grass land/ forest/ water body to get acquainted with their plant species.
2. Distribution pattern of different plant species determined by Quadrate/Transect/ Point centered Quarter methods.
3. To determine minimum size and number of quadrats required to study grassland.
4. Qualitative parameters of distribution of plant species, Frequency, Density, Basal cover,dominance, Abundance and IVI.
5. To determine diversity indices (Shanon-Weiner, species richness, B-diversity) from given data.
6. To estimate DO content in the eutrophic and oligotrophic water samples by azide modification of Winklers method.
7. To determine gross and net phytoplankton productivity by light and dark bottle method.
8. To estimate chlorophyll content in SO2 fumigated and unfumigated leaves.
9. Analysis of soils of two different areas i.e. Cropland and forest/ grassland for certain nutrients, CO3, NO3, Base deffiency.
10. To study ecological adaptations of the given plants

Based on Herbal Cosmetics & Medicines-

6. Identification of useful herbal plants.
7. To study different methods of herbal extractions.
8. To prepare different products. (Churna, Asava, Arishta)

Semester III
Paper-X
Angiosperms-II and Plant Nursery Management

Module I **Angiosperms Families-I**

General account, distinguished characters, floral variation and evolution, affinities of:- Magnolidae, Hamamelidae, Dilleniidae, Rosidae, Asteridae, circumscription as per Cronquist, 1968.

Module II **Angiosperms Families-II**

Alismatidae, commelinidae, Aracidae, Lilidae; Interesting features and systematic position of Cucurbitaceae, Cactaceae, Asteraceae, Amentiferae, Lemnaceae, Palmae, Orchidaceae.

Module III **Biodiversity**

IUCN categories of threat, distribution and global pattern of biodiversity.
Biological diversity concept and levels, role of biodiversity in ecosystem functions and stability, Endemism, hotspots and hottest hotspots, invasions and introductions, local plant diversities and its socioeconomic importance.

Module IV **Plant Nursery Management**

Nursery:- Concept, types & infrastructure requirements
Seed propagation:- Germination, Production, Collection, Storage & testing of seeds
Vegetative Propagation:- Natural and Artificial (Cutting, budding, grafting and layering)

Practicals-

1. Description of specimens from representative, locally available families.
2. Description of a species based on various specimens to study intra specific variation: collective exercise.
3. Description of various species of a genus, location of key characters and preparation keys at generic level.
4. Location of key characters and use of keys at family level.
5. Field trips within and around the campus; compilation of field notes and preparation herbarium sheets of such plants, wild or cultivated as are abundant.
6. Training in using floras herbaria for identification of specimens described in the class.
7. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
8. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.
9. To study effect of biotic and biotic factors on seed germination of tomato and groundnut.
10. To study factors affecting vegetative propagation (rooting and new shoot formation) by cutting of plant species (Duranta plumeri and Hibiscus, rosa-sinensis).

11. To study T-shaped budding of rose plants.

Semester III
Special Paper- XI
Molecular Biology & Plant Biotechnology

Module I DNA Replication

a. DNA replication: DNA replication in prokaryotic organism– Initiation, elongation, and termination, DNA replication in eukaryotes – origin, replication form, replication proteins, Comparative account of DNA replication in prokaryotes and eukaryotes, DNA replication proteins

b. DNA damage and repair: Types of DNA damage, factors for DNA damage, Repair system: Single base change, direct repair, mismatch repair, SOS response.

Gene expression and regulation: Transcriptional, translational and post-translational regulation

Module II rDNA Technology

a. Tools of rDNA technology: DNA manipulation enzymes- Nucleases, polymerases, ligases, kinases and phosphatases; methods of gene isolation.

b. Molecular probing: Recombinant DNA libraries (gDNA and cDNA, oligonucleotide probes); nucleic acid hybridization (southern, northern, dot-blot and slot-blot); antibodies as probe for proteins (immunoblotting or western blotting, immunoprecipitation, southwestern screening).

