NATIONAL EDUCATION POLICY-2020
PAPER CODING AND CREDIT DISTRIBUTION
M.Sc. (BOTANY)

S.No.	Name of Degree	SEMESTER	TITLE OF PAPER		CREDITS	CODE NUMBER
1	Bachelor (Research) of Science in Botany	VII	Microbiology, Microbial Genetics and Applications		4	B040701T
			Mycology and Plant Pathology		4	B040702T
			Phycology, Lichenology and Bryology		4	B040703T
			Pteridophytes, Gymnosperms and Paleobotany		4	B040704T
			Practical		4	B040705P
			RESEARCH PROJECT			
2		VIII	Plant Anatomy, Development and Reproduction		4	B040801T
			Plant Systematics and Taxonomy of Angiosperms		4	B040802T
			Cytology, Cytogenetics and Plant Breeding		4	B040803T
			Conservation of Plant Diversity, Plant Propagation and IPR	Choose ANY ONE	4	B040804T
			Industrial Microbiology		4	B040805T
			Ethnobotany, Pharmacognosy and Phytochemistry		4	B040806T
			Practical		4	B040807P
			Research Project		8	B040808R
		One Minor Paper to be selected from OTHER FACULTY in VII or VIII Semester			4/5/6	
3	Master of Science in Botany	IX	Plant Physiology and Biochemistry		4	B040901T
			Ecology and Environment Conservation		4	B040902T
			Integrated Pest and Disease Management	Choose ANY ONE	4	B040903T
			Ecotourism and Heritage Conservation		4	B040904T
			Green technologies, Green Auditing and Circular Economy		4	B040905T
			Advanced Phycology	Choose ANY ONE	4	B040906T
			Forest Botany, Dendrology and Economics		4	B040907T
			Soil Conservation and Reclamation		4	B040908T
			Practical		4	B040909P
			RESEARCH PROJECT			
4		X	Plant Resources and Utilization		4	B041001T
			Molecular Biology, Biotechnology and Bioinformatics		4	B041002T
			Plant Nursery, Gardening and Landscaping	Choose ANY ONE	4	B041003T
			Biotechnology and Human Welfare		4	B041004T
			Crop Genetics and Plant breeding		4	B041005T
			Weed Biology and management	Choose ANY ONE	4	B041006T
			Seed Pathology		4	B041007T
			Plant Genomics and Proteomics		4	B041008T
			Practical		4	B041009P
			Research Project		8	B041010R
5	P.G.D.R.	XI	Instrumentation and Phytotechniques		6	B041101T
			Biostatistics and Computer Application		6	B041102T
			Research Methodology		4	B041103T
			Research Project		Qualifying	B041104R

Students of Science Faculty may choose **MINOR** paper from Faculty of Commerce/ Arts, Humanities and Social Sciences/ Languages/Fine Art and Performing Art/Education/Rural Science.

PROPOSED SYLLABUS FOR MSc (BOTANY) AS PER NEP 2020

SEMESTER – VII

B040701T – Microbiology, Microbial Genetics and Applications

Credits: 4

Unit – I

History and development of Microbiology; Isolation, purification and culturing of microbes from soil, water and air; Important criteria used for classifications of micro-organisms. Classification of bacteria based on Bergey's Manual of Systematic bacteriology;

Unit – II

Archaebacteria and Eubacteria: Characters, Ultrastructure, nutrition and economic importance; Cyanobacteria: General characteristics, structure and importance; Nitrogen metabolism; Phytoplasma: General characteristics, structure and role in causing plant diseases.

Unit – III

Virus: Biological nature, characteristics and ultrastructure of Plant viruses and bacteriophages; Nomenclature and classification; replication, transmission and economic importance of viruses; Structure, reproduction and importance of viroids, virusoids and prions

Unit – IV

Viral and bacterial genomes and derived vectors; Recombination in viruses and bacteria (transformation, conjugation and transduction); Fine structure of gene; Gene expression and regulation in prokaryotes; Genetic recombination (Molecular Mechanism of Conjugation and Transformation; generalized and specialized Transduction, Nif genes: functions and regulations

Unit – V

Fermentation technology; Plasmids: types and applications; Basic principles of immunology, vaccines and antibodies, Biopesticides; degradation of xenobiotics; Bioremediation; Biosensors; Microbial enzymes; Microbes in nanobiotechnology.

B040702T – Mycology and Plant Pathology

Credits: 4

Unit I General characteristics and taxonomy of fungi; Cell Ultrastructure; Heterothallism, Heterokaryosis and Parasexual cycle; Asexual & Sexual reproduction, Nutrition, Fungal Sex hormones; Structure, nutrition and reproduction in Mastigomycotina and Zygomycotina

Unit II Structure, nutrition and reproduction in Ascomycotina, Basidiomycotina and Deuteromycotina; General characteristics of slime moulds

Unit III Fungi in Industry, secondary metabolites, medicine, food and agriculture; Mycorrhizae: Types and significance, Mycotoxins

Unit IV General introduction, history and principles of Plant Pathology; Classification of Plant Diseases; Pathogenesis and defence mechanism; Role of environmental factors, forecasting and plant disease epidemiology.

Unit V Important diseases caused by fungi, bacteria, viruses, mycoplasma and nematodes: Transmission and disease cycle, symptoms and management through physical, chemical, cultural, biological and regulatory methods; Integrated Pest and Disease Management.

