



Shri Vishwanath P. G. College Kalan, Sultanpur

(Affiliated)

DR. RAM MANOHAR LOHIA AVADH UNIVERSITY, AYODHYA

Structure of Syllabus for the Program: B.Sc.

Subject: **BOTANY**



SEMESTER-WISE TITLES OF THE PAPERS IN UG BOTANY COURSE					
YEAR	SEMESTER	COURSE CODE	PAPER TITLE	THEORY/PRACTICAL	CREDIT
CERTIFICATE					
FIRST YEAR	I	B040101T	Microbiology & Plant Pathology	Theory	4
		B040102P	Techniques in Microbiology & Plant Pathology	Practical	2
	II	B040201T	Archegoniates & Plant Architecture	Theory	4
		B040202P	Land Plants Architecture	Practical	2
DIPLOMA					
SECOND YEAR	III	B040301T	Flowering Plants Identification & Aesthetic Characteristics	Theory	4
		B040302P	Plant Identification technology	Practical	2
	IV	B040401T	Economic Botany, Ethnomedicine & Phytochemistry	Theory	4
		B040402P	Commercial Botany & Phytochemical Analysis	Practical	2
DEGREE IN BACHELOR OF SCIENCE					
THIRD YEAR	V	B040501T	Plant Physiology, Metabolism & Biochemistry	Theory	4
		B040502T	Molecular Biology & Bioinformatics	Theory	4
		B040503P	Experiments in physiology, Biochemistry & molecular biology	Practical	2
		B040504R	*Project-I	Practical	3
	VI	B040601T	Cytogenetics, Plant Breeding & Nanotechnology	Theory	4
		B040602T	Ecology & Environment	Theory	4
		B040603P	Cytogenetics, Conservation & Environment management	Practical	2
		B040604R	*Project-II	Practical	3

Semester I

Theoretical Paper

B040101T: Microbiology & Plant Pathology

Unit	Topics	Total No. of Lectures (60)
I	<p>Introduction to Indian ancient, Vedic and heritage Botany and contribution of Indian Botanists, in context with the holistic development of modern science and technology, has to be taught, practiced and assessed via class interaction/ assignments / self-study mentioned under Continuous Internal Evaluation (CIE).</p> <p>Microbial Techniques & instrumentation Microscopy – Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques for light microscopy, sample preparation for electron microscopy. Common equipment of microbiology lab and principle of their working – autoclave, oven, laminar air flow, centrifuge. Colorimetry and spectrophotometry, immobilization methods, fermentation, and fermenters.</p>	8
II	<p>Microbial World Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram-negative bacteria, Structure of a bacteria; Bacterial Chemotaxis and Quorum sensing, Bacterial Growth curve, factors affecting growth of microbes; measurement of growth; Batch culture, fed batch culture and continuous culture; Synchronous growth of microbes; Sporulation and reproduction and recombination in bacteria. Viruses, general characteristics, viral culture, Structure of viruses, Bacteriophages, Structure of T4 & λ-phage; Lytic and Lysogenic cycles, viroid, Prions & mycoplasma & phytoplasma, Actinomycetes & plasmids and their economic uses.</p>	8
III	<p>Phycology Range of thallus organization in Algae, Pigments, Reserve food –Reproduction - Classification and life cycle of – Nostoc, Chlorella, Volvox, Hydrodictyon, Oedogonium, Chara; Sargassum, Ectocarpus, Polysiphonia. Economic importance of algae - Role of algae in soil fertility- biofertilizer – Nitrogen fixation- Symbiosis; Commercial products of algae –biofuel, Agar.</p>	7
IV	<p>Mycology General characteristics, nutrition, life cycle, Economic importance of Fungi, Classification up to class. Distinguishing characters of Myxomycota: General characters of Mastigomycotina, Zygomycota: Rhizopus, Ascomycota: Saccharomyces, Penicillium, Peziza. Basidiomycotina: Ustilago, Puccinia, Agaricus; Deuteromycotina: Fusarium, Alternaria. Heterothallism, Physiological specialization, Heterokaryosis & Parasexuality.</p>	7
V	<p>Mushroom Cultivation, Lichenology & Mycorrhiza Mushroom cultivation. General account of lichens, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.</p>	7
VI	<p>Plant Pathology Disease concept, Symptoms, Etiology & causal complex, Primary and secondary inoculum, Infection, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection (Brief idea about Pre-penetration, Penetration and Post- penetration), Disease cycle (monocyclic, polycyclic and polyetic). Defense mechanism with special reference to Phytoalexin, Resistance- Systemic acquired and Induced systemic fungicides- Bordeaux mixture, Lime Sulphur, Tobacco decoction, Neem cake & oil</p>	7

VII	<p>Diseases and Control Symptoms, Causal organism, Disease cycle and Control measures of – Early & Late Blight of Potato, False Smut of Rice/ Brown spot of rice, Black Stem Rust of Wheat, Alternaria spot’ and ‘White rust of Crucifers, Red Rot of Sugarcane, Wilting of Arhar, Mosaic diseases on tobacco and cucumber, yellow vein mosaic of bhindi; Citrus Canker, Little leaf of brinjal; Damping off of seedlings, Disease management: Quarantine, Chemical, Biological, Integrated pest disease management.</p>	8
VIII	<p>Applied Microbiology Food fermentations and food produced by microbes, amino acids, Production of antibiotics, enzymes, vitamins, alcoholic beverages, organic acid & genetic recombinant vaccines. Mass production of bacterial biofertilizers, blue green algae, Azolla and mycorrhiza. Plant growth promoting rhizobacteria & biopesticides— Trichoderma sp. and Pseudomonas, Single cell proteins, Organic farming inputs, Microbiology of water, Biopolymers, Bioindicators, biosensors, Bioremediation, Production of biofuels, biodegradation of pollutants and biodeterioration of materials & Cultural Property.</p>	8