Module III Cloning Vector

a. Splicing of foreign DNA into cloning vector: Vectors for prokaryotes; ligation.

b. Introduction of foreign DNA into host cell: Transformation; transfection; transgenesis

c. Isolation of genes or protein products from clones: Expression vectors- Characteristics; vectors producing fusion proteins

d. Polymerase chain reaction: The basic techniques and its modifications; applications of PCR in molecular biology

Module IV Sequence Alignment and Phylogenetic Trees

a. Sequence alignment and phylogenetic trees: Pairwise (dot-matrix method, dynamic programming method, Word or k-tuple method) and multiple alignment, Local and global alignment, significance of alignment, phylogeny and phylogenetic trees; b. Genomics: Definition; Structural, functional and comparative genomics; c. Proteomics: Description of protein structure; classification of proteins on the basis of structure and sequence similarity; prediction of a protein structure.

Practicals-

Group A

1.To detect molecular polymorphism in different species using a suitable technique.

2. To demonstrate the presence of a particular polypeptide by Western blotting.

3. To design PCR primers to isolate the given gene for cloning it in the given vector.

4. To amplify and sequence the nrDNA by PCR
5. To find the sequences of a given protein in the protein database
6. To work out the sequence from given autoradiogram and to identify it from GeneBank by BLAST method.
7. To download the DNA sequences from databases and generate pairwise and multiple sequence alignment.
8. To download the protein sequences from databases and generate pairwise and multiple sequence alignment.
9. To generate phylogenetic tree using given sequences.
10. To predict a protein from given sequence by using online tools from NCBI.

Group B

11. To demonstrate *Agrobacterium tumefaciens* mediated gene transfer in a suitable plant.
12. To raise the suspension culture using a callus and plot the growth curve.
13. To induce the secondary metabolite synthesis in suspension culture.
14. To demonstrate the use of molecular markers to detect polymorphism in different varieties of plants/strains of microbes.
15. To isolate and develop the protein profile of different plant species by SDS-PAGE.
16. To demonstrate bacterial transformation and selection of transformed cells.
17. To perform DNA ligation and analysis of ligated DNA on agarose gel.
18. To study of expression of inducible genes at biochemical level.
19. To demonstrate Organogenesis using appropriate explants.
20. To demonstrate somatic embryogenesis using appropriate explants and prepare artificial seeds.
21. To demonstrate preparation of artificial seeds.
22. To demonstrate the anther culture.
23. To study the effect of heavy metals on the growth of plants.
24. To initiate micropropagation protocol of suitable plant species.

Semester III
Special Paper-XI
Mycology & Plant Pathology

Module I: General Microbiology

Bacteria- Morphology, size, shape, structure, Characters of Eubacteria, Actinomycetes, Archaebacteria, Bacterial nutrition, reproduction; Viruses- General Characteristics, structure, classification (LHI System), replication (lytic cycle & lysogeny); Rikettsia- General Characters.
Fungal diversity in different ecosystems, effect of environment on fungal growth and behaviour.

Module II: Mycorrhiza

1. Kinds of mycorrhizae. Ectotrophic and endotrophic mycorhizae, their morphology and anatomy. V A- mycorrhiza. Mycorrhiza in plant growth promotion, mycorrhiza in plant disease control.
2. Rhizoshere and phyllosphere -General concept and importance.
3. Medical Mycology- Dermatophytic fungi -Knowledge of common dermatophytes and human diseases caused by them viz. *Tinea pedis, Tinea capitis, Tinea barbae. Tinea, corporis* And Tinea manuum; Aspergillosis, fungi allergic to human beings.

Module III: Production of Metabolites by Fungi

A) Industrial Fungal Metabolites:
i) Antibiotics -Penicillin, Cephalosporin, Griseofulvin, Industrial production of Penicillin
ii) Enzymes -. Amylase, proteases, Lipases, Pectinases, Cellulase and xylanases.
iii) Organic acids -Critic acid, Gluconic acid, lactic acid, kojic acid. Itaconic acid. B)
Non Industrial Fungal Metaboilites:
i) Phytoalexins, ii) Mycotoxins

Module IV: Fungi as welfare to human beings

i) Fungi in food processing: Soybean products, cheese, fermented milk, other fermented foods.
ii) Fungal metabolites – General account of production and application: Primary metabolites (vitamins, proteins), Secondary metabolites (antibiotics, pigments, alkaloids)
iv) Fungi as food -edible mushrooms, methods of their cultivation
v) Concept of biodeterioration and Biodegradation
a) Biodeterioration of non-cellulosic materials (leather, plastics, hydrocarbons, pesticides)
b) Biodeterioration of cellulosic materials.
c) Role of microorganisms in Biodegradation of organic wastes. Factors affecting the process of Biodegradation.