B040703T – Phycology, Lichenology and Bryology

Credits: 4

Unit I General characteristics and classification of algae; Cell ultrastructure and thallus organization, reproduction, heterocyst and akinete development, algal pigments, food reserves, flagellation, their phylogenetic and taxonomic importance. Distribution, structure and reproduction in Chlorophyta and Charophyta.

Unit II Range of thalli and reproduction in Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta; Algal blooms, Biofertilizers, Algae as food, feed and uses in industry.

Unit III Classification and distribution of Lichens, thallus organization, physiology and reproduction, Lichens as bioindicators, bioprospection, Lichenometry.

Unit IV General characteristics and classification of bryophytes; Diversity; Ecological and economic importance of bryophytes; Distribution, structure and reproduction in Marchantiales, and Jungermanniales

Unit V Distribution, structure and reproduction in Anthocerotales, Sphagnales, Funariales, Polytrichales, Bryales

B040704T – Pteridophytes, Gymnosperms and Palaeobotany

Credits: 4

Unit I

Classification and origin of Pteridophytes; Fossil pteridophytes; Stelar theory; Telometheory; Heterospory: occurrence, causes and significance. Economic importance of pteridophytes.

Unit II Comparative study of Psilopsida, Lycopsida, Sphenopsida and Pteropsida with reference to structure, reproduction and life cycle;

Unit III Classification of gymnosperms up to the rank of orders. General account of Pteridospermales, Glossopteridales, Caytoniales, Bennettitales, Pentoxylales, Cordaitales

Unit IV

General account of Cycadales, Ginkgoales, Coniferales, Ephedrales, Gnetales and Welwitschiales. Distribution of Gymnosperms in India, Economic importance of gymnosperms.

Unit V

Principles of Palaeobotany; Geological time scale; Process of fossilization and types of fossils; Methods of study of fossils and carbon dating technique; Paleobotany in India.

B040705P – PRACTICAL (Based on Theory Syllabus)

RESEARCH PROJECT (Total duration one year; to be started in Semester VII but evaluated at the end of Semester VIII)

SEMESTER – VIII

B040801T – Plant Anatomy, Development and Reproduction

Credits: 4

Unit I

Organization of Shoot and Root Apical Meristem; Cell fates and lineages, Cytological and molecular analysis; Control of cell division and tissue differentiation; vascular tissue differentiation; secretory ducts and laticifers; lateral root, root hairs, root-microbe interactions, root nodules

Unit II

Cambium and derivative tissues, secondary xylem and phloem, anomalous secondary growth; wood development in relation to environment. Leaf growth and differentiation: Determination; Phyllotaxy; Control of leaf form, differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll. Floral development and differentiation; Genetics and use of mutants; accessory floral organs;

Unit III

Structure of anther, stigma and style; development of male and female gametophyte; Ovary-placentation and types of ovules; Microsporogenesis and megasporogenesis, Pollination, methods and contrivances promoting self and cross-pollination; molecular mechanisms of self-incompatibility.

Unit-IV

Pollen-pistil interaction, double fertilization; post fertilization metabolic and structural changes in embryo sac; endosperm: Structure and development embryo culture; Polyembryony; apomixis; Dynamics of fruit maturation; involvement of extra-ovarian parts;

Unit-V

Seed germination and seedling growth: metabolism of nucleic acids, proteins and mobilization of food reserves, tropisms, hormonal control of seedling growth; gene expression and role of mutants in understanding seedling development.

B040802T – Plant Systematics and Taxonomy of Angiosperms

Credits: 4

Unit I

Angiosperm characters: evolutionary trends; Species concept; contribution of Ancient India in taxonomy and classification of plants; Brief study, relative merits and demerits of Bentham and Hooker, Engler and Prantl; Hutchinson and system of classification.

Unit II

Botanical nomenclature: International code of nomenclature (ICN); Principles: rules and recommendations; Typification, priority, rules of effective and valid publications; retention and choice of names; Conservation of names, Name changes, Synonyms, Basionyms.

Unit III

Taxonomic evidences, tools and molecular approaches: Morphology, anatomy, cytology, palynology, embryology, phytochemistry, Genome analysis; Angiosperm phylogeny groups (APG); DNA barcoding and its practical implications; Application of DNA markers;

Unit IV

Taxonomic tools: Taxonomic keys, field and Herbarium techniques; Plant Collection and Documentation; GIS; Important International and National Herbaria and Botanical Gardens, their role in conservation of biodiversity.

Unit IV

Taxonomic features, systematic phylogeny and economic importance of families: Ranunculaceae, Caryophyllaceae, Asteraceae, Rosaceae, Rutaceae, Fabaceae, Myrtaceae, Asclepiadaceae, Scrophluriaceae, Bignoniaceae, Acanthaceae, Apiaceae, Lamiaceae, Euphorbiaceae, Moraceae, Amaryllidaceae, Arecaceae, Zingiberaceae, Cyperaceae, Poaceae.

B040803T – Cytology, Cytogenetics and Plant Breeding

Credits: 4

Unit I

Structure and function of cell wall; cytoskeleton; and plasmodesmata; Plasma membrane and membrane transport; nucleus and nucleolus; Structure, genome organization and function of mitochondria and chloroplast; Ultrastucture and function of endoplasmic reticulum, golgi apparatus, microbodies, lysosomes, peroxisomes, vacuole.

