Rayat Shikshan Sanstha's

Annasaheb Awate Arts, Commerce and Hutatma Babu Genu Science College

Manchar, Tal. Ambegaon, Dist. Pune

DEPARTMENT OF BOTANY

Course Outcomes - Under graduate

Sr. No.	Class	Course	Course Outcomes (CO)
1	F. Y. B. Sc Botany (Choice Based Credit System -CBCS Pattern) Semester I	BO111: Plant life and utilization I	CO1. Students will be made aware of plant life and its classification CO2. Students will know lower cryptogams, higher cryptogams and phanerogams CO3. The student will understand the role of lower and higher crypotogams with detailed understanding of their life cycles, and applications. CO4. To provide thorough knowledge about various primitive plant groups and their utilization.
		BO112: Plant morphology and Anatomy	CO1. The learners will be made aware of definition, descriptive and interpretative morphology so as to distinguish the plant forms. CO2. Students will acquire knowledge on different morphological features like, fruit, flower, inflorescences their types and distinguishing features. CO3. The learner will also have a deep understanding of anatomical features, types of tissues and its organization in the plant body with special emphasis on its role and functions. CO4. These learning points will help the student in further applied aspects of the subjects during their higher studies. CO5. The course will also develop their thinking ability to identify and let know the knowhow and importance of the plants to wider societal reach.

		BO113: Practical, Practical based on BO 111 & BO 112	To get acquainted with the subject in live form and visits to natural habitats.
	F. Y. B. Sc Botany (Choice Based Credit System - CBCS Pattern) Semester II	BO 121 : Plant life and utilization II	CO1. Students will be made aware of plant diversity in Pteridophytes, Gymnosperms and Angiosperms with reference to vascular plants CO2. The student will understand the role of these groups with detailed understanding of their life cycles, and applications. CO3. The learners will be acquainted with understanding of application and uses of such plants in utilization CO4. Gain knowledge about various primitive plant groups and their utilization.
		BO 122: Principles of plant science	CO1. The learner will understand the physiological processes in the plants. CO2. The students will get acquainted with different cellular functions and processes of cell division CO3. The learners will get knowledge of the subatomic molecules and their role and functions in the cell. CO4. The course will create an applied interest of the students in the subject and will provoke to consider research as one of the potential field as career.
		BO 123: Practical based on BO 121 & BO 122	To create foundation for further studies in Botany. To get acquainted with the subject in live form and visits to natural habitats.
2	S. Y. B. Sc Botany (Choice Based Credit System -CBCS Pattern) Semester I	BO 231: Taxonomy of Angiosperms and Plant Ecology	CO1. The students will be able know the objectives, importance and scope of plant systematics. CO2. The learners will get acquainted with sources of data on systematics, botanical nomenclature. CO3. The learner will have a deep knowledge on different plant families and its characterization features. CO4. The students will be made aware of environmental awareness, ecological grouping and community dynamics. CO5. The course will be made aware of his/her role in environment and will make them a responsible citizen it

			will also force to think students about sustainable ecology.
		BO 232: Plant Physiology	CO1. Learners will have an in deep knowledge about importance of plant physiology and its application CO2. Students will acquire understanding about biophysical phenomenon and various process in plants like plasmolysis, osmosis, diffusion, permeability CO3. The learner will have an understanding about water absorption, various cells involved in the process and their functioning. CO4. The course also emphasizes on understanding of various processes such as mineral and salt absorption with references to growth. CO5. The students will understand the role of plant growth regulators its types and also the process of flowering. CO6. The course will help students to take up research as career and will also those provoke understanding of growth and flowering to make them successful entrepreneurs.
		BO 233: Practical based on BO 231 & BO 232	To get acquainted with the subject in live form and visits to ecological belts.
	S. Y. B. Sc Botany (Choice Based Credit System -CBCS Pattern) Semester II	BO 241: Plant Anatomy and Embryology	CO1. The students will have an in deep knowledge about different types of tissues with understanding of their role in plant system CO2. The learner of the course will also understand the process of tissues systems in plants and will be able to know the growth types happening in the plant body. CO3. The student will understand the process of embryo formation, types of embryos and process of fertilization in plants. Which will help them to know about its application in horticulture and agricultural practices. CO4. The learner will also get an in deep idea about a branch of botany i.e., palynology, with its application in lucrative industries viz. honey making. This will certainly

