



M.Sc. Syllabus

Under

CBCS CURICULLUM

in

Botany

**DEPARTMENT OF BOTANY
TRIPPURA UNIVERSITY**

Department of Botany
Tripura University
CHOICE BASED CREDIT SYSTEM (CBCS)

Sl. No.	Topic	Subject Code	Paper Code	Core/ Elective	Credit	Marks	
Semester I							
1.	Algae, Fungi, Biology of Bryophytes	BT	701	C	4	100	
2.	Pteridophytes, Gymnosperms and Palaeobotany		702	C	4	100	
3.	Anatomy and Pharmacognosy		703	C	4	100	
4.	Plant Cell and Molecular Biology		704	C/E	4	100	
5.	Cytogenetics and Plant Breeding		705	C	4	100	
6.	Practical		706	C	4	100	
					Total	24	600
Semester II							
7.	Plant Pathology and Microbiology	BT	801	C	4	100	
8.	Plant Taxonomy Ecology and Evolution		802	C	4	100	
9.	Plant Physiology and Metabolism		803	C	4	100	
*10.	Practical		804	C	4	100	
11.	Plant Tissue Culture and Developmental Biology		805		E	4	100
	Environment and Green Chemistry						
12.	MOOC**				2	100	
					Total	22	600
Semester III							
13.	Basics of Statistics	STAT	704	E	4	100	
14.	Mushroom biology and production	BT	901	C	2	50	
*15.	Special Paper: Plant Systematics and Biodiversity – E1	BT	902	E	4	100	
	Special Paper: Cytogenetics and Plant Biotechnology – E2						
	Special Paper: Mycology and Plant Pathology – E3						
16.	Yogic Science	PE	704	E	4	100	
17.	MOOC**				2	100	
18.	Practical	BT	903	C	4	100	
19.	Project Work	BT	904	C	4	(75+25) = 100	
					Total	22	550
Semester IV							
20.	Reproductive Biology of Flowering Plants	BT	1001	E	4	100	
21.	Bamboo conservation, management and product	BT	1002	E	4	100	
*22.	Soft Skills -2	SKILL II	1004	C.F.	4	100	
*23.	Remote Sensing & GIS	FRBD	1005	E	4	100	
	English						
	Music						
24.	Project Work	BT	1003	C	4	100	
					Total	20	500
					Grand Total	88	2250

*The candidate shall have to choose any one of the elective paper(s). There shall be provision for change of subject for special papers, if required, Minimum Credits to be earned-80

**Students can opt for MOOC courses either in IInd Semester or in IIIrd Semester once based on the availability of the online courses

Semester I
CODE BOT –BT 701 C
(Algae, Fungi and Biology of Bryophytes)

Algae:

Classification of algae based on ultra-structures, thallus organization and range of variation, Origin and Evolution of eukaryotic algae and chloroplast, Cyanophyta–Cell structure, Cyanobacterial genetics, ecology and economic importance, Rhodophyta-general characters, ecology, phylogeny and importance, Bacillariophyta–Cell structure and cell division, reproduction ecology and economic importance, Phaeophyta-general Characters, cellular chemistry, ecology, Chlorophyta-general Characters, ultrastructure and affinity Phytoplankton ecology- factors influencing phytoplankton productivity, Algae as food, feed and uses in industry: algal bloom, algal bio fertilizer: phytoremediation.

Fungi:

Cytology and genetics. Homothallism and Heterothallism, genetic control of mating system, Parasexuality, Growth: Measurement and kinetics, nutritional and physical requirements, sporulation: Environmental control, Effect of physical factors, spore dormancy and spore dispersal, Fungi as saprophytes, predator, parasite and as symbiont; Uses of Fungi: Food, industrial and medicinal, biopolluting, Lignocellulosic conversion; cultivation of mushroom, mycorrhizae, Mycotoxin and Mycotoxicosis, Mycoses

Lichen:

Classification, structure, physiological function, Role of lichen in ecosystem, Pollution indicator, Economic importance

Biology of Bryophytes:

Current concepts of classification, origin and evolutionary trends, Ecology and economic importance. Classification of mosses with Indian examples and distribution, Cytogenetic of bryophytes, diversity of gametophytic and sporophytic structure of bryophytes, methods of spore dispersal. Mechanism.

CODE BOT – BT 702 C
(Pteridophytes, Gymnosperms and Palaeobotany)

Pteridophytes:

Classification (latest concepts); distribution of extant group in times and space, Evolutionary tendencies, affinities and their significance of the members of Rhyniophytosida, Zosterophylloids, Trimerophytosida; Psilotales, Lepidodendrales, Lycopodiales, Selaginellales, Isoetales, Sphenophyllales, Equisetales, Evolution of morphological, anatomical, reproductive structure of cladoxylales, Ophioglossales, Marattiales, Osundales, Filicales (Gleicheniaceae, Cyatheaceae, Polypodiaceae), Salviniaceae, Types of spore induction of spore germination, gametophytes types, stomata types and development. Ecological diversity of ferns; in an ecological perspective; endangered and endemic pteridophytes and their conservation, cytogenetic of ferns, apospory, apogamy, apomixis and polyploidy. *Dernstaedtiaceae*.

Gymnosperms:

Progymnosperms-Origin, classification, characterization; importance in tracing evolution of gymnosperms, Gymnosperms: classification economic importance and distribution in India, General account on the morphology, anatomy, reproduction and affinities of the major groups of plants (Extinct and Extant). Variation in the structure of sperms; pollen grains, pollen germination; trends of specialization in male and female gametophytes.