Unit II

Ribosomes, t-RNAs; Protein sorting; chromosome structure; specialized chromosomes; DNA packaging, molecular organization of centromere and telomere; Nuclear DNA content, C-value paradox, Genetic and physical mapping of genes; Apoptosis; Cell Cycle: molecular mechanism of regulation

Unit III

Genetics of chloroplast and mitochondria, cytoplasmic inheritance; Nuclear and cytoplasmic gene interaction, Sex determination in plants, Fine structure of gene, Introns and RNA splicing; Linkage groups, genetic markers; cis and trans arrangement of linked gene, crossing over, molecular mechanism of recombination, Rec A and RecBCD enzymes.

Unit IV

Mutations: spontaneous and induced; physical and chemical mutagens; molecular basis of mutation; site directed mutagenesis; Transposable elements and mutations; DNA damage and repair mechanism; Structural alterations in chromosomes; Robertsonian and B-A translocations; Numerical alterations in chromosomes; effect of aneuploidy on phenotype in plants

Unit V

Introduction to Plant Breeding; Domestication, plant introduction and acclimatization; Methods of selection and hybridization; selfing and crossing techniques, male sterility, self-incompatibility, Genetic basis of heterosis and inbreeding; Polyploidy and its significance; alien gene transfer of genome, chromosome and chromosome segment.

ELECTIVE PAPER :

Choose any one (B040804T/ B040805T/B040806T)

B040804T – Conservation of Plant Diversity, Plant Propagation and IPR

Unit-I

Plant Diversity: concepts, significance and application; Current conservation Status and need for conservation, Conservation Status Assessment of threatened species, Red list index; Conservation status by IUCN red list category and definition; Biodiversity in the World: genetic, species and ecosystem diversity; Biodiversity hotspots in India and the World, their role in conservation, Climate change and biodiversity.

Unit-II

Factors affecting biodiversity (biotic and abiotic), Reason for conservation deterioration (degradation of ecosystem, loss of mobility, expansion of vegetation, international trade and artificial conservation), Types of conservation (preventive, remedial and restoration),

Unit-III

In situ conservation - Protected areas, National parks, Wildlife sanctuaries, Biosphere reserves, Sacred forests; *Ex situ* conservation- Seed banks, Sacred groves, Botanical gardens; Cryopreservation, Natural reserves, Marine parks, Gene banks;

Unit-IV

Global strategy for plant conservation (GSPC), Model for plant development conservation and sustainable use; Conservation programmes –Non-governmental organizations (NGOs), Governmental bodies -UNEP, DST, MoEF, FSI, CPCB, NMPB, AYUSH

Plant propagation: sexual and asexual/ vegetative (Cutting, Layering, Grafting, Division and Budding); Role of tissue culture in plant diversity and its significance; Micropropagation; Clonal Propagation

Unit-V

Intellectual Property Rights: Introduction, Types, Need and Relevance, WIPO; WTO-TRIPS; National IPR Policy; Patents: Patentability Requirements, Types (process and product), Procedure, Specification, Infringement and remedies; Copyright and Trademarks: Basic Principles, Rights, and infringement; Geographical Indications; Plagiarism; Bioprospecting; Biopiracy; Bioethics

B040805T – Industrial Microbiology

Unit-I

Introduction and scope of industrial microbiology; Biology of industrially important microbes; Principles of Biofermentation, fermentor design, types; fermentations- batch, continuous etc. Culture parameters (pH, oxygen, temperature, foam etc.), fermentation media, raw materials used in media production, antifoaming agents, buffers, Isolation, maintenance, preservation of industrially important strains.

Unit-II

Downstream processing: Filtration, Ultracentrifugation, recovery of biological products by distillation, superficial broth extraction; Production aspects: Strain improvement strategies, substrates, Production optimization; Immobilization methods; Designer microbes using synthetic genome.

Unit-III

Microbes in medicines: Antibiotics (production of penicillin and streptomycin), Interferons, Vaccines, Hormones, Vitamins, Novel medicines from microbes. Bioplastics, Pigments, Microbial transformations.

Unit-IV

Production of Enzymes: amylase, protease. Production of Organic acids: citric acid, acetic acid, Production of Amino acids: glutamic acid, lysine. Bioremediation – microbial degradation of xenobiotics.

Unit-V

Production of Alcoholic beverages: beer and wine; Vinegar production; Production of biofuels: ethanol, methane, biogas; Microbial Biofertilizers and Biopesticides,

B040806T – Ethnobotany, Pharmacognosy and Phytochemistry

Unit - I

Ethnobotany: Introduction; Brief history of ethnobotanical studies in the world and in India; Subdisciplines of ethnobotany; Scope of ethnobotany with special reference to medicinal plants. Basic concepts of Folk medicine and Ayurveda;

Unit - II

Pharmacognosy: Definition, history, scope and development; Organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilages, oleoresins and oleo- gum -resins); Preparation of crude and commercial drugs; preparation of infusions, decoctions, lotions, washes, insect repellents, ointments, tinctures, herbal syrups, herbal oils and herbal salves.