			help them select the stream as one of the potential careers.
		BO 242: Plant Biotechnology	CO1. The student will be introduced and made acquainted with the applied field of biotechnology with special reference to the plants. CO2. The learner of the course will have a detailed knowledge on plant genome, genetic engineering and bioprocesses. CO3. The student will have an understanding about the different applied industries in the stream and its applications in food, medicine etc. CO4. The learner will not only be acquainted with production processes but also will be made aware about scale ups in upstream and downstream processes. CO5. The course will ensure enhanced the level of understanding of students in the subject area and provoke them to consider it as a potential career.
		BO 243 : Practical Practical based on BO 241 & BO 242	To equipped the students with skills related to laboratory as well as field based studies.
3	T. Y. B. Sc. Botany (Choice Based Credit System -CBCS Pattern) Semester I Discipline Specific Elective Course	BO 351: Botany Theory Paper I Cryptogamic Botany (Algae and Fungi	CO-1. To understand about Introduction: Cryptogams- meaning. Types- Lower Cryptogams, brief Review with examples. CO-2. Gain idea about Algae: General characters, distribution, Thallus organization, habit and Habitat reproduction and Classification (G.M.Smith 1955) up to classes. CO-3. Study of life cycle of algae with reference to taxonomic position, Occurrence, Thallus structure, and reproduction of Nostoc, Oedogonium Chara, Sargassum and Batrachospermum. CO-4. Know Economic importance of algae- Role in industry, agriculture, fodder and medicine. CO-5. To study Fungi: General characters, Habit and habitats, thallus organization, cell wall composition, nutrition and Classification. (Alexopoulos and Mims 1979) up to classes.

			CO-6. Study of life cycle of fungi with reference to taxonomic position, thallus structure, and reproduction of Mucor (Zygomycotina), Saccharomyces (Ascomycotina), Puccinia (Basidiomycotina), Penecillium and Cercospore (Deuteromycotina) [Two members of Deutero.] CO-7. Gain idea Symbiotic Associations - Lichens, Mycorrhiza and their significance.
		BO 352: Botany Theory Paper 2 Archegoniate	CO-1. Get idea about Introduction to Archegoniate. CO-2. To study Introduction, general characters, distribution of Bryophytes to land habit, classification of Bryophytes according to G.M. Smith (1955) up to classes with reasons. CO-3. Understand Range of thallus organization, origin of Bryophytes - Pteridophytes and Algal hypothesis, evolution of sporophyte. CO-4. Study of Life Cycle of Bryophytes with respect to Taxonomic position, Morphology, Anatomy, Reproduction, Gametophytes and sporophytes of Marchantia, Anthoceros and Funaria. CO-5. Gain knowledge about Ecological and economic importance of Bryophyte. CO-6. Get idea about Introduction, Vascular Cryptogams, General characteristics, Classification according to K.R. Sporne (1975) up to classes with reasons, Diversity and Distribution of Pteridophytes. CO-7. To study Resemblances of Pteridophytes with Bryophytes, Differences between Pteridophytes and Bryophytes, Origin of Pteridophytes -Algal and Bryophytes, Evolution of Pteridophytes- Telome Theory and Enation Theory. CO-8. Study of Life Cycle of Pteridophytes with respect to Taxonomic position, Morphology, Anatomy, Reproduction, Sporophytes and Gametophytes of Psilotum, Selaginella and Equisetum. CO-9. To know Ecological and Economical Importance of Pteridophytes.

		BO 353: Botany Theory Paper 3 Spermatophyta and Paleobotany	CO-1. Understand Origin of angiosperms: with reference to time, place and ancestry- 1) Pseudanthial theory 2) Transitional-Combinational Theory. CO-2. Know Speciation & Endemism Species concept (Biological, Taxonomic & Phylogenetic Species Concept), Speciation (Allopatric, Sympatric & Parapatric), Endemism and its types (Palaeoendemism, Holoendemism and Neoendemism). CO-3. Gain knowledge about Classification: Outline, Merit and Demerits of Cronquist's System and APG IV system of classification. Study of following families with reference to systematic position (As per Bentham & Hooker), Diagnostic characters, floral formula, floral diagram and any five examples with their economic importance – Nymphaeaceae, Oleaceae, Amaranthaceae, Cannaceae. CO-4. Understand Herbaria and Botanical Gardens Functions of Herbarium, Important herbaria (World: Kew herbarium; India: Central National Herbarium, Kolkata). Botanic gardens of the world (Royal Botanic Garden, Kew) and India (Lead Botanic Garden, Shivaji University, Kolhapur). CO-5. Get idea about Introduction, general characters, economic importance and classification according to Chamberlain (1934). CO-6. Study of life cycle of Pinus and Gnetum with reference to distribution, morphology, anatomy, reproduction, gametophyte, sporophyte, seed structure and alternation of generations. CO-7. Know Fossil- Definition, process of fossil formation, types of fossils. Impression, Compression, Petrifaction, Pith cast and Coal ball.
		BO 354: Botany Theory Paper 4 Plant Ecology	CO-1. To study Introduction, interrelationship between the living world and the environment, levels of organization, components and dynamism of ecosystem, homeostasis, niche concept, concept of limiting factors. CO-2. Understand Biogeography: Floristic realms, speciation and its types, biogeographic regions of India,