Palaeobotany:

Palaeobotany: radiometric datings (C^{14} , Argon and Uranium dating) techniques for studying fossil plants (ground thin section, peel technique and microfossil analysis), Fossil plants in the interpretation of past climatic changes (Quaternary and Pre-quaternary), Indian Gondwana system, Palaeo-palynology: basic principle and its application in stratigraphy; palaeoclimate and oil exploration.

CODE BOT – BT 703 C
(Plant Anatomy and Pharmacognosy)

Plant Anatomy:

Differentiation—alternate pathway of development, polarity, pattern formation, genetic control, environmental effect. Shoot and root apical organization including cytohistological zonation of shoot apical meristem. Cell wall- chemistry, ultrastructure, biosynthesis, phylogeny. Evolution of xylem and phloem; wood anatomy, nodal anatomy and floral vasculature in systematics. Vascular cambium, experimental anatomy on cambial activity. Factors influencing cambium activity; structure and function of cork cambium. application of anatomical studies in climatology, genetics, biomedical research and forensic science.

Pharmacognosy:

Drug chemistry and methods of studying bioenergetics pathways of medicinal plants. Drug evaluation techniques for quality control; Organoleptic evaluation of drugs; Microscopic evaluation of drugs, biological evaluation of drugs (bioassays) and its importance. Chemical structure, classification; definition of classes. Uses and general idea of drugs. Glycosides and glycoside yielding drugs-*Dioscorea* sp. Alkaloids and alkaloidal drugs- *Cinchona* sp., Steroids and steroidal drugs-*Digitalis* sp., *Thevetia* sp. Antibiotics-general account, classification, mechanism of action of penicillin, role of different antibiotics in humans.

CODE BOT –BT 704 Core/Elect- Plant Cell and Molecular biology

Cell biology:

General concept of prokaryotic and eukaryotic cells. Genome complexity and C- value paradox. Replicon function in eukaryotes, chromosomal DNA maturation. Regulation of cell cycle in yeast. Cytoskeleton: general concept on cytoskeleton microtubule microtubular organization in cilia, flagella and centrioles. Nucleus ultra-structural organization and functional nuclear components, nuclear envelop. Transportation of biomolecules through nuclear envelop, nucleolus and nuclear matrix. Ribosome: molecular organization of ribosomal RNA genes, ribosome biogenesis. Organelle: genome molecular structure, diversity and organization of cpDNA and mtDNA. Chromatin organization: chromosome structure and organization of nucleosome. Mitochondria: structure and organization of genome, biogenesis. Structure and functions of microbodies, golgi apparatus, lysosomes and endoplasmic reticulum. Plasma membrane: structure, models and functions, ion carriers, channels pumps, receptors,

Molecular Biology:

DNA replication: semi conservative and semi discontinuous replication. molecular basis of replication in prokaryotes-Enzymes involved in replication, different models of replication, origin and initiation of replication in *E.coli*. ϕ X 174 and M13, Klenow fragment, uracil fragment, Okazaki fragment, Nick translation, DNA methylation in replication. Transcription-Enzymes involve in transcription promoter and enhancer, PRIBNOW box, TATA box, Shine-Dalgarno sequence, initiation, elongation and termination in prokaryotes, polyadenylation methylated cap, mechanism of mRNA splicing, RNA editing. Translation; activation of amino acid, initiation of polypeptide chain elongation and termination of polypeptide, polysomes and couples translation.

Choice of vectors, DNA sequencing- the ultimate fine structure of gene, DNA fingerprinting, Chromosome walking, Restriction endonucleases, Restriction mapping. RFLP (Restriction Fragment Length Polymorphism). Polymerase chain reaction (PCR): components in PCR, inverse PCR, reverse transcriptase mediated PCR (RT-PCR), cloning of PCR products, genetic engineering by PCR, applications.

CODE BOT –BT 705 C

Cytogenetics and Plant Breeding

Cytogenetics:

Mendelian inheritance, alleles, pseudo alleles and multiple alleles, cis-trans complementation test; Penetrance, Expressivity, Epistasis, Pleiotropy. Crossing over, Gene mapping vs Physical mapping, Homologous recombination, Molecular mechanism of recombination; Effect of aneuploidy of phenotype in plants and animals, transmission of monosomic and trisomic and their uses in chromosome mapping of diploid and polyploid species, breeding behaviour and genetic of structural heterozygotes, complex translocation heterozygotes, translocation tester sets, Robertsonian translocations, B-A translocation; Transfer of whole genomes examples from wheat, *Arachis* and *Brassica*. Methods for detecting alien chromatin; characterization and utility of alien addition and substitution line; Population genetics, genetic drift, founder principle and polymorphism; Deciphering of genetic code (Duo), Sex determination and dosage compensation. Regulation of gene expression; **Lac**, Tryptophan and Arabinosis operon; Mutation: Physical and chemical mutagens, Mutagenicity detection test, molecular basis of gene mutation, suppressor mutation. DNA repair mechanisms; Somatic cell genetics.

Plant Breeding:

Mechanism of pollination control in crop plants: self-incompatibility, male sterility. Selection: mass selection, pureline selection, clonal selection and recurrent selection Heritability, Heterosis: theories of heterosis, hybrid and synthetic varieties, inbreeding depression. Mutation breeding in crop improvements.