Unit - III

Drugs from roots and their pharmacognosy: *Glycyrrhiza glabra, Withania somnifera.*
Drugs from rhizome and their pharmacognosy: *Zingiber officinale, Curcuma longa.*
Drugs from Leaves and their pharmacognosy: *Andrographis paniculata, Clitoria ternatea.*
Drugs from Bark and their pharmacognosy: *Terminalia arjuna, Holorrhena antidysentrica.*

Unit - IV

Drugs from Bulbs and their pharmacognosy: *Allium sativum, Urginea indica.*
Drugs from Flowers and their pharmacognosy: *Crocus sativus, Spilanthes acmella.*
Drugs from Seeds and their pharmacognosy: *Piper longum, Mucuna pruriens.*
Drugs from Fruits and their pharmacognosy: *Carum cuminum, Emblica officinalis.*

Unit - V

Phytochemistry (Drug constituents): Carbohydrates, Cardiac glycosides, Alkaloids, Flavinoids, Tannins, Volatile Oils, Resins, Quinines And Steroids.
Quality control of Drugs of Natural Origin: adulteration and evaluation by organoleptic, microscopic, physical, chemical and biological methods.

B040807P – PRACTICAL (Based on Theory Syllabus)

B040808R – RESEARCH PROJECT (Total duration one year; to be started in Semester VII but evaluated at the end of Semester VIII)

SEMESTER – IX

B040901T – Plant Physiology and Biochemistry

Credits: 4

Unit-I

Membrane transport and translocation of water and solutes, membrane transport proteins; Transpiration, mechanism of stomatal opening and closing; Mineral Nutrition, Enzymes: General characteristics and classification, active sites, isosymes, coenzymes Regulation of enzyme activity and allosteric mechanism, kinetics of enzyme catalysis; Michaelis-Menton equation.

Unit-II

Photosynthesis: Historical background, photosynthetic pigments and light harvesting complexes, photolysis of water, photosystems I and II; mechanism of electron and proton transport, Carbon assimilation: Calvin cycle, Photorespiration (C2 Cycle) and C4 cycle; CAM pathway; synthesis of starch and sucrose.

Unit-III

Respiration and Lipid metabolism: Glycolysis, Kreb's Cycle Pentose phosphate Pathway, electron transport and ATP synthesis; Glyoxylate cycle; Alternate oxidase system, Structure and functions of lipids, fatty acid biosynthesis, lipid catabolism

Nitrogen and sulphur metabolism: Biological nitrogen fixation, nodule formation and nod factors; mechanism of nitrate uptake and reduction; ammonia assimilation; sulphur assimilation. Secondary metabolites and their function

Unit-IV

Photoperiodism; Floral induction, genetic and molecular analysis; Vernalization; Phytochromes, cryptochromes; Biological clock and circadian rhythms; Biosynthesis, function and mechanisms of action of Auxins, Gibberellins, Cytokinins, Abscissic acid, Ethylene, Brasssinosteroids, Polyamines, Jasmonic acid and Salicyclic acid.

Unit-V

Plant responses to biotic and abiotic stress, mechanism of tolerance, HR and SAR; Stress Proteins (HSP, LEA etc.); Water deficit, drought resistance salinity, metal, temperature, light and oxidative stress; Programmed cell death (PCD) in plants during vegetative and reproductive stages; Developmental and stress-induced PCD; PCD and senescence.

B040902T – Ecology and Environment Conservation

Credits: 4

Unit-I

Ecosystem structure and function; primary production (methods of measurement); energy dynamics (trophic organization, energy flow pathways and ecological efficiency); Concept of carrying capacity; Biogeochemical cycles (C, N, P, S); Major terrestrial biomes, Vegetation patterns of India.

Unit-II.

Synecology- community and continuum; characters and coefficients, inter and intra-specific associations; Concept of ecological niche; Autecology; Plant responses to environmental factors (climate, edaphic, Biotic, topographic and geographic factors); Temporal changes (cyclic and noncyclic); Ecological succession (Relay floristics and initiation floristic composition, facilitation, tolerance and inhibition models)

Unit-III

Biodiversity: levels and role in ecosystem functioning; Endemism, Hotspots; Speciation and extinction; IUCN categories of threat; Strategies of conservation: *in situ* (sanctuaries, national parks, biosphere reserves, wet lands, mangroves and coral reefs) and *ex- situ* (botanical gardens, gene banks, seed banks, cryobanks); International efforts and Indian initiatives; Role of NSC, BSI, NBPGR, ICAR, CSIR, DST and DBT in conservation

Unit-IV

Air, water and soil pollution: causes, effects, control and quality parameters; Bio-indicators; Acid rain; Greenhouse gases, ozone depletion and Global warming; Consequences of Climate change; Radioactive and Noise pollution, Remediation of water and soil pollution.

Unit-V

Ecosystem stability: Concepts (resistance and resilience), Role of biodiversity; Plant invasions and introductions; Environmental Legislation; Ecological management: concepts; Environment Impact Assessment; Sustainable development, Sustainability indicators; General account of Remote sensing and its applications

ELECTIVE PAPER:

Choose any one (B040903T/ B040904T/B040905T)

B040903T – Integrated Pest and Disease Management

Unit-I

General introduction to Integrated Pest and Disease Management; History and modern concepts; Principles of Plant Pathology; Koch's postulates; Developing IPM programmes; Chemical weapons of pathogens – Enzymes and toxins; Role of growth hormones in plant diseases;

Unit-II

Transmission of diseases; Pathogenesis; Effect of environmental factors on disease development; Epidemiology and Disease forecasting; Pre-existing structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds; Molecular aspects of host pathogen interactions.

Unit-III

Introduction to economically important insect pests; Symptoms, disease cycle and management of important diseases caused by Bacteria, Viruses, Phytoplasma, Mycoplasma, and Nematode

Unit-IV

Symptoms, disease cycle and management of important diseases caused by Fungi: Blights, Rusts, Smuts, Rots, Mildews, Wilts and Damping off, Galls and curls, Blast disease of rice and Mango anthracnose; Seed Pathology, Seed certification.