Practicals-

1. Principles & working of tools, equipments and other requirements in the Mycology & Plant Pathology laboratory.
2. Micrometry and measurement of organisms.
3. Sterilization Processes viz. moist heat, dry heat, chemical and radiation.
4. Drawing of Camera Lucida diagrams and knowledge of computer based photomicrography and image processing
5. Preparation of different cultural media for cultivation of Fungi and Bacteria.
6. Monitoring and analysis of Aeromycoflora.
7. Isolation & identification of Phyllosphere mycoflora.
8. Demonstrate antifungal activities of different antibiotics and leaf, flower and root extract.
9. Study of toxicity of fungi in relation to seed germination, and seedling abnormality.
10. Cultivation of Mushrooms.
11. Demonstration on biodegradation of organic waste.
12. Isolation of Soil fungi by soil plate (War cup) and serial dilution (Walksman) method.
13. Isolation and identification of Rizosphere mycoflora.
14. Isolation of external and internal seed borne mycoflora by blotter and Agar Plate method. Cereals, pulses, oil seeds, fruit seeds.
15. Demonstration of Koch‟s Postulate.
16. Calculation of spore count using haemocytometer.
17. Qualitative estimation of enzymes – cellulases, amylases.
18. Estimation of sugars, proteins and aminoacids in fungal mycelium and culture filtrate.
19. Study of mycorrhiza (VAM)
20. Monographic study of locally available plant diseases caused by fungi (atleast 10).
21. Study of locally available crop plant diseases caused by Bacteria (Five)
22. Study of locally available plant diseases caused by viruses & Phytoplasma (Five)
23. Demonstration of morphological & physiological changes in disease plants.
24. Preparation and presentation of herbarium of pathological specimens available in the region (Atleast 15)
25. Field visit to different localities Visit to Agriculture University, Plant Pathological research centers

Semester III
(Foundation Course I /Subject Centric–I)
Paper XII – Aesthetic Botany

Module I – Phytogeography

Climate and Vegetation of the world; Floristic regions of the world. Phytogeographical regions of India; Endemism; Concept of hotspots, hot spots of the world. Forest types of India

Module II – Gardening

Garden Design: Scope and objectives of gardening; Style of gardens (Formal, Informal); Types of gardens (English, Mughal and Japanese); Components of garden; Planning of outdoor gardens- Small, Residential, Larger Home Garden, Roof Garden, Terrace Garden, Industrial garden, Housing complex, Indoor gardening ;Garden Features and Ornamentation: Water, Garden pool, Stream, Waterfall, Fountain, Rocks, Roads, Walks, Pavements and Steps, Walls fences and Gates, Hedges, Edges, Arches, Statues, Towers.

Module III– Floriculture

Nursery production and management: Scope, Site, Soil, Environment, Layout, Manure, Fertilizers, Maintenance, Garden tools, Culture and Garden calendar, Types, Nursery beds, Pest & Disease management; Propagation of ornamental plants by seeds, bulbs, layering, cuttings, grafting, budding & tissue culture; Plant disorders including nutrition, pests and diseases, and chimaeras Ornamental ferns and their propagation; herbaceous perennials, Annuals & Biennials: Important Genera and Species, their importance in garden designs.

Module IV – Landscaping

Landscape Design: Definition, objectives and scope, Landscape elements of construction and designing of Residential, Commercial, Bungalow, Public area, Hotel, Educational Institute and religious places Palms and Cycas: Characteristics, propagation, culture, pest and disease, importance and uses, genera and species of palms and Cycads. Bamboo and conifers: Genera, species and varieties; Lawns & Grasses: Planting methods, maintenance, pest management Ornamental succulents, Cacti; Polyhouse technology: Scope and objectives of floriculture.