CODE BOT – BT 706 Core- Practical

Algae:

1. Detailed workout of some important algal species.
2. Sorting of collection and preparation of specimens for identification.

Fungi:

1. Comparative study of fungal reproductive structures.
2. Biochemical analysis of edible mushrooms.

Bryophyta:

1. Comparative study of the gametophytes and sporophytes of the different groups of bryophytes from permanent slides.
2. Study of the peristome structures of Nematodonteae and Arthodonteae of the Bryopsida.

Pteridophyta:

1. Study of ornamentation of spores in different members of ferns.
2. Types of stomata in different members of ferns.
3. Types of sporangia in different members of ferns.
4. Study of stelar anatomy in Pteridophytes.
5. Study of scales/ hairs in some members of ferns.

Gymnosperms and Palaeobotany:

1. Comparative study of male and female reproductive structures: *Cycas*, *Pinus*, *Ephedra* and *Gnetum*.
2. Types of fossil and mode of preservation.
3. Techniques of study of plant fossils; impression fossils study of macerated sample of peat, lignite and coal.

Plant anatomy:

1. Secretory structures and cell inclusions-Nectaries, glandular hairs, oil glands salt glands, resin canals, laticifers, cystolith and crystals.
2. Nodal anatomy-unilacunar, trilacunar, multilacunar.

Pharmacognosy:

1. Principle and techniques of TLC and identification of crude drugs.
2. Identification of alkaloids, glycosides and steroidal drugs by chemical methods.
3. Analysis of drugs using spectrophotometers.

Cell biology, Molecular biology and Cytogenetics:

1. Preparation of different stages of mitosis and meiosis
2. Study of mitotic index
3. Pedigree analysis
4. SDS PAGE protein profile study
5. Isolation of genomic DNA and agarose electrophoresis of DNA

SEMESTER II
CODE BOT – BT 801C
Plant Pathology and Microbiology

Plant Pathology:

Mechanism of pathogenesis, Contact (Electrotaxis and Chemotaxis), Post penetration and development; Factors affecting infection, Plant factors, Nutrition of plant pathogen, Inoculum potential, Latent infection, environment and biotic factors; Enzymes and plant diseases; Physiology of diseased plant; Toxin and plant diseases; Biological methods of plant disease control, resistant varieties, hyper-parasites, trap crops and antagonistic plants, Antibiosis competition analysis; Chemical methods of plant disease control: types of chemical used, Methods of application of fungicides, Determination of fungi toxicity, Factors affecting fungicidal efficiency and systemic fungicides uptake, translocation and mode of action of systemic fungicides; Impact of air pollutant on plants parasites and plant diseases, source of air pollutant specific combustion sources, products of photochemical reaction, Naturally occurring phytotoxic air pollutants, gases released by green plants.

Microbiology:

Fine structure of bacteria, chemotaxis, Bacteria growth curve. Microbial media: types, preparation, methods of sterilization. Isolation of microorganism of environment and infected tissue. Techniques of pure culture. Staining: stains and dyes (negative staining, simple staining, differential staining and mechanism of staining), Acid fast staining. Microbial ecology: ecological groups, soil microbiology, sewage (waste water) treatment: methods and measure, biodegradation, microbial leaching. Microbial interaction: Mutualism, commensalisms, antagonism and parasitism. Nitrogen fixation: symbiotic and asymbiotic. Mycorrhizal and actinorhizal associations. Pollution indicator microorganism, MPN and membrane filtration. Industrial microbiology. Fermenter, batch fermentation vs continuous fermentation. Industrial production of enzymes (amylase and protease). Industrial production of amino acids (lactic acid and citric acid). Microbiology of milk and milk products. Food microbiology. Biofilm and siderophores.

Microbial genetics: Transformation, Transduction and Conjugation.

Viruses-Characteristics and ultra-structure of virions; isolation and purification of viruses; chemical nature, replication, transmission of viruses; economic importance.

CODE BOT – BT 802C

Plant Taxonomy, Ecology and Evolution

Plant Taxonomy:

Taxonomy/Systematic botany, Identification, Nomenclature, classification, Description. Principal of Taxonomy to specify. History of International Code of Nomenclature (ICN/ICBN), aims and important provisions for names of taxa of different ranks and hybrids, rules for valid and effective publication. Taxonomic hierarchy, numerical taxonomy (brief idea). Systems of classifications of Cronquist, Takhtajan and APG (brief idea) systems. Role of Botanic Gardens and Herbaria in taxonomic studies. Role of cytology, embryology, palynology and phytochemistry in taxonomy. Endangered, rare and threatened plants in India and their conservation. Study of angiosperm groups: Characterization of broad groups Caryophyllales, Asterales, Alismatales and Liliales, Cladistics (brief idea) of angiosperm following Cronquist's classification.

Ecology:

Ecosystem: Biosphere and ecosphere, abiotic and biotic components, biomass-standing crops. Ecological niche—spatial, trophic and multidimensional niche. Autecology, synecology, ecotone and its types. Homeostasis of ecosystem, indicator plants.

Pollution: Environmental deterioration- water Pollution (fresh water bodies), air Pollution, greenhouse effect, importance of ozone layers and its depletion, acid rain, noise pollution, radiation pollution, pollution of land by solid waste.