			Plant indicators. CO-3. To know Population ecology: Definition, characteristics, population growth form, r and k selection. CO-4. Gain Knowledge about Community ecology: Introduction and Definition, community structure, physiognomy, Raunkiaer's life form classification, keystone species, edge and ecotone. CO-5. Get idea about Biogeochemical cycles: The carbon cycle, N-cycle, Phosphorus cycle, and Hydrologic cycle. CO-6. To study Ecological Impact Assessment (EIA) Introduction, Historical Review of EIA, Objectives of EIA, Stages of EIA process: Screening; Scoping; Baseline study; Impact prediction and assessment; Mitigation; Producing Environmental Impact Statement (EIS); EIS review; Decision making; Monitoring, Compliance and Enforcement; Benefits of EIA. CO-7. Understand Environmental Audit; Meaning and concept, need, objectives, benefits, types, audit protocol, process, certification, personnel environmental audit. CO-8. To know Remote Sensing Definition, basic principles, process of ecological data acquisition and interpretation, global positioning system, application of remote sensing in ecology. CO-9. Gain knowledge of Ecological management: Concepts, sustainable development, sustainability indicators.
		BO 355: Botany Theory Paper 5 Cell and Molecular Biology	CO-1. Get idea about Introduction to Cell Biology: Definition, Brief history of Cell Biology, Units of measurement for cell, Interdisciplinary nature of Cell Biology. CO-2. Understand Cell organelles: Ultrastructure, components and functions of Cell wall and cell membranes, mitochondria and Chloroplast, endoplasmic Reticulum, Golgi apparatus, Lysosomes, Vacuoles, Peroxisomes & Glyoxysomes. CO-3. To study Nucleus: Morphology and ultrastructure of nucleus, nucleolus and nucleolar organizer nuclear

			envelope – structure of nuclear pore complex, transport of molecules across nuclear envelope. CO-4. Understand Chromosomes: Euchromatin and heterochromatin Histones, Packing of DNA into chromosomes in eukaryotes, Karyotype and ideogram, Polytene chromosomes and lampbrush chromosomes. CO-5. Gain idea about Cell signaling: Introduction and definition, signaling molecules and receptors, Calcium signaling pathway in plants. CO-5. To study Genetic material DNA: historical perspective from 1953 to 2020, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment CO-6. Understand DNA replication (Prokaryotes and Eukaryotes): Molecular mechanism of DNA replication. Enzymes involved in both prokaryotic and eukaryotic DNA replication and their inhibitors (antibiotics). CO-7. Know Gene expression: Transcription (Prokaryotes in details and passing remarks on Eukaryotes) Types of RNA: mRNA, tRNA, rRNA; types of promoters; types of RNA polymerase enzymes in eukaryotes; molecular mechanism of transcription. CO-8 To study Translation (Prokaryotes and Eukaryotes): Definition, concept and properties of genetic code; molecular mechanism of translation. CO-9. Gain idea about Regulation of gene expression: Concept of operon, lac operon and trp operon, positive and negative control, one gene one enzyme hypothesis.
		BO 356: Botany Theory Paper 6 Genetics	CO-1. Understand Introduction to Genetics: History, Definition, Concept, branches and applications of Genetics. CO-2. Know Mendelism: Genetical terminology, Monohybrid cross, Law of dominance, Incomplete dominance, Law of segregation, Dihybrid cross, Dihybrid ratio, Law of independent assortment, back cross and Test cross. CO-3. Understand Neo Mendelism (Gene Interaction): Genetic interaction, Epistatic interactions –supplementary

			gene (recessive epistasis 9:3:4), Inhibitory genes (13:3), Masking genes (12:3:1), non-Epistatic inter-allelic genetic interactions-Complementary genes (9:7), Duplicate genes (15:1). CO-4. To study Multiple alleles: Definition, Concept, Characters of multiple alleles, Examples of multiple alleles – Blood group in human and self-incompatibility in Nicotiana. CO-5. Gain knowledge about Linkage, Recombination and Crossing Over, Linkage- Definition and Types, Crossing over: Definition and Types, Construction of a linkage map by two-point test cross and three-point test cross, Recombination: Concept, definition and types. CO-6. To study Mutation: Concept, definition and types. CO-5. Get idea about Numerical alterations of chromosomes.: Euploidy, Aneuploidy-Concept and Types, Aneuploidy in Plants and Human, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy. CO-6. To study Structural alterations of chromosomes.: Types, cytology and genetic effects of Deletion, Duplication Inversion and Translocation with examples. CO-7. Understand Cytoplasmic & Quantitative Inheritance: Concept of quantitative inheritance, Inheritance of quantitative trait in Maize (Cob length), Cytoplasmic inheritance Definition and concept, Chloroplast- Varigation in Four O'clock plants, Mitochondria- Petite mutants in yeast. CO-8. Gain idea about Sex Linked Inheritance: Concept of Sex chromosomes and autosomes, Inheritance of X-linked genes –Inheritance of colour blindness in humans, Inheritance of Y-linked (Holandric genes) in humans, Sex influenced genes, Sex-limited genes.
		BO 357: Botany Practical Paper I Practical based on BO351 and BO352	CO-1. Study of Algae with respect to systematic position, thallus structure and reproduction of Nostoc, Oedogonium, Chara, Sargassum, Palmaria/Chondrus. CO-2. Study of Fungi respect to systematic position, thallus structure and reproduction of Mucor, Saccharomyces, Penicillium, Puccinia and Cercospora.