Unit-V

Management of plant diseases: Cultural, chemical, biological, regulatory, breeding for resistant varieties, Bio-insecticides: *Bacillus thuringiensis* (Bt), *Beauveria bassiana*; Molecular biology in plant disease control - transgenic approach for crop protection, engineering chemicals that elicit defense response to plants.

B040904T – Ecotourism and Heritage Conservation

Unit -I

Ecotourism: conserving natural and cultural heritage, forms (hard and soft ecotourism), risks benefits and disadvantages of ecotourism, Ecotourism indicators and conceptual differences between developed and developing countries, Sustainable ecotourism, characteristics and principles of sustainable ecotourism;

Unit-II

World Tourism Organization (WTO), World Tourism & Travel Council, (WTCC), Role and functions of National and state agencies involved in promotion of ecotourism in India. Promotional measures initiated by National and State Governments in India and Private Tourism Agencies – recent trends.

Unit-III

Planning ecotourism in Protected Areas; Visitor management: zoning, carrying capacity. Ecotourism in practice in important Protected Areas of India - Case studies of Periyar Tiger Reserve, Keoladeo National Park and Jim Corbett National Park; Limitations and problems of ecotourism.

Unit-IV

Culture and Heritage of India- History and Significance; Problems and prospects; Architectural Heritage: Temple Architecture, Indo-Islamic Architecture, Modern Architecture, Forts and Palaces with suitable examples

Unit-V

Cultural Heritage: Fairs and Festivals, Performing arts, Dance and Music, Myths and Legends, Cuisines, Handicrafts); Preservation and Conservation of Monuments and Culture; Management and Marketing of Religious Tourism, Festivals and Religious Events

B040905T – Green technologies, Green Auditing and Circular economy

Unit-I

Green technology-definition, importance, factors affecting green technology; Twelve principles of Green Chemistry; Role of Industry, Government and Institutions; Industrial Ecology and its significance in Green Technology. Green manufacturing systems; Sustainable Green Production Systems and their implementation.

Unit-II

Classification of energy sources, their Contribution in agriculture, Biomass utilization for bio-fuel production, Availability and applications; Types of Biogas plants and gasifiers, Bio-alcohol, Biodiesel, Briquetting; Solar energy, solar collectors and energy gadgets: solar cooker, solar water heater, Application of solar energy: solar drying, solar distillation, solar photovoltaic system and their application, Wind energy and its application

Unit-III

Energy management, Solid Waste Management, Water management, Hazardous waste Management, E-waste management, Green Buildings: Features and benefits, Ecofriendly and cost effective materials,

Generating carbon foot print data, Cleaner development technologies and mechanisms, role of industry; reuse, reduce and recycle, raw material substitution; wealth from waste; Carbon credits, Carbon trading, Carbon sequestration, Eco labelling.

Unit-IV

Green Auditing: Importance and methodology; Pre-audit Stage: Establishment of Environmental Management System,Governance of Environmental Management, Declaration of Environmental Policy, Planning of Programmes/Activities, Implementation and Operations

Audit Stage: Actual Auditing, Checking of Documents and Evaluation, Review of Environment Policy, Review of Programmes/Activities. Post-audit Stage: Evaluation of Findings, Reporting with Recommendations, Preparation of Action Plan, Follow-up, Certification, Continuous Process Assessment.

Unit-V

Linear Economy: Emergence, Economic and Ecological disadvantages; Circular Economy: Concept and its Development, Characteristics of Circular Economy: Material recovery, Waste Reduction, reducing negative externalities, Butterfly diagram, Concept of Loops Circular design, innovation and Assessment, Zero waste: Waste Management in context of Circular Economy, Circular design, Research and innovation, LCA, Circular Business Models;Linear Vs Circular Economy; Role of governments and networks, Universal circular economy policy goals, India and CE strategy.

ELECTIVE PAPER:

Choose any one (B040906T/ B040907T/B040908T)

B040906T – Advanced Phycology

Unit I:

Laboratory Culture of Algae: Culture of algae, Necessity, Types, Material, Synchronous, Continuous, Mass and "In vitro" culture. Methods of Algae isolation, Cryopreservation of algae, Strain selection, Growth kinetics and measurements of Algal growth.

Unit II:

Production of Algae: Laboratory to Land – Mass multiplication of economically important algae (Rhodophyta, Phaeophyta, Chlorophyta, Cyanophyta). Large scale cultivation, Processing, Yield chemical composition, Nutrition, Quality standard.

Unit III

Phycoremediation: Bioremediation, Sewage disposal and waste treatment, Textile and effluent sugar industry, Single cell protein, Phycocolloids, Biofertilizers and seaweed liquid fertilizers, Tissue culture of microalgae.

Unit IV:

Algal Biotechnology and entrepreneurship development, Algae in hydrogen and hydrocarbon production biofuel, seaweed resources of the world and India.

Unit V:

Aquatic pollution, Causes and consequence: Eutrophication and its impact on water quality, Algae as indicators in assessing water quality and pollution, Algae in environmental health, Sewage treatment and treatment in industrial water quality, Algae blooms, Nuisance of algae and their control.