Soil and water conservation: Soil erosion, its effect and control, water conservation, marine ecosystem, mangrove ecosystem, problems and managements of ecosystems.

Recent sensing technology-History of remote sensing, principles, types of remote sensing, applications. Geographic information system (GIS), Modern techniques of herbarium preparation.

Biodiversity: Concept of biodiversity, impact of human activities on biodiversity, conservation strategies, IUCN categories of threat.

Phytogeography: Theories of plant distribution (Theory of Continental Drift, Age and Area hypothesis and Theory of Tolerance). Endemism and its types, Major biomes of the world, Vegetational types of India.

Evolution:

Introduction - Pattern and process components of scientific theories: biological variation and evolutionary change (evidence for evolution). Darwin and Wallace – natural selection, adaptation. Microevolution, macroevolution. Evolutionary history: reading trees, monophyly, Tree of life. Evolutionary trends: maximum parsimony, origin and evolution of traits across life and green plants.

The fossil record. Geological fundamentals. Phylogeny and the fossil record. Evolutionary trends. Rates of evolution. The geography of life. Major patterns of distribution. Historical biogeography, phylogeography.

The Modern Synthesis: Concept of Population Genetics. Forces of evolution: Genetic drift – Sampling error; Mutation. Migration/Gene Flow. Adaptation – Fitness, coefficient of selection. One-locus models, multi-locus models, modes of selection. Non adaptive traits. Molecular evolution. Neutral theory. Testing for selection. Modes of selection.

Inferring phylogenies. Maximum Likelihood estimation of trees. Gene trees, species trees. Hybrid speciation, hybrid zones. Adaptive Radiation.

CODE BOT –BT 803C

Plant Physiology and Metabolism

Plant Physiology

Plant-water relations: Water potential and its components, mechanism of water transport through xylem, comparison of xylem and phloem transport, phloem loading and unloading, passive and active transport, various theories on the mechanism of active transport.

Mineral Nutrition: Macro, micro and trace elements, role of various elements in plant metabolism and deficiency symptoms, sand culture, hydroponics and aeroponics, balanced nutrient solution.

Photosynthesis and Photochemistry: Historical background, photosynthetic pigments and light harvesting complex, photo-oxidation of water- mechanism of electron transport, carbon assimilation-Calvin cycle, HSK-cycle, CAM pathway, mechanism of photorespiration and its significance.

Respiration: Overview of plant respiration, glycolysis, TCA cycle, electron transport chain (ETC) and mechanism of ATP synthesis, glyoxalate cycle, pentose phosphate pathway (PPP), alternative oxidase systems.

Plant hormones and Growth regulators: Historical background, structure and biosynthesis of IAA, GA and Cytokinin (CK), bioassay, physiological effects and mechanism of action of IAA, GA, CK, Ethylene and Abscissic acid.

Nitrogen fixation and metabolism: Biological nitrogen fixation and mechanism of nitrate and ammonium assimilation.

Physiology of flowering: Photoperiodism stimulus and functions of phytochrome, vernalisation and its significance, Biological rhythm, endogenous clock.

Senescence and abscission: Senescence and ageing, physiological and biochemical changes during Senescence.

Physiology of seed germination: Dormancy of seed, cause of dormancy and ways of breaking it, biochemical changes during seed germination, factors affecting germination, role of light on germination and involvement of phytochrome.

MicroRNA: Biogenesis, mode of action and target gene regulation in crop physiology.

Metabolism/ Biochemistry

Biological relevance of pH and pKa, determination of pKa of weak acid; Buffers: Henderson–Hasselbalch equation, preparation of buffers.

First law of thermodynamics, basic concepts of entropy and second law of thermodynamics, free energy changes, standard free energy change.

Carbohydrates: Classification monosaccharides, disaccharides and polysaccharides, reducing and non-reducing properties of sugars, structure of some mono and disaccharides, dextro and laevorotatory properties of monosaccharides, biochemical tests, biosynthesis of sucrose and starch in plants.

Lipids: Classification of lipids – simple lipids, compound lipids, different neutral & polar classes, sterols, terpenoids and plant waxes, biosynthesis of fatty acids, oxidation of fats, α -oxidation and β -oxidation.

Amino acids: Classification, structure. Biosynthetic pathways (including GS and GOGAT pathway in plants). Protein structure: Primary Structure – Purification and determination of amino-acid sequence, identification of N-terminal and C-terminal of peptide. Secondary structure: Configuration and conformation – β -conformation and the pleated sheet; Tertiary and quaternary structure of proteins, Ramachandran Plot. Transamination and oxidative deamination.

Nucleic acids: Nucleic acid (DNA, RNA): Non Watson-Crick base pairing, Sugar puckering and base stacking, Supercoiling - Linking Number, Writting number and Twisting Number.

CODE BOT –BT 804C

Practical

Plant Pathology and Microbiology

1. Enumeration of population of fungi and bacteria by dilution plate technique.
2. Study of viable and non-viable aeromycoflora using Anderson air sampler and Burkard air sampler.
3. Study of diseased plant material (symptoms, anatomy and spore features).
4. Estimation of total phenols from diseased and healthy plant leaves.
5. Study of external and internal seed mycoflora.
6. Isolation of arbuscular mycorrhizal fungi from soil samples.
7. Antimicrobial assay using standard antibiotics and mycelial extracts of endophytic fungi and mushrooms.

