Department of Botany
University of Kashmir

PG Syllabus

Self-Study Report (SSR) 2019-2023

SEMESTER 1st

Name of the course/Code: BOT-21101CR: PLANT TAXONOMY

Learning objectives: To acquaint the students with theoretical and practical knowledge about the principles, and methods of plant taxonomy including botanical classification, nomenclature and identification; and to also inculcate understanding about the flora at regional, national and global scales.

Learning outcome: The students will know the history of plant exploration in Kashmir Himalaya and get familiarized with local flora, will be trained in important skills: how to use plant classification systems, how to scientifically identify plants, how to apply correct scientific nomenclature, how to prepare herbarium, and how to design a botanical garden

Unit: I

Introduction to taxonomy: taxonomy, systematics, classification; relevance of taxonomy to human society; role of taxonomy in biodiversity science; history of plant exploration in Kashmir Himalaya

Approaches to plant classification: artificial, natural and evolutionary (historical account); phenetics (principles, selection of characters, character x taxon matrix, similarity matrix, phenogram construction and classification); cladistics (concept, terminology, taxon and character selection, character analysis, cladogram construction and classification)

Unit: II

Taxonomic characters and sources: characters (kinds and criteria); sources- morphology, cytology, palynology, phytochemistry, molecular biology

Taxonomic categories and hierarchy: taxonomic categories; taxonomic hierarchy (structure & properties) species concepts; speciation (allopatric and sympatric)

Unit: III

Taxonomic tools and institutions: herbarium (collection, preparation, preservation and role); botanic garden (concept, sections & importance); taxonomic literature (an overview); Botanical Survey of India (organization & role).

Plant identification: methods of identification; dichotomous keys (kinds and construction); cybertaxonomy (concept and scope)

Unit: IV

Scientific nomenclature: International Code for Nomenclature of algae, fungi and plants (ICN); principles of ICN; brief overview of nomenclature codes - Viral, Bacteriological, International Code for Nomenclature of Cultivated Plants (ICNCP)

Practice of nomenclature: type method (concept and kinds); author citation; effective and valid publication; basionyms and synonyms; homonyms; autonyms and tautonyms.

Name of the course/Code: BOT-21102CR: MICROBIOLOGY, FUNGI AND PLANT PATHOLOGY

Learning objectives: To provide students basic knowledge about diversity, biology, taxonomy, ecological and economical importance of microbes such as viruses, bacteria, micro and macro fungi and to impart understanding about the etiology, epidemiology resulting losses and control of plant diseases caused by plant pathogens

Learning outcome: The students will learn about basic concept, diversity, general characteristics and processes of important groups of microbes such as viruses, bacteria, phytoplasma, microfungi and macrofungi, will be able to identify and characterize these microbes and fungi, increase the awareness and appreciation of economic importance of viruses, fungi and bacteria and learn about the structural diversity and reproduction of various divisions of fungi, and will become knowledgeable about the isolation and identification of plant pathogens causing plant diseases and work out management strategies for the control of plant diseases

Unit: I

Eubacteria: origin and evolution, diversity assessment and classification criteria; bacterial growth and nutrition, ultrastuctural details; types of reproduction; ecological and economic importance

Archaebacteria: general account, major types (methanogens, extreme halophiles, extreme thermophiles); structural variations (comparison with eubacteria and eukaryotes); evolutionary significance

Cyanobacteria: salient features, cyanobacterial symbiosis, endosymbiotic evolution, biological and ecological importance

Unit: II

Viruses: general characteristics; Origin, chemical nature and ultrastructure.

Replication, tansmission and isolation: mechanisms of viral replication; difference between DNA and RNA viruses; transmission (ways and vectors); isolation and purification of p lant viruses

Virus-like agents: virions, viroids and prions - concept, structural aspects and evolutionary importance; economic importance of viruses.