Suggested Readings:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Aggarwal, S. K. 2009. Foundation Course in Biology, A one books Pvt. Ltd., New Delhi.
5. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, NewDelhi.
6. Annie Ragland, 2012. Algae and Bryophytes, Saras Publication, Kanyakumari, India.
7. Basu, A. N. 1993. Essentials of Plant Viruses, Vectors and Plant diseases, New Age International, New Delhi.
8. Chopra. G. L. 1984. A Textbook of Algae, Rastogi publications, Meerut, India.
9. Desikachari, T. V. 1959. Cyanophyta, ICAR, New Delhi.

Practical

B040102P: Techniques in Microbiology & Plant Pathology

Unit	Topics	Total No. of Lectures (60)
I.	Instruments & Techniques <ol style="list-style-type: none"> 1. Laboratory safety and good laboratory practices 2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter. 3. Buffer preparation & titration 4. Cleaning and Sterilization of glassware 5. Preparation of media- Nutrient Agar and Broth 6. Inoculation and culturing of bacteria in Nutrient agar and nutrient broth 7. Preparation of agar slant, stab, agar plate 8. Phenol Coefficient method to test the efficacy of disinfectants 	7
II	Bacterial Identification <ol style="list-style-type: none"> 1. Isolation of bacteria. 2. Identification of bacteria. 3. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall. 4. Cultural characteristics of bacteria on NA. 5. Pure culture techniques (Types of streaking). 6. Biochemical characterization: 7. IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis. 	8
III	Mycological Study <ol style="list-style-type: none"> 1. Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic. 2. Identification of fungi by lactophenol cotton blue method. Rhizopus, Saccharomyces, Penicillium, Peziza, Ustilago, Puccinia; Fusarium, Curvularia, Alternaria. 3. Agaricus: Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus. 4. Lichens: crustose, foliose and fruticose specimens. 	8
IV	Phycology <ol style="list-style-type: none"> 1. Type study of algae and Cyanobacteria –Spirulina, Nostoc. Chlorophyceae - Chlorella, Volvox, Oedogonium, Cladophora, and Chara; Xanthophyceae –Vaucheria; Bacillariophyceae – Pinnularia Phaeophyceae – Sargassum Rhodophyceae - Polysiphonia 	7
V	Experimental Plant Pathology <ol style="list-style-type: none"> 1. Preparation of fungal media (PDA) & Sterilization process. 2. Isolation of pathogen from diseased leaf. 3. Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Stem rot of mustard, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of Puccinia, Few viral and bacterial plant diseases. 	8
VI	Practical In Applied Microbiology-1 <ol style="list-style-type: none"> 1. Isolation of nitrogen fixing bacteria from root nodules of legumes. 2. Enumeration of rhizosphere to non rhizosphere population of bacteria. 3. Isolation of antagonistic Pseudomonas from soil. 4. Microscopic observations of root colonization by VAM fungi. 5. Isolation of Azospirillum sp. from the roots of grasses. 6. Isolation of phyllosphere microflora. 7. Isolation of P solubilizing microorganisms. 	8

<p style="text-align: center;">VII</p>	<p>Practical In Applied Microbiology-2</p> <ol style="list-style-type: none"> 1. Wine production. 2. Isolation of lactic acid bacteria from curd. 3. Isolation of lipolytic organisms from butter or cheese. 4. Immobilized bacterial cells for production of hydrolytic enzymes. 5. Enzyme production and assay – cellulase, protease and amylase. 6. Immobilization of yeast. 7. Isolation of cellulolytic and anaerobic sulphate reducing bacteria. 8. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria. 	<p style="text-align: center;">8</p>
<p style="text-align: center;">VIII</p>	<ol style="list-style-type: none"> 1. Cultivation of Spirulina, & Chlorella in lab for biofuel 2. Visit to NBAIM, Mau, Varanasi (Kashi)/ IMTECH (Institute of Microbial Technology), Chandigarh for viewing Culture Repository 3. Visit to biofertilizers and biopesticides unit to understand about the Unit operation procedures. 4. Mushroom cultivation for Protein 5. Alcohol production. from Sugarcane Juice. 	<p style="text-align: center;">8</p>

Semester II

Theoretical Paper

B040201T: Archegoniates and Plant Architecture

Unit	Topics	Total No. of Lectures (60)
I	Introduction to Archegoniates & Bryophytes Unique features of archegoniates, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Riccia, Marchantia, Anthoceros and Sphagnum. (Developmental details not to be included). economic importance of bryophytes.	7
II	Pteridophytes General characteristics, Early land plants (Rhynia). Classification (up to family) with examples, Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes.	8
III	Gymnosperms Classification and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples, structure and reproduction; economic importance	8
IV	Palaeobotany General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Brief account of process of fossilization & types of fossils and study techniques; Contribution of Birbal Sahni	8
V	Angiosperm Morphology Angiosperm Morphology (Stem, Roots, Leaves & Flowers, Inflorescence) Morphology and modifications of roots; Stem, leaf and bud. Types of inflorescences; flowers, flower parts, fruits and types of placentation; Definition and types of seeds.	7
VI	Plant Anatomy Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica - Corpus theory. Secondary growth - Root and stem- cambium (structure and function) annular rings, Anomalous secondary growth - Bignonia, Boerhaavia, Dracaena, Nyctanthes	7
VII	Reproductive Botany Plant Embryology, Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, types of pollination, Methods of pollination, Germination of pollen grain, structure of male gametophyte, Fertilization, structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and polyembryony.	8
VIII	Palynology Pollen structure, pollen morphology, pollen allergy, Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role in taxonomic evidence.	7