SEMESTER III

PRACTICAL V

Time : 6 Hours Full marks : 100

Q. 1	To perform the given ecological exercise A	15
Q.2	To solve the given statistical problem B	15
Q.3	To describe the given plant in technical language with floral formula and floral diagram C	10
Q. 4	To prepare the generic/family key D	5
Q. 5	To identify species of the given plant using Flora	5
Q. 7	Spotting- E(Paper IX), F(paper IX), G(Paper X), H(Paper X), I(Herbal Cosmetics & medicines), J(Plant Nursery Management)	15
Q. 8	Viva-voce	20
Q. 9	Practical Record	15

SEMESTER III

PRACTICAL VI

MYCOLOGY AND PLANT PATHOLOGY

Time: 6 Hours Full Marks:100

1.	Identify giving salient characters of fungi from the given culture. (A)	10
2.	Identification of given diseased material, their symptoms and characters. (B)	10
3.	Effects of different concentrations of sugar solutions on the conidial germination and presentation of data on graph paper.	10
4.	Drawing of camera lucida diagram of the given fungus/microorganism.	10
5.	Demonstration of pure culture techniques /transfer techniques.	10
6.	Spotting (two spots)	10
7.	Practical record, Herbarium and field report	20
8.	Viva-voce	20

SEMESTER III
PRACTICAL VI
MOLECULAR BIOLOGY AND PLANT BIOTECHNOLOGY

Time: 6 Hours Full Marks: 100

1. One Major Experiment from Group A	15
2. One Minor Experiment from Group A	10
3. One Major Experiment from Group B	15
4. One Minor Experiment from Group B	10
5. Identification and comments on given two spots	10
6. Practical record	20
7. Viva-voce	20

Semester IV
Paper XIII
Cell and Molecular Biology-II

Module I: Ribosomes

Ribosomes: Structure and function

Transcription: Transcription in prokaryotic and eukaryotic cells, plant promoters, transcription factors, types of RNA and their function, RNA splicing, mRNA transport

Translation: In prokaryotic and eukaryotic cells, structural levels of proteins, post-translational modification; structure and role of rRNA and tRNA.

Module II: Gene structure

Gene structure: Chemical nature & Fine structure of gene: Classical and modern concept of gene, Cis-trans test; fine structure analysis in eukaryotes; introns and their significance, RNA splicing Regulation of gene expression: Prokaryotes- Positive & negative control, inducible and repressible operons, lac operon, trp operon, attenutation, riboswitch; Eukaryotes- Regulation at DNA, transcription, translation & post translational level, Epigenetic regulation: Protein sorting: Protein glycosylation; vesicles involved in protein transport; protein targeting to plastids, mitochondria, peroxisomes, nucleus, vacuoles; modification during transport.

Module III: Genome Organization & Genetic Mapping

Genome organization in prokaryotes and eukaryotic organelles: Phage genome, genetic recombination in phage and mapping phage genes; mapping of bacterial genes through transformation, conjugation and transduction; genome of mitochondria and chloroplast.

Genetic recombination and genetic mapping: Recombination; independent assortment and crossing over; molecular mechanism of recombination; role of RecA and RecBCD enzymes; homologous, non-homologous and site-specific recombination; chromosome mapping- linkage group, genetic markers, types of maps,

Module IV: Cell cycle and Apoptosis

Cell cycle and apoptosis: Control mechanisms, role of cyclins and cyclin dependent kinases; retinoblastoma and E2F proteins; cytokinesis and cell plate formation; Apoptosis and its pathway; Signal transduction: Overview, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascades, diversity in protein kinases and phosphatises; Techniques in cell biology: Electrophoresis, immunotechniques, FISH, GISH, confocal microscopy.

Practicals-

1 Isolation and separation of plant cytosolic proteins by SDS-PAGE
2 To perform the restriction digestion of the DNA & analyse the digest over agarose gel.
3 To study transformation in bacterial cells.
4. To detect the presence of specific antigen by ELISA
5. Isolation of RNA and quantification by spectrophotometric method.
6. To map the genes on the basis of given cross-over data.