Unit: III

Fungi: general characteristics, cell ultrastructure; unicellular and multicellular organization; cell wall composition; nutrition (saprobic and biotropic); reproduction (vegetative, asexual and sexual); heterothallism; heterokaryosis, parasexual life cycle; recent trends in classification of fungi

Structural diversity and mode of reproduction in following groups of fungi: Myxomycota, Oomycota, Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota and Deuteromycota

Role of fungi with respect to food and medicine; mycorrhizae-types and role

Unit: IV

Plant Pathology: introduction, definition of terms used in plant pathology; plant diseases: concept, nature and classification of plant diseases

Symptoms, etiology, epidemiology and control of following plant diseases : paddy blast, powdery mildew of cucurbits, black stem rust, apple scab, peach lea f curl, damping off seedlings, black rot of

crucifers, angular leaf spot of cotton; phytoplasma: general characteristics and role in causing plant diseases; use of fungi as biocontrol agents

Name of the course/Code: BOT-21103CR: ALGAE AND BRYOPHYTA

Learning objectives: To impart students understanding about the diversity, evolutionary origin significance and economic importance of bryophytes and Algae and to acquaint them about the structure, morphology, reproduction of various groups of Bryophytes and algae

Learning outcome: The students will be able to demonstrate an understanding on diversity, morphology, anatomy and reproduction of Bryophytes, know about the significance of algal blooms and role of bryophytes in bioindication and will be able to learn proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes and algae growing in the region

Unit: I

Algae: diverse habitats (terrestrial, freshwater, marine); thallus organization; evolutionary relationships; cell ultrastructure; reproduction (vegetative, asexual, sexual); criteria for classification of algae (pigments, reserve food, flagella).

Classification and salient features: Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

Unit: Il

Algal blooms : causal factors and dynamics of freshwater algal blooms; physical and chemical means and bio- manipulation (top- down and bottom- up) for controlling nuisance blooms; role of phycoviruses in algal bloom control; algal bio- fouling of ships and its control.

Unit III

Origin of Bryophytes- evolution of gametophyte and sporophyte; economic, ecological and microbial importance of bryophytes, symbiotic associations of bryophytes

Liverwort and Hornworts: classification, morphology, anatomy and reproduction of Marchantiales, Metageniales, Jungermanniales and Anthocerotales.

Unit: IV

Mosses: classification, morphology, anatomy and reproduction of Funariales, Sphagnales and Polytricales.

Bryophytes in bioindication: direct and biomonitoring

Name of the course/Code:BOT-21104CR: PRACTICAL-1
Laboratory Exercises based on BOT18101CR:

- Preparation of herbaria of different types of leaves, inflorescences and fruits.
- Taxonomic description of various botanical families: Ranunculaceae, Brassicaceae, Fabaceae, Rosaceae, Malvaceae, Asteraceae, Apiaceae, Solanaceae, Poaceae, Liliaceae.
- Study of various Placentation types.
- Comparative morphology of different species of a genus and different genera of a family.
- Construction of dichotomous keys for identification.
- Preparation of similarity matrix and construction of dendrograms.
- Preparation of character-taxon matrix and construction of cladograms.

Laboratory Exercises based BOT18102CR:

- Learning methods of sterilization and techniques of inoculation.
- Preparation of culture media and aseptic transfer of pure cultures.
- Differential staining of microorganisms to study their morphology and staining reactions.
- Demonstration of the presence of nitrogen fixing organisms (*Rhizobium* sp.) in root nodules of legumes.
- Morphological study and identification of the following representative members of fungi: *Perenospora, Albugo, Mucor, Rhizopus, Ustilago, Polyporus, Morchella, Sacharomyces, Aspergillus, Penicillium, Alternaria, Cllętotrichum and Fusarium*
- Preparation of fungal cultures of *Rhizopus, Mucor, Aspergillus, Penicillium, Trichoderma, Alternaria,Verticillium*
- Sterilization methods (physical and radiation), Preparation of media (PDA, Soil extract Agar, Richards solution, peptone dextrose agar medium.
- Symptomology and studies of some diseases of Plants: White rust, downy mildew, Powdery mildew, rusts, smuts, wilts, rice blast, apple scab, citrus canker, peach leaf curl, tomato mosaic virus, cauliflower mosaic virus.