Suggested Readings:

1. Gangulee H. S. and K. Kar 1992. College Botany Vol. I and II. (New Central Book Agency)
2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
4. Rashid A (1999) An Introduction to Pteridophyta, Vikas Publishing House Pvt. Ltd. New Delhi.
5. Sharma OP (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
6. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Pteridophyta, S. Chand and Company,
7. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Gymnosperms, S. Chand and
8. Parihar NS (1976) Biology and Morphology of Pteridophytes. Central Book Depot.
9. Bhatnagar SP (1996) Gymnosperms, New Age International Publisher.
10. Pandey BP (2010) College Botany Vol II S. Chand and Company, New Delhi

Practical

B040202P: Land Plants Architecture

Unit	Topics	Total No. of Lectures (60)
I	Bryophytes: 1. Marchantia- morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). Sphagnum- morphology, 2. W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.	8
II	Pteridophytes: 1. Lycopodium: Habit, stem T. S. stobilus V. S., Selaginella: Habit, rhizophore T. S, stem T. S, axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll. 2. Equisetum - Habit, rhizome and stem T.S. and V. S. of strobilus. 3. Azolla – Habitat & its structure	7
III	Gymnosperms 1. Cycas – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and Rachis, micro and megasporophyll, male cone V. S., microsporophyll T. S. entire and V. S. of ovule. 2. Pinus - Branch of indefinite growth, spur shoot, T. S of old stem and needle R.L.S and T. L. S. of stem, male and female cone, V.S. of male and female cone. 3. Ephedra & Thuja: Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed.	8
IV	Paleobotany & Palynology 1. Morphology of Rhynia and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientist to learn fossilization. 3. Mark and know about Indian geographical sites rich in plant fossils.	6
V	Angiosperm Morphology 1. To study diversity in leaf shape, size and other foliar features. 2. To study monopodial and sympodial branching. 3. Morphology of Fruits 4. Inflorescence types- study from fresh/ preserved specimens 5. Flowers- study of different types from fresh/ preserved specimens 6. Fruits- study from different types from fresh/preserved specimens 7. Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous) 8. Modifications in Roots, stems, leaves and inflorescences	8
VI	Plant Anatomy: 1. Normal & Anomalous secondary thickening - Bignonia, Dracaena, Boerhaavia diffusa, Nyctanthes 2. Study of primary and secondary growth in the root and stem of monocots and dicots by section cutting and permanent slides. 3. Study of internal structure of dicot and monocot leaves. Study of structure of stomata.	8

<p style="text-align: center;">VII</p>	<p>Reproductive Botany</p> <ol style="list-style-type: none"> 1. Structure of anther, microsporogenesis and pollen grains 2. Structure of ovule and embryo sac development (through slides). 3. Study of embryo development in monocots and dicots. 4. Vegetative propagation by means of cutting, budding and grafting exercises. 5. Study of seed germination. 6. Study of pollen morphology of the following plants –Hibiscus, Vinca, Balsam, Ixora, Crotalaria, Bougainvillea by microscopic observation. 7. Calculation of pollen viability percentage using in vitro pollen germination techniques. 	<p style="text-align: center;">8</p>
<p style="text-align: center;">VIII</p>	<p>Commercial Uses and Production technology</p> <ol style="list-style-type: none"> 1. Azolla production 2. Production technology of Resins 3. Production and propagation of Ornamental Pteris, Cycadales, Coniferales for landscaping. 4. Lab method for qualitative testing/ extraction of Ephedrine, Taxol and Thuja oil. 	<p style="text-align: center;">7</p>

Semester III

Theoretical Paper

B020301T: Flowering Plants Identification & Aesthetic Characteristics

Unit	Topics	Total No. of Lectures (60)
I	<p>Taxonomic Resources & Nomenclature Components of taxonomy (identification, nomenclature, classification); Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens, Flora, Keys- single access and multi-access. Principles and rules of Botanical Nomenclature according to ICN (ranks and names; principle of priority, binomial system; type method, author citation, valid- publication).</p>	7
II	<p>Types of classification & Evidences Artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series) angiosperm phylogeny group (APG IV) classification. Introduction to taxonomic evidences from palynology, cytology, phytochemistry & Molecular biology data (Protein and Nucleic acid homology).</p>	8
III	<p>Identification of Angiospermic families-I <i>(Families can be chosen University wise as per local available flora)</i> A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system) Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Acanthaceae, Asclepiadaceae, Solanaceae.</p>	8
IV	<p>Identification of Angiospermic families -II <i>(Families can be chosen University wise as per local available flora)</i> A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system)- Amaranthaceae, Euphorbiaceae, Papaveraceae, Apiaceae, Lamiaceae, Orchidaceae, Liliaceae, Musaceae, Poaceae.</p>	7
V	<p>Modern trends in Plant taxonomy Brief idea on Phenetics, Biometrics, Cladistics (Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy).</p>	8
VI	<p>Tools & softwares in plant identification GIS (Mapping of (i) Patterns(ii) Features (iii) Quantities 0P02.010H11YLIP - Free Phylogenetic Software, Digital Taxonomy (e-flora), Description Language for Taxonomy – DELTA Internet directory for botany.</p>	7
VII	<p>Computer usage & Android Applications MS Office: PPT, Microsoft Excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media. GPS tagging, Plant Identification Apps.</p>	7
VIII	<p>Aesthetic Characteristics of Plants Aesthetic characteristics of plants, English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Trees, shrubs and shrubberies, climbers and creepers, rockery, Flower beds, Shrubbery, Borders, Water Garden). Some Famous gardens of India. Conservatory, green houses, Indoor Garden, Roof Garden, Topiary, Bonsai.</p>	8