			CO-3. Study of Marchantia with respect to systematic position, morphology of thallus –rhizoids and scales, Gemma Cup, structure of sporophyte, reproduction. CO-4. Study of Anthoceros with respect to systematic position, structure of gametophyte, anatomy of thallus, structure of Sporophytes, reproduction. CO-5. Study of Funaria with respect to systematic position, morphology of thallus- leaf, rhizoids, operculum, Anatomy of axis, leaf, reproduction. CO-6. Study of Sporophyte evolution in Bryophytes with the help of permanent slides. CO-7. Study of Psilotum with respect to Taxonomic position, Morphology of sporophyte, anatomy and reproductive structure. CO-8. Study of Selaginella with respect to Taxonomic position, Morphology of sporophyte, Anatomy and reproductive structures. CO-9. Study of Equisetumwith respect to taxonomic position, Morphology of Sporophyte, anatomy and reproductive structure. CO-10. Study of Stelar evolution in Pteridophytes with the help of permanent slides. Note: Botanical Excursion and submission of Tour Report with Photographs is compulsory.
		BO 358: Botany Practical Paper 2 Practical based on BO353 and BO354	CO-1. Study of following families with reference to systematic position (following Bentham & Hooker), Diagnostic characters, floral formula, floral diagram of Nymphaeaceae, Oleaceae, Amaranthaceae, Cannaceae. CO-2. Preparation of Botanical keys: Indented and bracketed keys by using vegetative and reproductive characters. CO-3. Study of internal and external morphology of Gnetum. CO-4. Study of internal and external morphology of Pinus. CO-5. Study of the following with the help of slides and/

			or specimens. i) Impression ii) Compression iii) Petrifaction. CO-6. Study of polluted water body with ref. to BOD (D zero day and D fifth day). CO-7. Study of physicochemical properties of water body by using Sacchi disc, pH meter and electric conductivity meter. CO-8. Acquisition of ecological data of particular locality by using GPS/ altimeter/geographicloa maps etc. CO-9. Study of suitable ecosystem by line/belt transect method/ nested quadrate method. Note: Excursion tours of long and short duration are compulsory
		BO 359: Botany Practical Paper 3 Practical based on BO355 and BO356	CO-1. Cytological techniques-preparation of Fixatives, preparation of stains (Aceto˘carmine and Aceto-orcein). CO-2. Isolation of nuclei and characterization. CO-3. Study of various stages of mitosis and meiosis. CO-4 Induction of C metaphase in suitable plant material. CO-4. Study of Chromosomes Morphology (from colchicines pretreated Onion root tip cells). CO-6. Isolation of plant genomic DNA by suitable method. CO-7. Estimation of Plant DNA by DPA method. CO-8. Extraction and estimation of RNA by Orcinol Method. CO-9. To study the monohybrid and dihybrid crosses with suitable data and its analysis by Chi-Square test. CO-10. Induction of tetraploidy in onion root cells and preparation of squash for observation of tetraploid cells. CO-11. Preparation of salivary gland chromosomes in Chironomous larvae. CO-12. Study of human genetic traits viz. PTC taste sensitivity, earlobe and rolling tongue, height, Skin colour,

			Hair colour, Eye colour in known population. CO-13. Genetic problems on gene mapping using three-point test cross data. CO-14. Study of structural heterozygotes (multiple translocations) in Rhoeo. CO-15. Problems on quantitative inheritance. (Cob length in Maize). CO-16. Problems on Multiple Alleles. (Blood group in Human).
	Skill Enhancement course	BO 3510: Botany Theory Paper 7 Medicinal Botany	CO-1. Gain idea about Medicinal Plants: History, Scope and Importance CO-2. Understand Indigenous Medicinal Sciences; Definition and Scope. CO-3. To study Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments. CO-4. Know about Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. CO-5. Get idea about Unani: History, concept: Umoor-e-tabiya, tumors treatments/ therapy, polyherbal formulations. CO-6. To understand Conservation of endangered and endemic medicinal plants: Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens. CO-5. To know about Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding. CO-6. Understand Ethnobotany and Folk medicines: Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National

			interacts, Palaeo-ethnobotany. CO-7. Gain knowledge about Folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.
		BO 3511: Botany Theory Paper 8 Plant Diversity and Human Health	CO-1. Gain idea about Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level. CO-2. Know Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes. CO-3. Understand Loss of Biodiversity: Loss of genetic diversity, species diversity, ecosystem diversity, agrobiodiversity, Projected scenario for biodiversity loss. CO-4. Gain knowledge about Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations. CO-5. Understand Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, In situ and ex situ conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. CO-6. To study Role of plants in relation to Human Welfare; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses.
	T. Y. B. Sc. Botany (Choice Based Credit System -CBCS Pattern) Semester II	BO 361: Botany Theory Paper I Plant Physiology and Metabolism	CO-1. To understand Mineral nutrition: Classification of mineral elements, macro and micronutrients; Role of essential elements; Transport of ions across cell membrane, Ionophores, Carriers and Channels. CO-3. To study Photosynthesis: Mechanism of photosynthesis- Electromagnetic spectrum Ultra-Structure of Chloroplast, Organization of Light-