Laboratory Exercises based on BOT18103CR:

- Morphological study of the representative members of Algae: *Anabaena, Nostoc, Pediastrum, Volvox, Hydrodictyon, Ulva, Clostridium, Chara, Botrydium, Enteromorpha, Padina, Bulbochaete, Ceramium* and *Batrachospermum*.
- Study of morphological, anatomical and reproductive structures of various bryophytes viz: *Riccia, Marchantia, Pellia, Porella, Anthoceros, Polytrichum, Andreaea, Bryum, Mnium* and *Funaria*.

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SEMESTER 2

Name of the course/Code: BOT-21201CR:PTERIDOPHYTA AND GYMNOSPERMS

Learning objectives: To aware students about the diversity, morphology and reproduction, evolutionary origin, significance and economic value of Pteridophytes and Gymnosperms and to provide them understanding about the structural features and evolutionary significance of fossil gymnosperms

Learning outcome : The students will be able to demonstrate an understanding of diversity of Pteridophytes and Gymnosperms, develop critical understanding on morphology, anatomy and reproduction and evolution of Pteridophytes and Gymnosperms and will be able to develop proficiency in the experimental techniques and methods of appropriate analysis of Pteridophytes and Gymnosperms growing in the region

Unit: I

Pteridophytes: origin and evolution, telome theory; stelar evolution; classification; economic importance

Fossil pteridophytes: structural features and evolutionary significance of Psilophytales Lepidodendrales, Calamitales

Unit: II

Diversity, morphology, anatomy and reproduction in: Psilopsida (Psilotales), Lycopsida (Lycopodiales, Selaginellales, Isoetales), Sphenopsida (Equisetales), Ophioglossales, Eusporangiate ferns (Marattiales), Leptosporangiate ferns (Filicales, Marsileales, Salviniales).

Unit: III

Gymnosperms: origin and evolution, classification (Sporne, Christenhuez); economic importance; diversity and distribution in India; gymnosperms of J & K state (an overview)

Fossil gymnosperms: structural features and evolutionary significance of Pteridospermales, Cycadeoidales, Cordiatales

Unit: IV

Diversity, morphology, anatomy and reproduction in: Cycadales, Ginkogoales, Coniferales, Taxales, Ephedrales, Gnetales, Welwitschiales

Name of the course/Code: BOT-21202CR: ECOLOGY

Learning objectives: To impart understanding to the students about the structural and functional attributes of ecological organizations at population, community and ecosystem levels and to inculcate in them the conceptual clarity about the evolutionary underpinnings of variation in diversity and abundance of organisms at multiple spatio-temporal scales.

Learning outcome : The students are expected to have conceptual clarity about ecology and evolution, having an understanding of structural and functional aspects of ecological organization at population, community and ecosystem level, the students would be better positioned to think about the potential ways of handling various ecological issues confronted by the contemporary world

Unit: I

Population ecology: population characteristics; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

Habitat and niche: concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Species interactions: types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Unit: II

Community ecology: nature of communities; community structure and attributes; species diversity and its measurement, richness and evenness; edges and ecotones; guilds

Community development: temporal changes (cyclic and non-cyclic); mechanism of ecological succession (relay floristics and initial floristic composition; facilitation, tolerance and inhibition models, resource ratio hypothesis); changes in ecosystem properties, concept of climax and its characterization.

Community stability: diversity- disturbance, and diversity stability relationships; ecology of plant invasion- process of invasion.

Unit: III

Ecosystem organization: biotic component-food chains, food web, trophic cascades; abiotic component-soil formation, soil profile development, soil horizons and soil classification.