Suggested Readings:

1. Plant Systematics. Arun K. Pandey & Shruti Kansana. 2020. Jaya Publishing House.
2. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
3. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Dun.
4. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys. <http://delta-intkey.com>
5. <https://www.naace.co.uk/school-improvement/ict-mark/>
6. <https://www.socitm.gov.uk>, (2002) Learning in the 21st century Executive briefing A Socitm Insight publication, July 2002 Socitm.

Practical

B040302P: Plant Identification technology

Unit	Topics	Total No. of Lectures (60)
I	Herbarium: Plant collecting, Preservation and Documentation Stepwise Practicing Herbarium techniques: 1. FIELD EQUIPMENTS, Global Positioning System (GPS) instrument & Collection of any wild 25 plant specimens 2. Learn to handle Herbarium making tools. 3. Pressing and Drying of collected plant specimens 4. Special treatments for all varied groups of plants 5. Mount on standard herbarium sheets 6. Label them using Standard method. 7. Organize them and give Index Register Number	7
II	Taxonomic Identification using plant structure. Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham and Hooker natural system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiales (Lamiaceae), Rubiaceae.	8
III	Identification during excursions 1. Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making FIELD NOTEBOOK and filling Sample of a page of field-book, used in Botanical Survey of India. 2. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons.	8
IV	Collection, Preservation and Storage of Algae, Fungi Bryophytes, Pteridophytes (Two each)	7
V	Botanical Nomenclature & reporting Method Give nomenclature to collected plants as per ICN rules and prepare labels as per BSI Author Citation, Effective Publication and Principle of Priority: To show a specimen paper on Basic structure of a taxonomic Research published on a new species in taxonomic journal	7
VI	COMPUTERS 1. Learning to use EXCEL Microsoft PowerPoint and Word., Working with Folder and Windows Utility, Create and Manage Files and Folder Tree. 2. Practice browsing different sites using search engines. practice and understand different E-Mail services – Outlook, Yahoo mail, rediffmail etc. Practice Creating E-Mail accounts, Sending, Receiving & Storing of mails. 3. Create and Participate in virtual conferencing in an interactive Zoom Meeting	7
VII	Computer Application in taxonomy 1. Use Taxonomic Software (Dichotomous Key) 2. Practical on Phylogenetic analysis 3. Make line drawing of Plants for description 4. Using of plant identification apps on android phones	8
VIII	1. Create a Bonsai of any plant. 2. Develop a miniature garden. 3. Draw Layouts of various types of gardens 4. Plant Propagation methods practice	8

Semester IV

Theoretical Paper

B040401T: Economic Botany, Ethnomedicine and Phytochemistry

Unit	Topics	Total No. of Lectures (60)
I	Origin and domestication of cultivated plants Centers of diversity of plants, origin of crop plants. Domestication and introduction of crop plants. Concepts of sustainable development; cultivation, production and uses of Cereals, legumes, Spices & beverages.	7
II	Botany of oils, Fibers, timber yielding plants & dyes Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible & essential oils; Sugar, Starch; Fibers; Paper, Fumitories & Masticatories, Rubber, Dyes, Timber, biofuel crops.	7
III	Commercial production of Flowers, Vegetables, and fruits (To be Chosen area wise) Commercial greenhouse cultivation of rose, Gerbera, Gladiolus, Anthurium/lilium/lily, tomato, bell pepper, cucumber, strawberry & Exotic leafy vegetables using Hydroponics.	7
IV	IPR & Traditional Knowledge IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, TIFAC, NRDC, Rights, Procedure of obtaining patents, Working of patents, Infringement, Copyrights, Trademarks, Geographical Indications, Traditional Knowledge Digital Library, Protection of Traditional Knowledge & Protection of Plant Varieties and Biotech inventions.	8
V	Ethnobotany Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CI-MAP and CARI. Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation.	8
VI	Medicinal aspects Study of common plants used by tribes (Aegle marmelos, Ficus religiosa, Cynodon dactylon, Eclipta alba, Oxalis, Ocimum sanctum and Trichopus zeylanicus) Ethnobotanical aspect of conservation and management of plant resources, Preservation of primeval forests in the form of sacred groves of individual species and Botanical uses depicted in our epics. Plants in primary health care: common medicinal plants: Tinospora, Acorus, Ocimum, Turmeric and Aloe. Indian Pharmacopeia, Quality Evaluation of crude drugs & adulteration	8
VII	Pharmacognosy Preparation of drugs for commercial market - Organoleptic evaluation of drugs - microscopic evaluation of drugs - Physical evaluation of drugs - Active and inert constituents of drugs - Classification of drug plants - individual drugs - drug adulteration. Sources of crude drugs – roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds; organoleptic study of Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metel, Eclipta alba, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Ricinus communis, Vinca rosea and Zingiber officinale.	8
VIII	Herbal Preparations & Phytochemistry: Collection of wild herbs - Capsules - compresses - Elixirs - Glycerites - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Plant natural products, general detection, extraction and characterization procedures. Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Lignans, Terpenes, Volatile oils and Saponins, Carotenoids and Alkaloids Carotenoids and pharmacological activities.	7