Practical (Advanced Phycology)

1. To study and identify various (at least 5) algae available in your locality along with their Camera Lucida drawings.
2. To survey market products of algal material.
3. To illustrate various methods prescribed for algal culture.
4. To culture any one alga (*Spirulina/ Chlorella / Scenedesmus/ Botrycoccus/ Dunaliella*) in laboratory.

5. To isolate and maintain any two nitrogen fixing Blue Green Algae (BGA).
6. To isolate and in vitro maintenance of *Spirulina*.
7. To estimate the algal proteins of the cultured alga.
8. To extract DNA and its quantification by using suitable algal material.
9. To extract RNA and its quantification by using suitable algal material.
10. Biochemical analysis of the cultured alga for food/bio-fuel properties.
11. To Separate proteins from cultured alga by using SDS-PAGE Electrophoresis Technique.
12. To isolate algal protoplast and study its fusion.
13. To study BGA biofertilizer production technology.
14. Visit commercial algal production unit and submission of report.
15. To prepare culture medium for Algal growth.
16. To draw the Camera Lucida diagram of a given Algal slide for identification.
17. To calibrate the magnification of Algae using micrometer under low or high power of microscope.
18. To learn how the algal genus pollution index is used to determine the level of organic pollution in a water/soil sample.

B040907T – Forest Botany, Dendrology and Economics

Unit – I

Forests – definition, classification and brief description of forest types. Forestry –scope and branches. Silviculture: scope and objectives; Site and species selection, planting, maintenance and other silvicultural operations. Types of Forest plantations and Rotations, High density short rotation plantations, pulpwood plantations and energy plantations.

Unit – II

Forest Pathology: Diseases, signs and symptoms of bacterial and fungal tree diseases(wood decay, root rot, wilt, rust, canker). Role of mycorrhizae in tree health; Forest Entomology: insect-plant relationship, population dynamics of forest insects, insect feeding groups, Insect pests of Teak, Sal, Sheesham and Pine. Integrated management of pests and diseases in Silviculture

Unit – III

Sustainable Forest management (SFM) and livelihood strategies, Joint Forest Management (JFM) as a strategy for SFM; National Forest Policy; National Green Tribunal Act 2010

Unit – IV

Taxonomy and its relevance to wood science. Taxonomic identification tools: bark, stem, leaf, flower, fruit, seed. Systematic positions and diagnostic features of Teak, Sal, Sheesham and Pine.

Unit – V

Forest Economics: Nature and scope; Concept of demand and supply, Measurement of National income, GNP and GDP. Application of microeconomics in solving forest resource problems, Forest products demand and supply analysis; Forest product marketing; Forest Capital Theory, concept of cost and benefits, Trade of timber and non-timber forest products (NFTPs), Ecosystem services

B040908T – Soil Conservation and Reclamation

Unit – I

Soils: Parent material and development of soil, Major processes of soil formation: calcification, podsolization and laterization; Soil profile, physical chemical and biological properties of soils; Soils of India, Characteristics of problem soils

Unit – II

Soil erosion: definition and classification. Nature and extent soil erosion in India, Factors and processes of soil erosion; its impact on environment and biosphere, Rainfall erosivity and soil erodibility, Shifting cultivation, vegetative and mechanical measures of soil erosion control; Reclamation of ravine lands. Sand dune stabilization; Impact of grazing and forest fires, Control measures of grazing and forest fires.

Unit – III

Assessment and criteria for soil degradation, sedimentation and desertification; Role of climatic factors (water and temperature) for soil degradation. Technological development for management of various types of wastelands - hot desert, saline-alkali, ravine, coastal soils, laterites, rocky eroded hill slope, coal mine areas etc.

Unit – IV

Biological aspects of soil conservation: conservation farming and irrigation, role of vegetation, conservation tillage and mulch in various land climate conditions; Biological measures in dryland, rainfed, arid, semi-arid, and humid lands; Water use efficiency, selection of draught tolerant plants, role of grasses, legumes in conservation, pasture and range-land management and its improvement; Management of waterways, canal bank, bench terrace through biological means.

Unit – V

Restoration of chemically degraded soils: Acid soils – nature, distribution, formation and properties, effect of acidic, halomorphic and hydromorphic conditions on plant growth and nutrient availability. Acid sulphate soils – occurrence, distribution, characteristics and effects on plant growth and nutrient availability and its reclamation techniques.

B040909P PRACTICAL (Based on Theory Syllabus)

RESEARCH PROJECT ((Total duration one year; to be started in Semester IX but evaluated at the end of Semester X)

SEMESTER – X

B041001T – Plant Resources and Utilization

Credits: 4

Unit I

Plant biodiversity: concepts, status in India, its importance for Man; Origin of cultivated plants; Vavilov's centres of origin Primary diversity, Secondary centres, The Indo-Burma Centre; Plant introductions, Indian perspective.

Unit II

Origin, evolution, botany, cultivation and uses of Cereals and Millets; Legumes and Pulses; Fruits and Vegetables.

Unit III

Origin, evolution, botany, cultivation and uses of Forage/fodder crops; Oil yielding crops; Fibre crops; Spices and condiments; Medicinal and aromatic plants; Fumitory and masticatory materials.

Unit IV

Origin, evolution, botany, cultivation and uses of Beverage yielding plants; Wood and timber yielding plants, Non-wood forest products (NWFPs); Gum, tannin, resin, and dye yielding plants, Latex yielding plants.

Unit V

Avenue trees for shade, pollution control and aesthetics; Biofuel plants; innovations for meeting world food demand; Green Revolution: Benefits and adverse consequences.