Semester IV
Paper XIV
Plant Biotechnology & Plant Breeding

Module I Recombinant DNA Technology

a. Recombinant DNA technology: Gene cloning- Principles and technique; vectors- types (cloning & expression; plasmid & viral) and their properties; construction of DNA libraries (gDNA and cDNA); splicing of insert into the vector; screening of DNA libraries and introduction of the recombinant DNA into the host cells.

b. Genetic engineering of plants: Aims, strategies for development of transgenics (with suitable examples); Agrobacterium- the natural genetic engineer; T-DNA and transposon mediated gene tagging.

Module II Genetic Engineering

a. Microbial genetic manipulation: Bacterial transformation, selection of recombinants and transformants,

b. Genomics and proteomics: high throughput sequencing; functional genomics; Protein profiling and its significance.

c. DNA synthesis; DNA sequencing; basic polymerase chain reaction and applications of PCR; DNA fingerprinting

Module III Plant Tissue Culture

Plant tissue culture: Basic concepts; Principles and scope; tissue culture media; callus induction and cell suspension; aspects of morphogenesis; haploid and triploid production; production of somatic embryos; applications of plant tissue culture; protoplast isolation and culture; production of cybrids

Transgenic production: Methods to introduce gene in plants; selection of transformed plants/explants; salient achievements in crop biotechnology.

Module IV Bioinformatics and Plant breeding

Bioinformatics: Introduction, History, Definition and applications of bioinformatics; Database: Sequences (nucleotide and amino acid); nomenclature- IUPAC symbols, nomenclature of DNA & protein sequences, Definitions, types and classification of databases- Primary Databases, Secondary databases, **Plant breeding**: Methods of breeding sexually (self and cross pollinated) and vegetatively propagated crops; heterosis and inbreeding depression and their genetic basis.

Practicals-

1. To study the growth characteristics of *E. coli* using plating and turbidimetric methods.
2. To isolate the plasmid from *E. coli* and quantify it with suitable method.
3. To perform restriction digestion of the given plasmid DNA and to estimate of the size of various DNA fragments.
4. To Clone the given DNA fragment in a plasmid vector.

5. To prepare competent cells from the given bacterial culture.
7. To prepare the media for plant tissue culture.
8. To surface sterilize the given seeds/explant for tissue cultural manipulation.
9. To isolate protoplast and determine its viability.
10. To workout the DNA sequence from the given autoradiogram and identify the gene using online tools.
11. To search literature database of different organisms.
12. To search the genes in the Genebank.
13. To use the various tools to retrieve information available from NCBI
14. To locate gene(s) on chromosomes for a given disease/disorder.

Semester IV
Special Paper-XV
Molecular Biology & Plant Biotechnology

Module I: Transgenic Plants

Transgenic plants: Cloning vectors for higher plants; Methods for gene transfer, *Agrobacterium tumefaciens* mediated gene transfer- Basis of tumour formation, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes; Direct DNA transfer- particle bombardment, electroporation, microinjection, liposomes, pollen transformation; PEG method; transformation of monocots; transgene stability and gene silencing; chloroplast transformation.

Module II: Applications of Transformation

a. Applications of transformation: Herbicide resistance; insect resistance; Bt genes, disease resistance; Nutritional quality; biopesticides and biofertilizers; hazards and safety regulations for transgenic plants.

b. Transgenics and molecular farming: Production of secondary metabolites; industrial enzymes; biodegradable plastics (PHB); edible vaccines; antibody production and other important drugs.

Module III: Plant Tissue Culture

Plant tissue culture: History, Culture types- Callus culture, organ culture, suspension culture for production of secondary metabolites, protoplast culture, fusion and somatic hybrids, Somatic embryogenesis, production of haploid plants, somaclonal variations, organogenesis (direct and indirect).

Module IV: DNA Fingerprinting

a. DNA fingerprinting and marker assisted breeding: RFLP maps; linkage analysis; RAPD markers; STS; SSR (microsatellites); ISSR; SCAR (sequence characterized amplified regions); SSCP (single strand conformational polymorphism); AFLP; molecular marker assisted selection

b. Cleaner Biotechnology: Pollution control through genetically modified organisms; bioremediation and phytoremediation.