	Discipline Specific Elective Course		Absorbing Antenna Systems, Light Reaction: (Cyclic and Non-cyclic photophosphorylation), Dark Reaction: Calvin–Benson Cycle, Photorespiration, C4 cycle and CAM pathway of carbon fixation). CO-4. Understand Respiration: Types of respiration (Aerobic and anaerobic), Mechanism of aerobic respiration (Glycolysis, TCA cycle, Terminal oxidation and phosphorylation in respiratory chain); Pentose Phosphate Pathway. CO-5. Know Stomatal Biology: Light-dependent Stomatal Opening, Mediation of Blue-light Photoreception in Guard Cells by Zeaxanthin, Reversal of Blue Light–Stimulated Opening by Green Light, The Resolving Power of Photo physiology (Overview). CO-6. Get idea about Translocation in phloem: Composition of phloem sap, girdling experiment; Pressure flow model. CO-7. To study Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene. CO-8. Gain knowledge about Photomorphogenesis: Red and far-red light responses on photomorphogenesis; Phytochrome (discovery and mode of action).
		BO 362: Botany Theory Paper 2 Biochemistry	CO-1. Understand Foundation of Biochemistry: From molecules to the first cell (origin of a cell), Miller and Urey experiment. Biomolecules of a cell, functional groups in biomolecules, conformations and configurations of biomolecules. CO-2. Know about Water: The solvent of life: Physical properties of water, structure of water molecule, polarity of water molecule, weak interactions in aqueous solutions. CO-3. To study Amino acids and proteins: Structure, classification, properties and functions of amino acids. Structure (primary, secondary, tertiary and quaternary), properties and functions of proteins. Biological disorders of amino acid metabolism. Commercial applications. CO-4. Gain idea about Enzymes: Definition, nature of enzymes and co-factors, classification and properties of

			enzymes, active site. Mechanism of enzyme action: free energy, activation energy, binding energy, transition state, lock and key hypothesis, induced fit theory. Factors affecting enzyme activity: pH, temperature, substrate concentration, enzyme concentration. Enzyme inhibition: Competitive, uncompetitive, non-competitive. Reversible and irreversible inhibition, feedback inhibition. CO-5. To study Carbohydrates: Definition, classification of carbohydrates-Monosaccharides: aldoses and ketoses, configurations, linear to ring structure; Oligosaccharides: glycosidic bond, reducing and non-reducing sugars; Polysaccharides: homopolysaccharides, heteropolysaccharides, examples, their structures, locations and role. Properties and functions of carbohydrates. Commercial applications. CO-6. Gain knowledge about Lipids: Definition, classification of lipids: simple, conjugate and derived lipids, properties and functions of lipids. Biological disorders of lipid metabolism. Commercial applications. CO-7. Understand Vitamins: Definition, classification of vitamins. source and functions of vitamins.
		BO 363: Botany Theory Paper 3 Plant Pathology	CO-1. To study Fundamentals of Plant Pathology: Introduction, Important terminology- Incitants, Host, Symptoms, Parasite, Pathogen, Inoculum, Penetration, Infection, Incubation, Disease. Economic importance of plant diseases, History of plant pathology, Introduction to Indian Agriculture Research Institute (IARI), International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Contribution of Anton De Bary and Prof. B.B. Mundkur. CO-2. Understand Disease Development: Concept of disease cycle, Inoculation, Prepenetration, Penetration, Infection, Dissemination. Epidemics-Forms. Decline, Exponential model. CO-3. Know Defense Mechanisms: Concept and Definition, Types-Preexisting-Structural and chemical, Induced- Structural and Biochemical. CO-4. Gain knowledge about Methods of Studying Plant Diseases. Macroscopic study, Microscopic study, Koch"s postulates. Types of culture Media, Pure culture