Suggested Readings:

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
3. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency, India.
4. Reddy P. Parvatha. 2016. Sustainable crop protection under protected cultivation. Springer, Singapore.
5. Amit Deogirikar. 2019. A Text Book on Protected Cultivation and Secondary Agriculture. Rajlaxmi Prakashan, Aurangabad, India.
6. Singh, B., B. Singh, N. Sabir and M Hasan. 2014. Advances in protected cultivation. New India Publishing Agency, India.
7. Sharma, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw Hill Co. Ltd., NewDelhi.
8. Joe J. Hanan. 1997. Greenhouses: Advanced Technology for protected horticulture. CRC Press.
9. Krishnamurthy, K.V. (2004). An Advanced Text rbook of Biodiversity - Principles and Practices. Oxford and IBHPublications Co. Pvt. Ltd. New Delhi
- 10.N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001)

Practical

B040402P: Commercial Botany & Phytochemical Analysis

Unit	Topics	Total No. of Lectures (60)
I	Economic Botany & Microtechnique: <ol style="list-style-type: none"> 1. Cereals: 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) 2. Legume: Pea or ground nut (habit, fruit, seed structure, micro-chemical tests) 3. Source of sugars and starches: 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. 4. Tea- tea leaves, tests for tannin 5. Mustard- plant specimen, seeds, tests for fat in crushed seeds 6. Timbers: section of young stem. 7. Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fiber following maceration technique. 8. Study of specimens of economic importance mentioned in Unit I-& II 	8
II	Commercial Cultivation <ol style="list-style-type: none"> 1. Field visit to Green houses for understanding Floriculture & vegetables production. 2. Development of hydroponics nutrient solutions & running models for cultivation of vegetables 3. Development of hydroponics nutrient solutions & running models for cultivation of fodder 	8
III	Cultivating Medicinal and aromatic plants & Essential oil extraction <ol style="list-style-type: none"> 1. Lemon grass/ Neem/ Zinger /Rose/Mint 	7
IV	Documentation from Traditional Knowledge Digital Library <ol style="list-style-type: none"> 1. Mark the Geographic Indications on Map, 2. Understand –Nakshtra Vatika, Navgrah vatika and develop in your college 3. To extract the names of the plants and Botanical uses depicted in our epics. 4. Visit NISCAIR, New Delhi 	7
V	Ethnobotany <ol style="list-style-type: none"> 1. Study of common plants used by tribes. Aegle marmelos, Ficus religiosa, Cynodon dactylon. 2. Visit a tribal area and collect information on their traditional method of treatment using crude drugs. 3. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. 4. Observe the plants of ethnobotanical importance in your area. 5. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital 	7
VI	Instrumentation and herbal Preparations <ol style="list-style-type: none"> 1. Develop Capsules of herbs/ Develop Herbal oils/ Develop Poulitice/cream Analyse some active ingredients using chromatography /Spectrophotometry 	8
VII	Pharmacognosy <ol style="list-style-type: none"> 1. Organoleptic studies of plants mentioned in the theory : 2. Morphological studies of vegetative and floral parts. 3. Microscopic preparations of root, stem and leaf. 4. Stomatal number and stomatal index. 5. Vein islet number. 6. Palisade ratio. 7. Fibres and vessels (maceration). 8. Starch test 9. Proteins and lipid test 	8

VIII	Phytochemistry: <ol style="list-style-type: none"><li data-bbox="256 230 1246 293">1. Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. Dimensions of Calcium oxalate crystals in powdered crude drug.<li data-bbox="256 297 1238 360">2. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins & resins.<li data-bbox="256 365 608 392">3. Any 5 herbal preparations.	7
-------------	--	----------

Semester V

Theoretical Paper -I

B040501T: Plant Physiology, Metabolism & Biochemistry

Unit	Topics	Total No. of Lectures (60)
I	Plant water relation, Mineral Nutrition Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops, Transport of ions across cell membrane, active and passive transport, Composition of phloem sap, girdling experiment; Pressure flow model.	7
II	Carbon Oxidation Krebs cycle, Glycolysis, fate of pyruvate- aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Krebs cycle, mitochondrial electron transport, oxidative phosphorylation, ATP-Synthetase, Chemiosmotic mechanism, P/O ratio, cyanide-resistant respiration, factors affecting respiration.	7
III	Nitrogen Metabolism Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes), Physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination and transamination, amino acid synthesis.	8
IV	Lipid Metabolism & Photosynthesis Lipid Metabolism: Synthesis and breakdown of triglycerides, -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, -oxidation. ; Photosynthesis: Pigments, Action spectra and Enhancement effect, Electron transport system and Photophosphorylation, C3 & C4 photosynthesis, CAM- Reaction and Significance	7
V	Plant Development, Movements, Dormancy & Responses Developmental roles of Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene.) autonomic & paratonic movements, Control and Coordination in plants, Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red-light responses on photomorphogenesis, Seed physiology & Dormancy, Vernalization & Senescence	8
VI	Biomolecules Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (Sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage – starch, inulin). Lipids: Storage lipids: Fatty acids structure and functions, Structural lipids: Phosphoglycerides; Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers	8
VII	Proteins: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, Ramchandran plot, tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleic acids, Nucleic acid denaturation & Renaturation, MiRNA	7