Plant Taxonomy and Ecology

1. Determination of the Optimum Quadrat size by Species Area Curve method in a grassland.
2. Study of Basic Community parameters using a “Vegetation Map”
3. Determination of diversity index of a vegetation stand.
4. Determination of pH, free Carbon dioxide (FCO_2), dissolved Oxygen (DO_2), alkalinity and chlorinity of supplied water samples.
5. Study of angiospermic plants by working out morphological characters and identification upto species level.

Plant Physiology and Metabolism

1. Determination of total carbohydrate (in g %) from the supplied plant material.
2. Determination of total protein (in g %) from the supplied plant material.
3. Estimation of the effect of variation substrate concentration ($[\text{S}]$) and enzyme concentration ($[\text{E}]$) on the rate of amylase activity in the supplied germinating seedlings and graphical expression.
4. Finding the Osmotic pressure (O) of the cell sap of endosperm of potato tuber and by 50% plasmolysis method calculation of water potential (Ψ).
5. Estimation of the effect of Variation of temperature and pH and on vitro nitrate reductase (NR) activity in the supplied leave specimen.
6. Estimation of the effect of inhibitor concentration ($[\text{I}]$) on vitro nitrate reductase (NR) activity in the supplied leave specimen.
7. Determination of Rate of transpiration by DCPIP method and estimation of stomatal frequency.
8. Estimation of Hill Reactivity.
9. Separation of amino acids by circular paper chromatography and Identification of the unknown.
10. Estimation of ascorbic acids (Vit-C) and carotenoids.

SEMESTER II
Plant Tissue Culture & Developmental Biology

CODE BOT –BT- 805 Elective (E)

Plant Tissue Culture: Basic concept, history, principles and scope; Concept of cellular differentiation, totipotency and pluripotency

Callus & Cell Suspension culture: Callus growth and its characteristics, types, Cell suspension cultures, factors affecting cell suspension culture; Assessment of growth and viability of cultured cell. Synchronisation of cell culture, habituation, Application of callus and cell suspension culture in plant biotechnology.

Biochemical basis of in vitro exudation, problem and control measures

In vitro technique of plant regeneration: Organogenesis, factors affecting organogenesis, application.

Micropropagation: Concept, in vitro technique, factors affecting stages of micropropagation, vitrification and its control measures; application of micropropagation in plant improvement.

Somaclonal variation, chromosomal instability, Origin and mechanism of somaclonal variation. Significance of somaclonal variation.

Production of virus free free plants, virus indexing methods, concept of cross protection.

Androgenesis: Anther and Pollen culture, merits and demerits, factors affecting androgenesis, methods of diploidization of haploids, utilisation of haploidy in agriculture.

Somatic Embryogenesis: Methods, factors affecting somatic embryo development. Application of somatic embryogenesis in Plant biotechnology.

Protoplast Culture technique: Isolation, purification and Culture of Protoplast, application.

Green House: Concept of green house, types of green houses based on shape of the structure, utility, nature of covering material, uses and utility.

Concept of cell polarity and tissue patterning in plants.

Plant Developmental Genetics: genetical and molecular basis of shoot apical meristem(SAM) and root apical meristem(RAM) development.

Development of leaf, root hairs and trichomes.

Floral induction and development. ABC model of flower development

Signal transduction in plant growth and development. Role of plant protein kinases in signal transduction.

SEMESTER II
CODE BOT –BT- 806

MOOC

SEMESTER III
Mushroom Biology and Production
THEORY
PAPER CODE BOT –BT 901 (C)
Total Marks: 50

Unit-I: History of Mushrooms Factual record on mushroom occurrence, Basic concept on mushrooms, Mushrooms in India.

Unit- II: Mushroom Morphology: Different parts of a typical Mushroom and variations in mushroom morphology, Key to differentiate Edible and Poisonous mushrooms.

Unit- III: Mushroom Ecology and collection- Epigenous and Hypogenous, Natural Habitats- Humicolous, Lignicolous and Coprophilous. Wild mushroom collection, Spore print, Drying and preservation techniques.

Unit-IV: Biology of Mushrooms: General characters of mushroom with reference to general Morphology and distinguishing characteristics, Life cycles of Mushrooms. Diseases of mushrooms. Nutraceutical properties of mushrooms.

Unit-V: Spawn Preparation Facilities required for spawn preparation, Preparation of spawn substrate, Preparation of pure culture, media used in raising pure culture, Culture maintenance, and storage of spawn.

Unit-V: Mushroom Cultivation Introduction to cultivable mushrooms of India. Cultivation techniques of Oyster mushroom / Paddy straw mushroom.

Practical for Mushroom Cultivation

1. Study of external characters of mushroom.
2. Study of internal structure of mushroom.
3. Study of different species of mushrooms.
4. Identification of edible and poisonous mushroom.
5. Photographic of field collection of different species of mushroom.
6. Preparation of the record of different types mushroom of your locality.
7. Methods of preservation of mushrooms.
8. Field survey/field work.
9. Biochemical tests on food and medicinal values.
10. Cultivation technique of mushroom

SEMESTER III

Plant Systematics and Biodiversity

SPECIAL PAPER CODE BOT –BT 902(E1)