			methods- Streak plate, pour plate, Spread plate. CO-5. Get idea about Fungal Plant Diseases Introduction to fungi as plant pathogens. Study of Diseases- Downy mildew of Grapes, Head smut of Jowar, Tikka diseases of Groundnut with reference to causal organism, symptoms and disease management. CO-6. To study Bacterial Plant Diseases. Introduction to bacteria as plant pathogens, Study of Diseases- Citrus Canker, Black arm of Cotton with reference to causal organism, symptoms and disease management. CO-5. Know Mycoplasma Plant Diseases: Introduction to Mycoplasma as plant pathogens, Study of Diseases- Grassy shoot disease of sugarcane, Little leaf of brinjal with reference to causal organism,symptoms and disease management. CO-6. Understand about Nematodal Plant Diseases: Introduction to Nematodes as plant pathogens. Study of Diseases- Root knot diseases of vegetables, Soyabean cyst Nematodes with reference to causal organism, symptoms, Integrated management of Nematodal diseases. CO-7. To study Viral Plant Diseases: Introduction of Virus as plant pathogens. Study of Diseases- Papaya Mosaic Disease, Bunchy top of Banana with reference to causal organism, symptoms and causal organism. CO-8. Understand Non-Parasitic Diseases. The impact and abiotic causes- Temperature, Soil moisture and relative humidity, Poor oxygen, Poor light, Air pollutants, mineral deficiencies. Herbicidal injury, Study of Mango necrosis, Black Heart of Potato. CO-9. Know Principles of plant diseases control: General account, Quarantine, Eradication, cultural control practices, biological control. Curative measures, chemical control, Use of Effective Microorganism solution (EMS), Microbial Pesticides.
		BO 364: Botany Theory Paper 4 Evolution and	CO-1. Understand Organic Evolution: Distinction between Origin of life and Organic Evolution, Historical account of Origin of life, Origin of Earth Vs Origin of life: Gaia Hypothesis, Earliest Fossils, Prebiotic Evolution, Abiotic synthesis of organic matter, Primordial soup,

		Population genetics	origin of membranes, Oparin's Coacervate model, Theory of Panspermia, Early life and RNA and Origin of genetic code. CO-2. To study Organic Evolution: The concept of organic evolution, Theories of Evolution, Pre-Darwinian period, Theory of Inheritance of acquired characters (Lamark's), Darwinism- Theory of Natural Selection, Post-Darwinian period- Modern synthetic theory. CO-2. Gain idea about Evidences of Evolution: Direct evidences and conclusions from fossil records, Indirect evidences, Evidences from Genetics, Evidences from bio-geographical relations. CO-4. Understand Evolution Through Ages: Fossils and Geological Time scale: Fossils and Fossilization, Conditions of fossilization, Dating of fossils: Uranium Lead method, Radio-carbon method, U-series and ESR method, Geological Time scale: Eras, Periods, epochs, and duration in millions of years and plant life. CO-5. Gain knowledge about Population Genetics and Evolution: Concept of Mendelian population, Gene Pool and its models, Hardy-Weinberg law of gene frequencies, Factors affecting allelic frequency, Genetic polymorphism. CO-5. To study Speciation and Isolating Mechanisms: Introduction, Morphological Criteria for Species and Races, Allopatric and Sympatric Populations, Isolating Mechanisms: Pre zygotic Isolation mechanisms: Concept, Spatial & Ecological; Seasonal Isolation, Ethological Isolation, Mechanical Isolation, Post zygotic Isolation mechanisms: Concept, Hybrid in viability, Hybrid sterility and Hybrid breakdown.
		BO 365: Botany Theory Paper 5 Advanced Plant Biotechnology	CO-1. Understand Biotechnology: Introduction, Traditional and modern Biotechnology. Impact of Biotechnology on Health care, Agriculture, and Environment. CO-2. Know about Plant Tissue Culture: Concepts of Cell theory & Cellular totipotency, Landmarks in plant tissue culture. Pluripotency, Differentiation, dedifferentiation, redifferentiation, Hormones used in PTC, 'Explant' for plant tissue culture and Response of explants in vitro– callus formation, organogenesis (direct

			and indirect) and embryogenesis (direct and indirect). Micro propagation of Banana (in detail from Selection of explant to hardening and marketing). CO-3. Get idea about Techniques of Genetic Engineering and Methods of gene transfer in Plants- Introduction to Molecular tools: Definition and role of Nucleases, Polymerases, Ligases, Polynucleotide kinases, Alkaline Phosphatases. Types of vectors- Definition and characters (2-4) of Plasmids, Phages, Cosmids, BAC, YAC, Plant viruses, Animal viruses. Methods of gene transfer in Plants – Direct gene transfer – Definition and concept of Electroporation, Microinjection, and Gene gun Indirect gene transfer- Agrobacterium mediated gene transfer method, Ti-plasmid: structure and functions, T-DNA Gene amplification technique -Polymerase chain reaction DNA finger printing. CO-4. Understand Cryopreservation and Germplasm Conservation Definition and concept, techniques of cryopreservation, cold storage, long term and short-term storage, applications. Germplasm Conservation: Preservation of Cell, tissue, organ, whole organism. Concept of Gene Bank, DNA Bank, Seed Bank, Pollen Bank etc. CO-5. Know Biotechnology and Society Biotechnology-Benefits, GM foods and its safety, Recombinant foods and religious beliefs, Recombinant therapeutic product for human health care. Patenting of biotechnological inventions and Intellectual property rights. CO-5. Gain knowledge about Microbial Biotechnology: Biochemistry of fermentation, Microorganism used in fermentation, fermentable substrate, Ethanol fermentation methods, Distilleries producing alcohols. Commercial production: Alcoholic beverages, organic acids, citric acids. Advantages of fermentation. Transgenic Plants as Bioreactors: Metabolic engineering of starch, cyclodextrins, fructans, Bioplastics, genetically engineered plants as protein factories, Production of therapeutic proteins from plants. CO-6. To study Nano-biotechnology: Definition and concept, Applications of nanotechnology in agriculture