VIII	<p>Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), enzyme inhibition and factors affecting enzyme activity, Allosteric enzymes & Abzymes.</p> <p>Phytonutrients, Nutraceuticals, dietary supplements and antioxidants.</p>	8
-------------	---	----------

Suggested Readings:

1. Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.
2. A Handbook On Mineral Nutrition And Diagnostic Techniques For Nutritional Disorders Of Crops (pb) ISBN : 9788177543377 Edition : 01 Year : 2011 Author : Pathmanabhan G , Vanangamudi M , Chandrasekaran CN , Sathyamoorthi K , Babu CR , Babu RC , Boopathi PN Publisher : Agrobios (India)
3. Jain, V.K. Fundamental of Plant Physiology (7th ed.) 2004. S. Chand and Company.
4. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.
5. Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
6. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
7. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pthways 2008, New Central Book. Agencies.
8. Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
9. Mathews, C.K., Van Holder, K.E. & Ahren, K.G. Bio-Chemistry (3rd ed.), 2000, Pearson Education.
10. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.

Theoretical Paper-II

B040502T: Molecular Biology & Bioinformatics

Unit	Topics	Total No. of Lectures (60)
I	<p>Genetic material Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase, bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): semi- conservative. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi- conservative, semi discontinuous RNA priming, θ (theta) mode of replication, replication of linear, dsDNA, replicating the 5' end of linear chromosome including replication enzymes.</p>	7
II	<p>Transcription & Regulation of gene expression Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation, (Prokaryotes and eukaryotes), genetic code. Regulation of gene expression in Prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes</p>	7
III	<p>Principles & Techniques of genetic engineering Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e., RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Antibody Engineering.</p>	8
IV	<p>Applications of Genetic engineering Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products, Biosafety concerns.</p>	7
V	<p>Bioinformatics & its applications Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand-based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.</p>	8
VI	<p>Biological databases Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss- Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem)</p>	8
VII	<p>Data Generation and Data Retrieval Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)</p>	7
VIII	<p>Phylogenetic analysis Similarity, identity and homology, Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA). Phylogenetic analysis: Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees.</p>	8

Suggested Readings:

1. Primrose, SB. 1995. Principles of Genome Analysis. Blackwell Science Ltd.Oxford, UK..
2. E.J. Gardner and D.P. Snustad. PRINCIPAL OF GENETICS (1984), John Wiley & Sons, Ney York.
3. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008 Molecular Biology of the Gene 6thedition. Cold Spring Harbour Lab. Press, Pearson Pub.
4. Freifelder - Molecular Biology.
5. P.K. Gupta. BIOTECHNOLOGY AND GENOMICS. Rastogi Publications, 7th Reprint (1st Edition): 2016-2017.

Practical

B040503P: Experiments in physiology, Biochemistry & molecular biology

Unit	Topics	Total No. of Lectures (60)
I	<p>Plant water relation, Mineral Nutrition and translocation in phloem</p> <ol style="list-style-type: none"> Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of Rhoeo / Tradescantia. Osmosis – by potato osmoscope experiment Effect of temperature on absorption of water by storage tissue and determination of Q10. Experiment to demonstrate the transpiration phenomenon with the bell jar method. Experiment for demonstration of Transpiration by Four-Leaf Experiment: Structure of stomata (dicot & monocot) Determination of rate of transpiration using cobalt chloride method. Experiment to measure the rate of transpiration by using Farmer’s Potometer Experiment to measure the rate of transpiration by using Ganong’s potometer Effect of Temperature on membrane permeability by colorimetric method. Study of mineral deficiency symptoms using plant material/photographs. 	8
II	<p>Nitrogen Metabolism, Photo Synthesis & Respiration</p> <ol style="list-style-type: none"> A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography. Separation of plastidial pigments by solvent and paper chromatography. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method. Effect of HCO₃ concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting). Measurement of oxygen uptake by respiring tissue (per g/hr.) Determination of the RQ of germinating seeds. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott’ bubble 	8
III	<p>Plant Development, Movements, Dormancy & Responses</p> <ol style="list-style-type: none"> Geotropism and phototropism — Klinostat Hydrotropism Measurement of growth — Arc and Liver Auxonometer To study the phenomenon of seed germination (effect of light). To study the induction of amylase activity in germinating grains. Test of seed viability by TTC method. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA bioassay) 	8
IV	<p>Techniques for biochemical analysis</p> <ol style="list-style-type: none"> Weighing and Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc. Separation of amino acids by paper chromatography. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples., Qualitative Analysis of carbohydrates, Estimation of reducing sugar by anthrone method, Qualitative Analysis of Lipids Qualitative analysis of Amino acids and Proteins Quantitative Analysis of Nucleic Acids, Analysis of dietary supplements, nutraceuticals & antioxidants Testing of adulterants in food items. 	8
V	<p>Genetic material</p> <ol style="list-style-type: none"> Instruments and equipments used in molecular biology. 	7