Ecosystem function: primary production (gross and net primary production, controlling factors and methods of measurement), energy flow pathways, ecological efficiencies; litter accumulation and decomposition (mechanisms, substrate quality and climatic factors).

Global bio-geochemical cycles: biogeochemical cycles of C, N, P and S (pathways, processes, budgets and anthropogenic impact)

Unit: IV

Diversity Patterns: species abundance distribution, diversity patterns (latitudinal gradient-contributory factors and explanatory theories)

Equilibrium Ecology: Equilibrium and Non-equilibrium Ecology; Characteristics of equilibrium and non-equilibrium systems; Resilience theory and applications.

Biogeography: MacArthur and Wilson's Island biogeography equilibrium theory-limitations and modifications; colonization vs. extinction; species area relationship

Biomes: types (terrestrial and aquatic), distribution and unique features

Name of the course/Code: BOT-21203CR: CELL AND MOLECULAR BIOLOGY

Learning objectives: To impart students knowledge about structure and function of cell wall and cell membrane and about the structure, organization and function of different organelles of cell and to aware them about the different mechanisms of cell and molecular biology associated with cell and its different organelles.

Learning outcome : The students will understand structure and function of cell wall, cell membrane, cell organelles and learn about the relations and mechanisms involved between these organelles, learn about structure of DNA and RNA, differentiate between prokaryotes, and eukaryotes, understand various steps in gene expression, transcription, protein synthesis and protein modifications

Unit: I

Cell wall and plasma membrane: structure and functions; membrane proteins – integral and transmembrane proteins.

The cytoskeleton: organization and role of microtubules and microfilaments, motor proteins.

Nucleus: nuclear membrane and nuclear pore complex, transport of proteins and RNAs across nuclear membrane.

Unit: II

Chloroplasts and Mitochondria: genome organization, protein import, endo-symbiotic origin.

Golgi complex and ER: role in protein sorting and transport, Lysosomes – endocytosis and phagocytosis.

The cell cycle: phases of cell cycle, regulation of cell cycle progression, role of cyclin and cyclin-dependent kinases.

Unit: III

DNA: DNA structure, mechanism of DNA replication, DNA damage and repair mechanisms.

Transcription: RNA polymerase, introns and their significance, transcription factors, mechanism of transcription, major differences between prokaryotes and eukaryotes (at transcriptional level).

RNA processing: post transcriptional modifications, RNA editing.

Unit: IV

Ribosomes - structure and assembly, tRNA and genetic code.

Translation: mechanism of protein synthesis, initiation, elongation and termination factors, major differences between prokaryotes and eukaryotes (at translational level).

Regulation of gene expression: in prokaryotes (Lac operon, tryptophan operon) and eukaryotes (ro le of promoters, activators, repressors and DNA methylation).

Name of the course/Code: BOT-21204CR : PRACTICAL-2

Laboratory Exercises based on BOT-21201CR:

- Study of morphological, anantomical and reproductive structures of the representative Pteridophytes viz: *Azolla, Lycopodium, Psilotum, Ophioglossum, Selaginella, Dryopteris, Equistem, Marsilea* and
- *Pteris*.
- S tudy of important fossil Pteridophytes from prepared slides.
- Study of morphological, anatomical and reproductive structures of representative Gymnosperms, such as *Pinus, Cedrus, Abies, Picea, Taxus, Cephalotaxus, Araucaria, Taxodium, Gnetum, Ephedra, Ginkgo, Cycas*.