Unit-I

Systematics: concept and historical development; Natural systems to cladistics: Natural systems, phyletic systems, phenetics and cladistics. Importance of Floras, Revisionary studies, Monographs and Taxonomic literature. Taxonomic characters and their states; sources of characters, evaluation of characters. Preparation of Taxonomic keys and its importance. Phylogenetics: The nature of phylogeny, importance of homology. Classification of Angiosperms: a brief history and comparative study of different systems of classification, APG IV system of classification. Important orders of Angiosperms (Sensu Cronquist) with reference to their characteristics, interrelationship and evolutionary trends. Phenetic in taxonomy, Cladistics in taxonomy, Taxonomic hierarchy, Species, Genus, Family and other categories, Principles used in assessing relationship, Delimitation of taxa and attribution of rank

The species concept: Taxonomic hierarchy, Principles used in assessing relationship; delimitation of taxa and attribution of rank. Historical development of the international Code of Botanical nomenclature (ICBN); Principles and salient provisions of the code; typification; role of priority; retention; rejection and conservation of epithets(names); name of hybrids. Taxonomic evidences: Use of evidences from Palynology, Embryology, Cytology, Phytochemistry, Ultrastructure in taxonomy. Plant genomes: nuclear, mitochondrial, chloroplast; molecular markers.

Unit II

Biodiversity: concept and levels; distribution and global patterns, IUCN Redlist categories, Strategies for conservation: *in situ* conservation: Government and community initiatives; Protected areas in India- Sanctuaries, National parks, Biosphere reserves, *Ex situ* conservation: botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks. International treaties and conventions with special reference to Convention on Biological Diversity (CBD) and Conference of Parties (COPs) under CBD.

Herbaria and data information systems. Herbarium specimens, Herbarium operations, Role of Botanic gardens in conservation of biodiversity, Concept of Virtual herbarium, Circumscription, Specimen Imaging, role of Macbeth Color Checker in Virtual herbaria

Phytogeography: Vegetation of the world, Origin of Angiosperms and primitive angiosperms, Endemism, Plant migration, Island biogeography.

SEMESTER III
Plant Systematics and Biodiversity

SPECIAL PAPER

CODE BOT–BT 903C

Practical paper

1. Methods of non-destructive field collection and documentation, Techniques of herbaria preparation
2. Preparation of artificial key (at least five) based on appropriate character combination
3. Morphological characterization of selected families of dicots (10 families) and monocots (5 families) and identification upto families
4. Identification of given plant (at least six) up to species with the help of modern flora keys.
5. Live plants/ Herbarium specimens of the following families will be provided in the class for description and identification (classification based on Cronquist, 1981):
6. Writing exercise
7. Nomenclature exercise
8. Classification exercise
9. Cladogram construction and analysis
10. Techniques in molecular systematics
11. Interspecific variation: Species. Phylogenetic trees, reading and using trees.
12. Intraspecific variation: Phenotypic morphological variation: Intraspecific variation in size and shape of leaves. Statistical analysis (distribution, mean, mode, median, standard deviation).

Semester III Cytogenetics and Plant Biotechnology

SPECIAL PAPER

CODE BOT –BT 902(E2)

Unit-I

Nature of active chromatin. CEN fragment and telomeres. Karyotype concept and evolution. Cytogenetical methods for determination of the basic chromosome number and affinities of a species.

Molecular basis of recombination. Initiation of recombination through double stranded breaks and role of Rec A and Rec BCD enzymes. Gene conversion.

Mechanism of RNA splicing (tRNA and rRNA). Simple sequence of DNA, satellite DNA. Complexity of DNA determined through Cot1/2, Non-repetitive DNA, expression of non-repetitive genes.

In situ hybridisation – concept and technique. Flow cytometry and confocal microscopy in karyotype analysis.

Mobile genetic elements. Replicative and non replicative transposition. IS elements, Composite transposon, Controlling elements in maize (AC/DS; Spm/Dspm family etc). Hybrid dysgenesis in *Drosophila*, Retroposons. Yeast Ty elements.

Eukaryotic RNA polymerase-initiation and regulation of transcription.

Protein translocation: Co-translational transfer. Role of Leader sequence, signal sequence, Transfer of protein from the ER through Golgi stacks.

Genotoxicity–bioindicators, genotoxic agents, types, and nature of genotoxic effects. Different tests for cytological evaluation of genotoxicity.

Lytic and Lysogenic cascade.

Oncogenes and Cancer.

Unit II

Plant biotechnology: basic concept, principles and scope.

Somatic protoplast hybridisation and its mechanism. Factors controlling somatic protoplast hybridisation. Selection of somatic hybrids. Application.

Synthetic seed technology (artificial seed): Concept of artificial seed, basic requirements for artificial seed production, types of gelling agents. Principle, methods and condition of encapsulation.

Cytodifferentiation: Biochemical and molecular basis of differentiation in plant tissue culture. Cell line and cell line selection techniques: variant and mutant cell line. Selection strategies of variant cell line. Genetical and biochemical basis of variant cell line production, applications.

Biotechnology of secondary metabolite production: Primary and secondary metabolites, secondary metabolite production through *in vitro* techniques, role of elicitors, co-culture technique, cell immobilization and biotransformation.

Transformation technology: concept of transgenic plant production, *Agrobacterium*-mediated DNA transformation, tumour inducing principle and the Ti plasmid, function of virulence genes, T-DNA processing, transfer and integration, advantage and disadvantage of *Agrobacterium*-mediated gene transfer system.