	<ol style="list-style-type: none"> 2. Preparation of LB medium and cultivating E.coli on it. 3. Isolation of Genomic DNA 4. Isolation of DNA from plants 5. Examination of the purity of DNA by agarose gel electrophoresis. 6. Quantification of DNA by UV-spectrophotometer 7. Estimation of DNA by diphenylamine method. 	
VI	<p>Preparation of models/ charts:</p> <ol style="list-style-type: none"> 1. Study of experiments establishing nucleic acid as genetic material (Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments) through photographs 2. Numericals based on DNA re-association kinetics (melting profiles and Cot curves) 3. Study of DNA replication through photographs: Modes of replication - Rolling circle, Theta and semi-discontinuous; Semiconservative model of replication (Messelson and Stahl's experiment); Telomerase assisted end-replication of linear DNA. 4. Study of structures of: tRNA (2D and 3D); prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs 5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozymes and Alternative splicing 6. Understanding the regulation of lactose (lac) operon (positive & negative regulation) and tryptophan (trp) operon (Repression and De-repression & Attenuation) through photographs. 7. Understanding the mechanism of RNAi by photographs 	7
VII	<p>Genetic Engineering</p> <ol style="list-style-type: none"> 1. Isolation of protoplasts. 2. Construction of restriction map of circular and linear DNA from the data provided. 3. Isolation of plasmid DNA. 4. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph). 5. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results. 6. Agarose gel analysis of plasmid DNA 7. Restriction digestion of plasmid DNA -Demonstration of PCR 	7
VIII	<p>Applications of Genetic engineering</p> <ol style="list-style-type: none"> 1. ELISA Test, 2. Viability tests of cells 3. Study of methods of gene transfer through photographs: Agrobacterium- mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 4. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs. 	7

Semester VI

Theoretical Paper- I

B040601T: Cytogenetics, Plant Breeding & Nanotechnology

Unit	Topics	Total No. of Lectures (60)
I	Cell biology Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions - Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus. Chromosomal nomenclature- chromatids, centromere, telomere, satellite, secondary constriction. Organization of chromosomes- Nucleic acid and histones- types and classification. Lampbrush chromosomes and polytene chromosomes- Karyotype and idiogram. Cell cycle: G0, G1, S and G2 phases – mitosis: open and closed mitosis – amitosis - meiosis. Variation in Chromosome number (Numerical aberrations)- aneuploidy and Euploidy-haploidy, polyploidy- significance (Structural aberrations) - deletion, duplication, inversion and translocation.	8
II	Genetics Chromosome theory of inheritance, crossing over and linkage; Incomplete dominance and codominance; Interaction of Genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance; Extra-nuclear Inheritance, Linkage, crossing over, Concept of sex determination and Sex chromosomes; Patterns of Sex determination in plants	7
III	Plant breeding Plant introduction. Agencies of plant introduction in India, Procedure of introduction - Acclimatization – Achievements, Selection - mass selection, pure line selection and clonal selection. Genetic basis of selection methods, Hybridization: Procedure of hybridization, inter generic, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties, Male sterility, Heterosis and its exploitation in plant breeding, Mutation, Molecular Breeding (use of DNA markers in plant breeding), achievements in India, Breeding for pest, pathogenic diseases and stress resistance.	8
IV	Biostatistics Definition, statistical methods, basic principles, variables- measurements, functions, limitations and uses of statistics. Biometry: Data, Sample, Population, random sampling, Frequency distribution- definition only, Central tendency– Arithmetic Mean, Mode and Median; Measurement of dispersion–Coefficient of variation, Standard Deviation, Standard error of Mean; Test of significance: chi- square test for goodness of fit. Computer application in biostatistics - MS Excel and SPSS	7
V	Plant tissue culture Principles, components and techniques of in vitro plant cultures, Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplast- principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells, Somaclonal variation, Plant secondary metabolites production.	8
VI	Nanotechnology Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus). Nano-particles synthesis, Biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, nano-pesticides, nano-fertilizers, nano-sensors.	7

VII	Artificial Intelligence in Plant Sciences Big Data Analytics, Blockchain Technology, 3-D Printing, Machine learning, Algorithms of Machine Learning, Expert systems and Fuzzy logic, Artificial Neural Networks and Genetic algorithms, Predictive Analytics, Agents and Robotics, IoT Sensors, Object Image capture & analysis ; Applications of Artificial Neural Networks in Plant Science.	8
VIII	Introduction to use of Digital technologies – AI, IoT & ICT in Botany Educational software- INFLIBNET, NICNET, BRNET, internet as a knowledge repository- google scholar, science direct. resource management, weather forecasting. IoT Database management, IoT platforms, IoT Graphical user interface • IoT application development for Android Mobile phones, ICT Applications for different crops and horticulture	7

Suggested Readings:

1. G.M. Cooper. (2015). The cell: A Molecular Approach. 7th Edition. Sinauer Associates.
2. Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of Cell. 6th Edition. WW. Norton & Co.
3. Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.
4. Campbell, P.N. and Smith, A.D. (2011). Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
5. Tymoczko, J.L., Berg, J.M. and Stryer, L. (2012). Biochemistry: A short course, 2nd ed., W.H.Freeman.
6. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2011) Biochemistry, W.H.Freeman and Company