Laboratory Exercises based on BOT-21201CR:

- Types of quadrats (sampling units) and their utility.
- Determination of minimum size and number of quadrats for phytosociological studies.
- Computation of Frequency, Density, Abundance and Cover of constituent species of different communities.
- Computation of Relative Frequency, Relative Density, Relative Abundance and Relative Cover of constituent species of different communities.
- Estimation of IVI of the species in different communities.
- Estimation of species diversity and dominance.
- Comparison between protected and unprotected grasslands using community co-efficient

Laboratory Exercises based on BOT-21203CR:

- Study of DNA replication mechanism
- Demonstration of cell cycle, mitosis and meiosis.
- Identification of different stages of mitosis and meiosis from temporary and permanent slides.
- Study of morphology of metaphase chromosomes from onion root meristems.
- Study of various cell organelles using prepared slides and models
- Cell wall staining with calcoflour
- Preparation of various types of stains for chromosome analysis.
- Demonstration of microscopes (Simple compound microscope, phase contrast, fluorescence, SEM).
- Isolation of plant DNA and its quantification by spectrophotometric method.
- Plant DNA extraction using standard protocols.

SEMESTER 3rd

Name of the course/Code: BOT-21301CR: REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY OF ANGIOSPERMS

Learning objectives: To impart student knowledge about the morpho-anatomical features of plant organs, acquaint them about the flower development, microsporogenesis and megasporogenesis, pollination, seed developments and other processes and to make them understand the molecular mechanisms behind development of plant organs, seed development, seed germination and flowering

Learning outcome : The students will develop an understanding of concepts and fundamentals of plant anatomy, embryology, examine the internal anatomy of plant systems and floral organs, and develop critical understanding on the evolution of concept of organization of shoot and root apex and mechanisms behind development of plant organs

Unit: I

Flowe r development: floral evocation, floral organ formation, flowering in perennials, seasonal flowering, polycarpy and biennial bearing.

Male and female gametophyte: structure of anther, role of tapetum, micro-sporogenesis and development of pollen, regulation of asymmetric first pollen mitosis, control of second pollen mitosis and sperm cell differentiation, female gametophyte development: initiation, patterning, cell fate specification and maintenance of cell identities of female gametophyte.

Unit: II

Pollination, pollen-pistil interactions and fertilization: pollination mechanisms, pollination syndromes, structure of pistil, pollen germination and compatible pollen-stigma interactions, sporophytic and gametophytic self- incompatibility, pollen tube growth and guidance, double fertilization

Seed development, fruit growth and dormancy : endosperm development, embryogenesis- landmarks of embryo pattern formation, polyembryony and apomixes, dynamics of fruit growth, importance and types of dormancy, seed dormancy, overcoming seed dormancy, bud dormancy.

Unit: III

Root development: organization of root apical meristem (RAM); vascular tissue differentiation; lateral roots, root hairs.

Leaf growth and differentiation: determination; phyllotaxy; control of leaf form; differentiation of epidermis with special reference to stomata**,** trichomes, and mesophyll

Senescence and programmed cell death (PCD): concept, types of cell death, mechanism of PCD. PCD in the life cycle of plants, metabolic changes associated with senescence

Unit: IV

Patterns in plant development: growth, differentiation and develop ment, genetic control and hormonal regulation of development, physiology of hormones in plant development.

Shoot development: organization of the shoot apical meristem (SAM); cytological and molecular analysis of SAM; mechanisms of cell division and cell to cell communication; tissue differentiation with reference to xylem and phloem; secretary structures and laticifers

Wood development in relation to environmental factors.

Name of the course/Code: BOT-21302CR: CYTOGENETICS AND GENETICS

Learning objectives: To give knowledge to the students about structural and functional aspects of genes and chromosomes, consequences of gene and chromosome aberrations such as structural chromosomal changes, aneuploidy, euploidy, gene mutations, etc.

Learning outcome: The student will gain knowledge on understanding basic structural and functional aspects of gene and chromosome, behavior of chromosomes during mitosis and meiosis, various abnormalities in humans and plants due to various gene and chromosome aberrations. develop proficiency in the experimental techniques and methods in the field of cytogenetics and genetics

Unit: I

Principles of inheritance: Dominance, Independent assortment, incomplete dominance, co-dominance, multiple alleles, epistasis.