Gene cloning vector: Concept of plasmids and plasmid vectors (pBR322, pUC vectors and Yeast plasmid vectors), *Agrobacterium tumefaciens* as cloning vectors: disarmed Ti plasmid, Co-integrative and Binary vectors.

Transgenics in crop improvements: Transgenics for male sterility, terminator seed and insect resistance.

Hairy root culture: General properties of *A. rhizogenes* and Ri- plasmids, factors affecting virulence of *A. rhizogene* strains, characteristic of hairy root transformants, establishments of hairy root culture, genetics of transformation, application of hairy root culture.

Germplasm conservation: *In vitro* short and longterm conservation of germplasm, cryopreservation technique, factors affecting the freezing process and viability of frozen tissue, prospect of cryopreservation.

Intellectual Property Rights (IPR): Forms of protection, patent and types of patents, criteria for utility patent, biotechnological inventions. Patentability of biotechnological inventions, Myriad Dilemma. Revocation of patent, revocation of the turmeric patent. Genetically Modified Organisms, benefits and controversies.

SEMESTER III
Cytogenetics and Plant Biotechnology

SPECIAL PAPER CODE BOT –BT 903(C)
Practical paper

1. Karyotype analysis from five flowering plants.
2. Effects of phyto-chemical/ chemicals /physical agents on cytotoxicity or genotoxicity using suitable experimental material.
3. Estimation of total soluble proteins using Lowry's method.
4. Studies on genomic protein profile using native and SDS –PAGE technique.
5. Isolation of genomic DNA and plasmid DNA; Bacterial transformation, Molecular fingerprinting using molecular markers.
6. Plant DNA barcoding.
7. Organization and demonstration of tissue culture laboratory.
8. Methods of formulation of different types of experimental culture media.
9. Disinfection and sterilization techniques of tissue culture materials.
10. Establishment and demonstration of cell suspension culture technique.
11. Studies on cell growth and viability.
12. Studies on control measures of *in vitro* exudation problem.
13. Effect of growth regulators on cultured explants.
14. Isolation and inoculation technique of zygotic embryo culture.
15. Biochemical analysis of morphogenetic tissue under different stress.
16. Isoenzyme profile study in morphogenetic tissues.
17. Marker gene (GUS) transformation and assay in Tobacco.

SEMESTER III

Mycology and plant pathology

SPECIAL PAPER CODE BOT –BT 902(E3)

Unit-I

Modern systems of classification of fungi, Molecular identification of fungi, Modern phylogenetic position of fungi.

Fungal cell wall, Hyphal tip growth, Sporulation, Spore dormancy and germination, Fungus sporocarp, spores, methods and mechanism of spore discharge. Role of sex hormone in reproduction of fungi, Genetic variation in fungi-Heterokaryosis and parasexual cycle and its significance, fungal metabolism-carbon, nitrogen and vitamins, Regulation of carbohydrate and nitrogen compounds metabolism. Nutrient sensing and uptake in fungi.

Ecology and distribution of Fungi. Fungi as symbionts-Lichen, Mycorrhizae and Endophytes. Role of fungi in degradation of plant and animal biomass/Role of saprotrophs in ecosystem.

Economic importance of fungi: Deterioration of textiles, papers, proteins, foods, pesticides and other waste materials, Fungal diseases of human, Fungi as allergens, fungal toxins and mycotoxicoses, Fungi used in medicines. Industrial production of alcohol, enzymes, organic acids and proteins. Food processing, Fungi in biocontrol of plant pathogens, insects and nematodes. Bioremediation. Industrial strain improvement.

Genetic control of vegetative growth, asexual and sexual development. Gene cloning and fungal biotechnology. Genome organization in fungi. Principles and general methods of fungal genetic engineering. Retroposon and Retrotransposon in fungi. Regulation of protein synthesis in fungi. Heat shock proteins and Chaperon. Signal transduction pathway.

Fungal transformation: Transformation of yeast and filamentous fungi and their application.

Application of molecular techniques in Mycology: PCR, RAPD, in situ hybridization, AFLP, SSRs, SNPs.

Unit II

Nomenclature and classification of plant viruses. Chemistry, isolation and purification of plant viruses, RNA in plant pathology. MLO: Classification, morphology and characteristics of MLOs. Identification techniques of MLOs.

Epidemiology: Role of environmental factors in disease development, Monocyclic, Polycyclic, Polyetic diseases, Decision Support Systems (DSS).

Stages of disease developments: Prepenetration, Penetration, Post penetration and Colonization. Role of enzymes and toxins in disease development- Cell wall degrading (cellulolytic, pectolytic, proteolytic and lypolytic enzymes, toxins-lycomarasmine, alternaric acid, fusaric acid, piricularin and victorin).

Defense mechanisms in host: Structural, Physiological, Genetical and Chemicals including enzymes (Phenolics, Phytoalexins, Phytonaticipins, PRproteins, SAR, PCD, ROS and Lipoxigenase). Concept of Vertical and Horizontal resistance, Non-host and Marginal-host. Hypersensitive reaction-The mechanisms of elicitor-receptor concepts.

Genetics of host pathogen interaction: gene for gene hypothesis, Alarm signal and signal transduction mechanisms. A molecular overview of the plant immune system. Pathogen

Triggered Immunity (PTI), Effector Triggered Immunity (ETI), Guard Hypothesis. Molecular regulation of SAR and ISR Pathways.

Plant disease management: chemical methods, formulation and classification of fungicides, uptake and mode of action, seed, soil and plant treatments of fungicides.