Theoretical Paper-II

B040602T: Ecology & Environment

Unit	Topics	Total No. of Lectures (60)
I	<p>Natural resources & Sustainable utilization: Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water, Wetlands; Threats and management strategies, Ramsar sites, Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy, Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting.</p>	7
II	<p>Ecology & Ecosystem Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem– Concept of an ecosystem-structure and function of an ecosystem. Abiotic and biotic com-Energy flow in an ecosystem Ecological Succession-Definition & types. Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary & secondary), Hydrosere and Xerosere. Food chains and food webs, Ecological pyramids, production and productivity; And components. Types of ecosystems: Forest Ecosystem, Grassland, Crop land, aquatic Ecosystems Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.</p>	8
III	<p>Soil Formation, Properties & Conservation Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soil processes, Soil Erosion, Biogeochemical cycles, Soil Conservation: Biological– Contour farming, Mulching, Strip cropping, Terracing and Crop rotation. Mechanical–Basin Listing, Construction of dams, Watershed Management, Soil reclamation</p>	7
IV	<p>Biodiversity and its conservation Definition -genetic, species, and ecosystem diversity. Value of biodiversity: social, ethical, aesthetic and option values; hotspots of Biodiversity threats to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecotypes, ecological indicators. Conservation of Biodiversity: Ex-situ and in-situ conservation, Red data book, botanical gardens, National park, Sanctuaries, hot & hottest spots and Bioreserves. Role of Seed Bank and Gene Bank Valuing plant resources, ecotourism, Role of NBPGR, FAO, BSI.</p>	7
V	<p>Phytogeography Biogeographic regions of India & world, Agroecological & Floristic zones of India. Natural vegetation of India, static and dynamic plant geography, basic principles governing geographical distribution of plants, Phytogeographical regions of India, Vegetational types in Uttar Pradesh.</p>	7
VI	<p>Environmental audit & Sustainability Concept of environmental audit; Guidelines of environmental audit; Methodologies adopted along with some industrial case studies; Environmental standards: ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Life cycle analysis; Concept of energy and green audit, Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice.</p>	8
VII	<p>Pollution, Waste management & Circular Economy Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers,</p>	8

	biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG ;Waste- Types , collection and disposal, Recycling of solid wastes (hazardous & non-hazardous) - classification, collection and segregation , Incineration, Pyrolysis and gasification, Sanitary landfilling; composting, Biogas production, Circular Economy & sustainability.	
VIII	<p>Environmental ethics, Carbon Credits & Role of GIS</p> <p>Carbon credit: concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Clean development mechanism.</p> <p>Geographical Information Systems: definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.</p>	8

Suggested Readings:

1. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press
2. Shukla, R.S. & Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co.
3. Kumar, H.D. Modern Concept of Ecology, Latest Ed. Vikas Publishing House
4. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders
5. Sharma, P.D. Elements of Ecology, Latest Ed., Rastogi Publications
6. Ambasht, R.S. & Ambasht, N.K. A Text Book of Plant Ecology, Latest Ed., CBS Publication & Distributors
7. Mani, M.S. Bio-Geography of India, Latest Ed., Springer-Verlag.

Practical

B040603P: Lab on Cytogenetics, Conservation & Environment management

Unit	Topics	Total No. of Lectures (60)
I	Cell biology 1. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum 2. Measurement of cell size by the technique of micrometry. 3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains) 4. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of Allium cepa.	7
II	Genetics 1. Monohybrid cross (Dominance and incomplete dominance) 2. Dihybrid cross (Dominance and incomplete dominance) 3. Gene interactions (All types of gene interactions mentioned in the syllabus) a. Recessive epistasis 9: 3: 1. b. Dominant epistasis 12: 3: I c. Complementary genes 9: 7 d. Duplicate genes with cumulative effect 9: 6: 1 e. Inhibitory genes 13: 3 4. Observe the genetic variations among inter and intra specific plants. 5. Demonstration of Breeding Techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment.	8
III	Biostatistics 1) Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2) Calculation of correlation coefficient values and finding out the probability. Determination of goodness of fit in Mendellian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance. 3) Computer application in biostatistics - MS Excel and SPSS	7
IV	Plant tissue culture 1. Familiarization of instruments and special equipments used in the plant tissue culture experiments 2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media. 3. Surface sterilization of plant materials for inoculation (implantation in the medium) 4. Micropropagation of potato/tomato/ - Demonstration 5. Protoplast isolation and culturing – Demonstration	8
V	Ecology & Environment 1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites 2. Study of morphological adaptations of hydrophytes and xerophytes (four each). 3. Study of biotic interactions of: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus. 5. Field visit to familiarize students with ecology of different sites	8

VI	Soil Formation, Properties & Conservation <ol style="list-style-type: none"> 1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 4. Soil Profile study 5. Soil types of India-Map 	8
VII	Biodiversity and Phytogeography <ol style="list-style-type: none"> 1. 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). 2. Marking of vegetation types of India, World & Uttar Pradesh on maps 3. Phytogeographical areas of India 	7
VIII	Pollution & Waste management <ol style="list-style-type: none"> 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter. 2. Estimation of chloride and dissolved oxygen content in water sample 3. Comparative anatomical studies of leaves from polluted and less polluted areas. 4. Measurement of dissolved O₂ by azide modification of Winkler's method. 5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 6. Microbiological assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water 7. Making kitchen waste from compost/vermicompost by Enzymes/Bio decomposer/ Whey with dung. 8. Climate Change, Carbon Credits & Role of GIS 9. Conducting Waste Audit of your Institution -Demo 10. Green auditing of the College/University -Demo 	7

Project

B040604R: Project in Botany for Graduation

SUGGESTIVE LIST OF PROJECTS

- Prepare beds for growing nursery for herbs, shrubs and trees.
- Develop Green house facility in college and grow plants Develop hydroponics facility in college and grow plants.
- Develop botanical garden in the college with labelling Vertical gardens, roof gardens.
- Culture & art of making bonsai.
- Computer Aided Designing (CAD) for outdoor and indoor scaping Exposure to CAD (Computer Aided Designing)
- Phytochemical Analysis of Medicinal plants Bio-composting and Vermicomposting.
- Performing Aromatherapy by essential Oils

Refer: libraries, journals, Memoirs, encyclopedias, herbaria, Museums, etc.