Linkage and crossing over: Concept and types of linkage, crossing over & genetic recombination, recombination frequencies, chromosome mapping (three factor cross).

Nuclear DNA content and c-Value paradox, repetitive DNA - types and utility.

Concept of gene: Split genes, overlapping genes and pseudo genes.

Unit: II

Chromosomes: Chromosome structure and chromatin organization, euchromatin & heterochromatin, organization of centromere and telomere.

Karyotype – Concept, essential features and evolution of karyotype.

Chromosome banding techniques (Q, C and G) and their utility.

B chromosomes – Origin, characteristics and distribution of B- chromosomes.

Structural changes: Origin, meiotic behavior and consequences of deletion, duplication, inversions and translocation, Robertsonian translocation, B-A translocation.

Unit: III

Euploidy: Origin, meiosis and breeding behaviour of haploidy, autopolyploids and allopolyploids. Chromosome and chromatid segregation in autopolyploids,

Crop improvement: Economic importance of autopolyploids. Role of allopolyploidy in evolution of crop plants (wheat, cotton, triticale, Brassica).

Aneuploidy: Types of aneuploids, origin of aneuploids, meiosis and breeding behaviour of aneuploids, aneuploid aberrations in humans.

Unit: IV

Mutations- Spontaneous and induced mutations, types of point mutations, molecular basis of gene mutations, pleiotrophy, back mutations and suppressor mutations, brief account of physical and chemical mutagens.

Alien gene transfer: Production and utility of alien addition and substitution lines, transfer of individual chromosome and chromosome segments (examples from wheat).

Population genetics: Concept of gene pool and gene frequencies**,** Hardy-Weinberg law, factors affecting allelic frequencies (selection, mutation, genetic drift).

Insitu-hybridization: Brief account of FISH, GISH and McGISH.

Name of the course/Code: BOT-21303CR: PLANT METABOLISM

Learning objectives: To educate the students about the biochemical events, mechanisms and bioenergetics of various metabolic pathways that lead to the synthesis of important biomolecules and their catabolism. The main focus will be upon bioenergetics, enzyme catalysis and the biochemical mechanisms of metabolic processes, such as photosynthesis and the assimilation of carbon, nitrogen, sulphur and lipids

Learning outcome: The students will be able to comprehend different thermodynamic principles in relation to various biological processes, metabolism of nitrogen and sulphur, understand the unique aspects of electron transport system, phosphorylation and role of lipid metabo lism in relation to plants and learn the photochemistry of photosynthesis and the assimilation of carbon through various pathways

Unit: I

Principles of bioenergetics: bioenergetics and thermodynamics; concept of free energy; biological oxidation-reduction reactions- redox potential and free energy; phosphoryl group transfer and ATP.

Enzymes: kinetics of single-substrate enzyme catalyzed reactions- Michaelis-Menton equation and its significance; enzyme inhibition and mechanism of enzyme catalysis; extraction and purification of enzymes (brief account).

Unit: II

Nitrogen and sulphur metabolism: nitrogen in environment; mechanism of nitrate uptake and assimilation; ammonium assimilation; biological nitrogen fixation; nodule formation and nod factors; photorespiratory nitrogen cycle; sulphur uptake, transport and assimilation.

Unit: III

Respiration and lipid metabolism: glycolysis and citric acid cycle (overview and unique features in plants); pentose phosphate pathway; electron transport system; synthesis and release of ATP; alternative oxidase system; cyanide resistant respiration; classification of lipids; fatty acid biosynthesis; oxidation of saturated and unsaturated fatty acids; glyoxylate cycle.

Unit: IV

Photochemistry and photosynthesis: photosynthesis from historical and evolutionary perspective**;** photosynthetic pigments; components of light reaction; light harvesting complexes; photo-oxidation of water; mechanisms of electron and proton transport; carbon assimilation, Calvin cycle (C3 cycle), C4 Cycle, CAM pathway; characteristics of C3, C4 and CAM plants; photorespiratio n and its energetics.