B041002T – Molecular Biology, Biotechnology and Bioinformatics

Credits: 4

Unit – I

Basic concepts of Molecular biology; structure and nature of DNA and RNAs; DNA replication; Protein synthesis in prokaryotes and eukaryotes, regulation of protein synthesis (Structural, regulatory genes and operon model), ubiquitins.

Unit – II

Basic concepts and scope of Biotechnology; Plant Cell and Tissue Culture: Basic concepts, culture media, cell culture; embryo culture, anther culture; applications of plant tissue culture: Clonal propagation, artificial seed, production of secondary metabolites/natural products, cryopreservation; Somatic hybridization and applications.

Unit – III

Recombinant DNA technology: principles, tools and techniques, choice of vectors; Gene tagging; Genetic engineering of plants: Aims, strategies for development of transgenics with *Agrobacterium* (with suitable examples), Chloroplast information and its utility.

Unit – IV

DNA synthesis and sequencing; Preparation of molecular probes and their uses RAPD, RFLP, AFLP; Polymerase Chain Reaction; DNA fingerprinting; Genomic and cDNA libraries, Genetic improvement of industrial microbes and nitrogen fixers; Intellectual Property Rights; Ethical concerns.

Unit – V

Bioinformatics: General introduction and applications; Databases: Classification, NCBI, EMBL, PubMed; Patent databases: TAIR, PDB; Online tools - BLAST, ORF finder, Primer3, Protein motif and structure prediction tools; DNASTAR, CSIthread; Bioinformatics in genome sequencing and annotation.

ELECTIVE PAPER:

Choose any one (B041003T/ B041004T/B041005T)

B041003T – Plant Nursery, Gardening and Landscaping

Unit-I

Nursery Management and Production, Plant Morphology, Plant pests, diseases and protection, Soil properties, Nutrient deficiency in plants, Common garden weeds and weed control, Tools and implements, Greenhouse, Polyhouse, Composts, Irrigation; Plant propagation (Cuttings: Soft stem, semi hard and hard wood; Layering, Grafting, Division and Budding), Floral decoration, Flower arrangement and Ikebana, Entrepreneurship Development.

Unit-II

History, importance and scope of gardening; Types of gardens-formal and informal; Different styles of gardens-Hindu gardens (van), Mughal gardens, Persian gardens, Italian gardens, English gardens, Japanese gardens; Popular gardens in India

Unit-III

Garden Features and Ornamentation: Water features, Bridges, Rocks, Paths, Walls, Fences, Gates, Hedges, Edges, Arches, Pergolas, Screens, Statues, Conservatories, Lighting, Lawn grasses, Plantation of lawns, Flower beds, Borders, Carpet bedding, Shrubberies, Indoor Gardening, Terrariums, Kokedama, Container gardening, raised beds and Hanging baskets, Vertical walls,

Unit-IV

Specialized Gardens(Herb, Kitchen, Rock, Water, Bog etc.), Identification and Choice of Plants-Annuals, Perennials, Seasonals, Ground cover plants, Bulbous plants, Hedges and edge, Topiary, Palms, Foliage and Flowering Shrubs, Climbers and Ramblers, Hydrophytes, Bonsai,

Unit-V

Principles and Elements of Landscape Designing, Planning and Laying out, Budget and estimation ,Hard-scaping and soft-scaping, Landscape designing for homes, recreational gardens, children's parks, public places, commercial buildings, educational_institutes etc. Streetscaping and Avenues, Landscaping softwares.

B041004T — Biotechnology and Human Welfare

Unit-I

Fermented foods and beverages; Industrial production of cheese and bread, Industrial production of fermented vegetables and dairy products; Industrial production of alcoholic beverages (beer, wine) and vinegar; Production of Probiotics and prebiotics; food colouring and naturally occurring flavour modifiers.

Unit – II

Food modifying enzymes (amylase, proteases, lipases) in food processing; Amino acid production: glutamic acid and lysine; Enzymatic bioconversions (starch and sugar conversion processes); Production of Bioenergy, Bioethanol and Biodiesel, Biomethanation (Biogas from anaerobic treatment),

Unit – III

Production of antibiotics; Gene Therapy; recombinant DNA and protein based vaccines, plant-based vaccines, Monoclonal antibody based pharmaceuticals; Microarrays; Diagnostic proteomics and metabolomics; Direct detection and identification of pathogens; Predictive biomarkers for personalized onco-therapy; DNA fingerprinting in solving crimes (murder, rape) and paternity claims.

Unit – IV

Plant tissue culture and applications; Genetic engineering: Transgenic plants for pest, herbicide,disease resistance, abiotic stress tolerance, production of useful products, Production and uses of haploids; Biopesticides; Biofertilizers; Improvement of Nitrogen fixing microbes

Unit – V

Water pollution control: primary, secondary and tertiary treatment; industrial waste water and sewage treatment; Solid waste and soil pollution management: Biodegradation of xenobiotics and toxic wastes (chlorinated and non-chlorinated organic pollutants), Degradation of hydrocarbons and agricultural wastes, Phytoremediation, Environmental monitoring using bioindicators, biomarkers and biosensors; Biopolymers and Bioplastics.

B041005T – Crop Genetics and Plant Breeding

Unit-I

History of genetics, Mendelian Genetics, Chromosomal theory of inheritance; Mendelian inheritance and interaction of genes: Complementary, Epistasis, Inhibitory, Duplicate, Polymeric, Lethal and Additive interaction of genes. Extra chromosomal inheritance: Cytoplasmic inheritance involving chloroplast (*Mirabilis jalapa, Zea mays*) and Mitochondria (petite yeasts and cytoplasmic male sterility in higher plants), paternal inheritance.