			(fertilizers and pesticides).
		BO 366: Botany Theory Paper 6 Plant Breeding and Seed Technology	CO-1. Get idea about Introduction: Definition, Scope and objectives and History of Plant breeding in India. CO-2. Understand Techniques and practices of plant breeding A. Plant Introduction: Definition, Types (Primary and Secondary), Procedure, Merits and Demerits, Important Achievements. B. Selection methods: Concept, Types of selections – mass selection, pure line selection and clonal selection. Advantage and disadvantages of selection, Achievements of selection breeding. C. Hybridization: Definition, Concept and Objectives, Precaution to be taken during hybridization, Types: Intervarietal and Distant, General procedure of hybridization, Methods of hybridization: Pdigree and bulk, Hybrid vigour and heterosis. CO-3. Know aboutAdvanced techniques in Plant breeding A. Mutation breeding: Definition and concept, Mutagens (Physical and Chemical), Mutants, Types of mutation (Spontaneous and Induced), Application of mutation breeding, Limitations of mutation breeding. B. Tissue Culture: Definition and concept, Totipotency, Application of tissue, embryo and anther culture in seed production. CO-4. To study Introduction to Seed Technology: Seed as a basic input in agriculture, Classes of seed 1. Nucleus 2. Breeder 3. Foundation 4. Certified Role of seed technology. CO-5. Get idea about Seed legislation, Introduction, Seed legislation in India (Seed Act). CO-6. Understand Seed Production, Introduction, National Seed Corporation (NSC) and its objectives, State Seed Corporation (SSC) and its objectives, General procedure for Seed Production, Location and Season, Land requirement, Importance of soil and water testing, Cultural practices, Isolation distance, Plant protection, Weed Control, Rouging, Harvesting, Threshing, Seed

			Processing. CO-7. Know about Seed Certification: Definition, Objectives and Concept, Phases of Seed Certification, General procedure of seed certification, Field inspection, Duties of seed inspector. CO-8. To study Seed Testing A. Physical Purity Analysis: Definition of purity components, Physical Purity Work Board, Procedure B. Moisture Testing: Concept, Air oven method, Digital Moisture Meter, C. Germination testing: Definition and objectives, Procedure and methods for germination testing (Paper, Sand and Soil), Seedling evaluation (Normal Seedlings, Abnormal Seedlings, Multigerm Seed Units and Non-germinated Seeds). 03 CO-9. Gain knowledge about Seed Pathology and Entomology: Definition, Seed Borne pathogens, Fungi, Bacteria, Viruses, Influence of seed borne pathogens on seed production, Common insect pest and its impact on seed production. CO-10. Understand Seed Storage: Definition and Concept, Seed treatment, Management of seed storage structures, Sanitization, Dehumidification, Fumigation.
		BO 367: Botany Practical Paper I Practical based on BO361 and BO362	CO-1. Determination of osmotic potential of plant cell sap by plasmolysis method. CO-2. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte. CO-3. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration. CO-4. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis. CO-5. Comparison of the rate of respiration in any two

			parts of a plant. CO-6. Separation of amino acids by paper chromatography. CO-7. Demonstration experiments (any four) i). Bolting. ii). Effect of auxins on rooting. iii). Suction due to transpiration. iv). R.Q. v). Respiration in roots. CO-8. Estimation of total free amino acids by spectrophotometry. CO-9. Separation of amino acids by paper chromatography. CO-10. Estimation of soluble proteins by Lowery et. al. method. CO-11. Demonstration of Enzyme activity: Amylase /invertase /catalase. CO-12. Estimation of reducing sugars by DNSA method. CO-13. Estimation of Vitamin C (Ascorbic acid) from plants. CO-14. Qualitative tests for starch, lipids and proteins. CO-15. Determination of the iodine number of lipids using Hanus method.
		BO 368: Botany Practical Paper 2 Practical based on BO363 and BO364	CO-1. Preparation of any one culture media for isolation of plant pathogens. CO-2. Culture technique- Streak plate methods, pour plate methods, Spread plate methods. CO-3. Study of any two of fungal (Downy mildew of Grapes, Head smut of Jowar, Tikka diseases of Groundnut) diseases. CO-4. Study of any two of each bacterial and mycoplasma diseases. CO-5. Study of any two of each viral and non-parasitic diseases of plants. CO-6. Preparation of 1% Bordeaux mixture and Bordeaux paste 10%.