Integrated disease management, quarantine laws, culture methods, avoidance of pathogen. Development of disease resistant varieties and their uses.

Antibiotics and biological control of plant pathogens. Bio control agents-arbuscular mycorrhizal fungi, *Trichoderma viride*, *T. harzianum*, *Pseudomonas fluorescences*, *Glomus*. Use of Botanicals and other biopesticides.

Development of disease resistant crop line by genetic engineering. Methods of Plant Transformation: Genes used for disease resistance; promoters commonly used for disease resistance; population to be taken for large scale cultivation of genetically modified resistance crops.

Deterioration of seeds in storage; biosynthesis of mycotoxins; effects of mycotoxin contamination in food feed. Control of seed deterioration and mycotoxin contamination.

SEMESTER III

Mycology and Plant Pathology

SPECIAL PAPERCODE BOT–BT 903C

Practical paper

1. Isolation and identification of fungi from natural samples.
2. Enumeration of population of fungi.
3. Study of fungal nuclei.
4. Laboratory evaluation of fungicidal efficiency using any standard fungicide and appropriate plant pathogen.
5. Biological control by dual culture technique.
6. Preparation of spawn and cultivation of mushroom.
7. Study of air borne fungi using air sampler.
8. Spore germination of pathogenic fungi in two different media.
9. Isolation of pathogen from diseased tissue (leaf, stem and fruit).
10. Study of diseased plant material (symptoms, anatomy and spore features).
11. Estimation of nucleic acids, protein and total phenols from healthy and infected plants.
12. Study of production of organic acids alcohol and enzymes.
13. Extraction and detection of aflatoxins from fungi.
14. Study of external and internal seed mycoflora.
15. Growth curve of unicellular fungus.
16. Assay of antibiotic and determination of MIC.
17. Assay of fungicide and determination of LD₅₀.

SEMESTER III

SPECIAL PAPERCODE BOT–BT 904C

Project / Dissertation work

1. 25 marks: study/project work/seminar presentation from a free online courses/MOOC
2. 75 marks: assigned project work

SEMESTER IV
CODE BOT–BT 1001 (E)

Reproductive Biology of Flowering Plants

Introduction: History and Scope. Anther: Structure, ontogeny; tapetum; structure and functions; micro-sporogenesis. Pollen Biology: Microgametogenesis, pollen wall development, MGU (male germ unit) structure, NPC system, pollen wall proteins; pollen viability, storage and germination; pollen tube structure. Ovule: Structure, ontogeny, types; special structures-endothelium, operculum, obturator, aril, arillode, caruncle, hypostase, epistase: female gametophyte-megasporogenesis and megagametogenesis, organization and ultrastructure of mature embryo sac. Pollination and fertilization: Pollination types and significance; adaptations; pollination biology; pollen-pistil interaction; structure of stigma and style; double fertilization. Self-Incompatibility: Basic concepts; methods to overcome self-incompatibility. Endosperm: Types, development and functions; endosperm haustoria. Embryogenesis: Classification, development, organization and differentiation of crucifer and Najas embryo; embryo-endosperm relationship; physiological and genetical control. Polyembryony and Apomixis: Introduction; classification; cause and applications.

SEMESTER IV
CODE BOT–BT 1002 (E)
Bamboo Conservation, Management and Products

Bamboo taxonomy and species identification, conventional and modern approach to bamboo classification, Geographical distribution of bamboo in India, Diversity of bamboos in the North east region.

Ecological function of bamboo, Principles and methods of bamboo stand management for sustained yield, Pest and diseases of bamboos and their management.

Techniques of bamboo propagation, Bamboo nursery techniques and management, Macroproliferation technique and plantation of bamboos through seeds, seedlings and branch cuttings, nursery types and facilities, management of bamboo nursery. Tissue culture techniques as a means of improvement and large scale propagation of bamboos, Hardening concept. Greenhouse, types and nature of greenhouse and their utility.

Bamboo primary and secondary processing, Treatment of bamboo with Borax, Boric, smoke chamber and other chemical process, Bamboo crafting, sculpting, furniture making and minor products, Knowledge of various joints, method of joints and uses of joints, Incense stick preparation and value addition, Free hand drawing of different bamboo products

Modern application of bamboo and its products, Techniques of bending, buffing, polishing of bamboo, Chemical and natural dyes for colouring, varnish of bamboo products, Making various jigs and fixtures for uniformity of the products

Post harvesting techniques for bamboos, utilization of bamboo resources, bamboo as a source of food and their traditional and laboratory techniques for preservation. Proper storage and packaging of finished bamboo products, Bamboo based industry and prospects

Various types of tools and their specification, Tools and methods for product design and development, Customer Needs and Market Research Essentials, Entrepreneurial forms and function, Indigenous, conventional and modern bamboo products,

Multiple interdisciplinary tasks and design bamboo product, Bamboo product marketing, finance, industrial design, Technology, production, bamboo working skills and value addition, Knowledge of safety and precautions taken in bamboo work,

National and state policies for bamboo. Function of National Mission on Bamboo Applications (NMBA), National Bamboo Mission (NBM) and Joint Forest Management (JFM). Role of Remote sensing and GIS. Thematic map creation of bamboo resources.

SEMESTER IV

PROJECT / DISSERTATION WORKCODE BOT–BT 1003C

Total marks 100for assigned project work