Unit-II

Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters; polygenes and quantitiave trait loci (QTL); Mutations and mutagenic agents, their practical application in crop improvement (brief idea of molecular basis); Population: Mendelian population, Random mating population, Frequencies of genes and genotypes, Hardy-Weinberg equilibrium.

Unit-III

Plant Breeding: Past perspective and future, green revolution, evergreen revolution; Mating Systems: Self-fertilization, full sib mating, half sib mating, back crossing; inbreeding and backcrossing; random mating, assortative and disassortative matings, sister line crosses, convergent crosses, complex crosses, diallel selective mating. Breeding self-pollinated crops: pure line theory and its genetic basis; pure line and mass selection; pedigree method and its modification, bulk population method and its modifications. Backcross method; testing and evaluation of pure lines,

Unit-IV

Breeding cross pollinated crops: Self-incompatibility and male sterility in crops, genetic basis and use in hybrid seed production; Heterosis, exploitation and fixation of heterosis; selection, recurrent selection; development of hybrids, synthetics and composites. Hybrid breeding: genetic consequences of hybridization (segregation and recombination of genes); composition of populations derived from hybrids; role of genotype and environment in continuous variation;

Unit-V

Breeding methods in asexually/clonally propagated crops, Somatic mutations, examples of sugarcane and potato crops; Special breeding techniques-Mutation breeding; Breeding for abiotic and biotic stresses. Crop varieties: Identification, release and notification of crop varieties, institutions involved in release of varieties. Participatory Plant Breeding; Plant breeder' rights and regulations for plant variety protection and farmers rights.

ELECTIVE PAPER:

Choose any one (B041006T/ B041007T/B041008T)

B041006T – Weed Biology and Management

Unit – I

Weeds: Definition, Characteristics and significance; Classification of weeds; Common Morphological characteristics of weeds. Invasion and Introduction of weeds (Case studies); weed persistence.

Unit – II

Common weeds and their lifecycle: *Parthenium hysterophorus, Ageratum conyzoides, Argemone mexicana, Cyperus rotundus, Cuscuta reflexa, Eicchornia*; Weed propagation and dissemination; Reproductive methods and ecology in specific systems, Phenology.

Unit – III

Weed ecology, Crop weed competition/interferences; factors affecting crop weed competition; Allelopathy and weed control. Weed control methods: prevention, physical, cultural, chemical and biological control.

Unit – IV

Herbicide classification, formulations and modes of action, Herbicide behaviour in soil and plants, Selectivity of herbicides; Adjuvants, Herbicide resistance: origin, mechanisms and management;

Unit – V

Integrated Weed Management Programmes, Developing Weed Management Programmes, Weed management in major field and horticultural crops, Problematic weeds and their control.

B041007T – Seed Pathology

Unit-I

Introduction, history and importance of seed pathology; Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds; Seed structure and development in relation to infection and infestations.

Unit-II

Mechanism of seed infection, Factors affecting seed transmission of pathogens; Evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases; Recent advances in the establishment and subsequent cause of disease development in seed and seedling; Forecasting of epidemics through seed borne infections.

Unit-III

Important seed-borne diseases: their nature, detection, transmission , development and control, Losses caused by seed-borne diseases; Deterioration of seed by storage fungi. Production of toxic metabolites affecting seed quality and its impact on human and animal

Unit-IV

Seed health testing, methods for detecting microorganisms; Seed testing organizations network in India; National and international seed testing rules; Seed sampling, heterogeneity test, Insect damage, Seed treatment,

Unit-V

Seed certification and quality control: Importance; Seed quality standards - definition and concept. Concept, purpose and phases of seed certification; tolerance levels; Seeds Act and Seeds rules and law enforcement; Seed inspection procedures and equipment; Role of Quality Control for import and export of seeds

B041008T – Plant Genomics and Proteomics

Unit I

Introduction to Genomics, Prokaryotic and eukaryotic genome, C value paradox, CoT curve analysis, repetitive DNA, DNA sequencing methods – manual & automated: Maxam & Gilbert method, Sangers method; Pyrosequencing; Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

Unit II

Gene analysis: methods for sequence alignment and gene annotation; Approaches to analyze differential expression of genes - ESTs, SAGE, microarrays (cDNA and protein microarray)and their applications; gene tagging; gene and promoter trapping; knockout and knock-down mutants, and annotation.

Unit III

Transcriptomics and expression profiling: Genome expression analysis, RNA content and profiling, RNAi and gene silencing, genome imprinting, small RNAs and their biogenesis, Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, NCBI genome; Genomics of model plants and related crop species.

Unit IV

Introduction and Importance of proteomics, strategies in analysis of proteome: 2-D PAGE, Mass spectrometry, Protein sequencing method (Edman degradation, MALDI TOF/TOF); Structure of protein and formation of oligomers; Protein solubility and interaction with solvents and solutes, activity of proteins

Unit V

Applied proteomics: Databases and Search engines in proteomics, Post translational protein modifications, protein localization, Identification and characterization of novel proteins, protein engineering principles.

B041009P – PRACTICAL (Based on Theory Syllabus)

B041010R – RESEARCH PROJECT(Total duration one year; to be started in Semester IX but evaluated at the end of Semester X)