			CO-7. Preparation of Jivamruta. CO-8. Study of Koch's Postulates. CO-9. Study of Fungicides and Microbial pesticides. CO-9. Study of Geological time scale. CO-10. Study of types of Fossils: i) Coal ball ii) Rhynia vii) Lyginopteris iii) Pentoxylon iv) Nipaniophyllum v) Lepidodendron. CO-11. Demonstration of any three evidences of Organic Evolution. CO-12. Numerical Problems based on Allele frequency and Genotype frequency. CO-13. Numerical Problem based on Hardy-Weinberg Equilibrium. CO-14. Study of Sympatric and Allopatric speciation with suitable example. CO-15. Study of Isolation mechanism: Prezygotic & Postzygotic (Any one example from each). CO-16. Submission of Report on Visit to Paleobotany Laboratory/Museum/Fossil Garden.
		BO 369: Botany Practical Paper 3 Practical based on BO365 and BO366	CO-1. Preparation and sterilization of MS Medium and Callus Induction using leaf primordia. CO-2. Production of secondary metabolites in any suitable plant material. CO-3. Artificial seed production by Sodium Alginate method encapsulation (somatic embryogenesis). CO-4. Demonstration to Equipments used in genetic engineering like gene gun, PCR, gel doc, microcentrifuge, electrophoresis, micropipettes, incubator, shaker etc. (live/videos/photographs/visit to research labs). CO-5. Study of Transgenic plants- Arabidopsis thaliana as a model plant, Bt-Brinjal, Flr-svr Tomato, and other GM crops like soybean, maize, tobacco as a pharmaceutical, banana as a edible vaccine etc. (live/videos/photographs/visit to research labs).

			CO-6. Preparation of plant-based nano-particles. CO-7. Demonstration to Fermentation of fruit juice and wine production from grapes/pomegranate/jamun/ apple/ber (live/videos/photographs/visit to research labs). CO-8. Problems on genetic engineering (set of problems will be given on restriction enzymes, vectors etc.). CO-9. Demonstration of Hybridization Techniques (Emasculation, Hand Pollination, Bagging and Tagging) in cotton and tomato. CO-9. Effect of chemical mutagens on seed germination and seedling growth. CO-10. Study of pollen viability and floral morphology of crops. CO-11. To test seed moisture by hot air oven method. CO-12. To study germination methods (Paper, Sand and Soil). CO-13. Physical purity analysis of seed sample. CO-14. Visual examination of dry seeds for disease symptoms. CO-15. To study any one common seed insect pest w.r.t to their life cycle, way of infestation/damage, symptoms and control measures. CO-16. Visit to a Plant Breeding Research Centre/ Seed Industry and report submission. Note: Submission of minimum 10 seed samples along with their botanical names, family, variety etc. to the department at the time of final practical examination
	Skill Enhancement course	BO 3610: Botany Theory Paper 7 Nursery and Gardening Management	CO-1. To study Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. CO-2. Know Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion –Seed production technology - seed

			testing and certification. CO-3. Understand Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants– greenhouse - mist chamber, shed root, shade house and glass house. CO-4. Get idea about Gardening: definition, objectives and scope - different types of gardening -landscape and home gardening - parks and its components - plant materials and design -computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting. CO-5. Understand Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.
		BO 3611: Botany Theory Paper 8 Biofertilizers	CO-1. Know Introduction: 1.1 Introduction, Scope and importance of Biofertilizers 1.2 General account of the microbes used as Biofertilizers CO-2. Understand Bacterial Biofertilizers 2.1. Isolation of Rhizobium, Identification, Mass multiplication, Carrier based inoculants. 2.2. Azospirillum isolation and mass multiplication, carrier-based inoculants and associative effect of different organisms 2.3. Azotobacter, classification and characteristics 2.4. Crop response to Azotobacter inoculums, Mass multiplication of Azotobacter 2.5. Applications of Azospirillum 2.6. Phosphate solubilizing Bacteria. CO-3. Gain knowledge about Algal Biofertilizers: 3:1. Cyanobacteria (Blue Green Algae): Isolation of Anabaena from Azolla, Mass Multiplication of Anabaena 3.2. Azolla - Anabaena relationship 3.3. Biological Nitrogen fixation 3.4. Blue Green algae in a rice cultivation. 3.5. Applications of BGA.

			CO-4. To study Fungal Biofertilizers: 4.1. Introduction, Occurrence and Distribution of Mycorrhizal association. 4:2. Types of Mycorrhizal association, growth and yield - colonization of VAM - Vesicular Arbuscular Mycorrhiza 4.3. Mycorrhizal applications in agriculture. CO-5. Know about Compost and Manure: 5.1. Organic Farming, green manuring, organic manures and their uses. 5.2. Recycling by composting method of biodegradable, municipal, agricultural and industrial wastes. 5.3. Bio compost making methods, Types and methods of vermicomposting 5.4. Benefits of vermicompost, field applications.