Semester IV
Special Paper-XV
Mycology and Plant Pathology

Module I: Phytopathology

History: Milestones in phytopathology with particular reference to India. Major epidemics and their social impacts. Historical developments of chemicals, cultural and biological protection measures; Altered metabolism of plants under biotic and abiotic stresses. Koch's Postulates Epidemiology and forcasting of plant diseases Indian Institutes and their research activities in Mycology and Plant Pathology

Module II: Principles of Plant pathology

i. Principles of plant pathology-Importance, nature, classification and general symptoms of plant diseases.

ii. Pathogenecity of microorganisms and pathogenesis.

iii. Host parasite relationship and Interaction; Signal transduction.

iv. Defence mechanism in host plants against pathogens:morphological,structural defence mechanism; Biochemical defence mechanisms role of phenolic compounds, enzymes & toxins,

v. Principles and methods of plant disease control -cultural methods, chemical methods, Biological control, transgenic approach for plant disease control, integrated pest management (IPM), Biopesticides.

Module III: Fungal Diseases

A Detailed study of the Diseases of the following crops caused by fungal pathogens with effective control measures.:Diseases of Cereals: Seedling blight of cereals, Smut of wheat, Foot rot of wheat, Covered smut of Barley, False smut of rice, Downey mildew of jowar, Green ear disease of Bajra, Ergot of Bajra, Downey mildew of maize;Diseases of Vegetable crops with special reference to the important diseases of the following: Chilli, Brinjal, Tomato, Onion, Bhindi; General knowledge of post harvest diseases of fruits and vegetables and their control. Diseases of Oil Seed Crops viz. *Linum*, *Seasamum*, Groundnut, Mustard and Sunflower Diseases of Fruit Trees- With special reference to important diseases of the following Citrus, Apple, Mango, Banana and Grapes.

Module-IV: Bacterial Diseases

Bacterial diseases of plants - Bacterial blight of rice, Tundu disease of wheat, Angular leaf spot of cotton, stalk rot of maize, Fire blight of Apple, Bacterial soft rot of fruits and Vegetables. Viral Diseases of Plant- Bunchy top of Banana, Leaf curl of Papaya, Yellow vein mosaic of Bhindi. Mosaic of Cucurbits, Viral diseases of Tobacco, Potato and Tomato.; Mycoplasma/Phytoplama (PPLO) Diseases of Plants- Citrus greening, Rice yellow dwarf: Little leaf of Brinjal, Sandal Spike; Nematode Diseases of Plants: General knowledge of plant parasitic nematodes and important nematode diseases viz. Root knot of Vegetables, Ear cockle of wheat.

Semester IV
Foundation Course II /Subject Centric - II
Paper XVI - Plant Resources

Module 1: Economic Botany

Food plants: History, origin, distribution and nature

Morphology and anatomy of: Fiber yielding plants, forest resources (timber and non-timber plants), gum and resin yielding plants, fumitories and masticatories, spices and condiments; Food adulteration

Module 2: Pharmacognosy

Introduction, classification of crude drugs, plant anatomy (stomata, trichomes, xylem, phloem, ergastic substances); Evaluation of drugs: organoleptic, microscopic, chemical, physical and biological; Drug adulteration.

Module 3: Phytochemistry

Structure, classification, properties, importance and plant sources of: alkaloids, terpenoids, phenolics, steroids, glycosides

Module 4: Industrial Botany

Paper and pulp industry: Paper making, raw materials, manufacture of wood pulp, paper manufacture, kinds of paper and paper products.

Beverages: Source, plant description, cultivation, manufacturing, chemical composition- Tea Coffee and Cocoa.

Dyes: Plant sources (Description, chemical nature, extraction of dyes).

Essential oil: Occurrence, extraction, essential oils used in perfumery and other industries.

Rubber and latex: Classification of rubber, Natural rubber- source, cultivation, collection of latex, processing, uses of rubber.

SEMESTER IV
PRACTICAL VII

Time : 6 Hours | Full marks : 100

Q. 1 One experiment from Paper XIII A	15
Q. 2 One experiment from Paper XIII B	10
Q. 3 One experiment from Paper XIV C	15
Q. 4 One experiment from Paper XIV D	10
Q. 5 Spotting from Elective Paper II	10
Q. 6 Viva-voce	20
Q. 7 Practical record	20

SEMESTER IV
PRACTICAL VIII

Project Full marks : 100