Name of the course/Code: BOT-21304CR: PRACTICAL-3

Laboratory Exercises based on BOT-21301CR:

- Study of living shoot apex of *Hydrilla*
- Study of cytological zonation in the shoot apical meristem in double stained permanent slides of
- any suitable plant.
- S tudy of different leaf arrangements
- Study of C. S. of typical dicot and monocot leaves
- Study of epidermal peels of leaves of appropriate to study various stomatal types
- Study of anatomy of dicot and monoct roots and stems using appropriate materials
- Study of microsporogenesis and gametogenesis in appropriate materials
- Estimation of pollen germination and average pollen tube length *in vitro*

- Study of different types of ovules, embryo sacs through examination of permanent slides
- Isolation of monocot and dicot embryos from suitable materials

Laboratory Exercises based on BOT-21302CR:

- Study of mitotic index from suitable plant material.
- Study of meiosis of selected plants through temporary squash preparations
- Techniques of preparation of permanent and semi-permanent slides.
- Carmine, Orcein and Feulgen staining of the chromosomes – preparation of stains.
- Characteristics and behavior of B chromosomes using maize or any other appropriate material.
- Study of Mendel's laws through seed ratios, chi-square analysis
- Study the effect of mono and trisomy in humans through permanent preparations (slides, photographs, PPTs).
- Induction of polyploidy using colchicine in different ways.
- Study various chromosomal aberrations (stickiness, laggards, non-disjunction, inversion bridges, translocation rings) using permanent preparations, photographs etc.
- Karyotype analysis and preparation of kario- idiogram.

Laboratory Exercises based on BOT-21303CR:

- Estimation of reducing sugars in a sample by titrimetric method.
- Estimation of total titrable acidity in the plant material.
- Determination of saponification value of a given fat or oil.
- To study the effect of time and enzyme concentration on the rate of reaction(e.g. action of diastase on starch) by spot plate method.
- To study the effect of substrate concentration on the activity of enzyme and
- determination of its Km value.
- Study of enzyme kinetics with respect to the effect of pH.
- Extraction and separation of chloroplast pigments in the plant material bypartitioning
- into different solvent systems.
- Separation of chloroplast pigments by thin layer chromatography.
- Determination of rate of photosynthesis in an aquatic plant by Winkler's method.
- Determination of succinate dehydrogenase activity.
- To study principles of colorimetry and spectrophotometry.
- Extraction of chloroplast pigments from leaves and preparation of absorption spectrum of photosynthetic pigments and anthocyanins.
- Determination of activity of polyphenol oxidase and peroxidase.

4th Semester

Name of the course/Code: BOT-21401CR: PLANT PHYSIOLOGY

Learning objectives: The objectives of the course are to impart to the students an in-depth understanding of physical (structural), chemical and biological functioning of plants with special emphasis on mechanisms of various physiological processes such as transport processes, signal transduction, flowering, biological rhythms and plant growth and development

Learning outcome: The students will be able to understand the water relations of plants, mechanisms of various transport processes and various aspects of signal transduction mechanisms, appreciate the role and properties of various photoreceptors and the physiological effects of plant growth regulators and learn about the mechanism of process of control flowering in plants and the role of endogenous clock in various physiological processes

Unit: I

Membrane transport, translocation of water and solutes: plant water relations (water potential and its components); mechanism of water transport through xylem; root– microbe interactions in facilitating nutrient uptake; phloem transport; phloem loading and unloading; membrane transporter proteins and processes.

Unit: II

Signal transduction: general concept; diversity in protein kinases and phosphatases; heterotrimeric G-protein complex; phospholipid signaling; calcium- mediated signaling; annexins; CyclicAMP (cAMP); specific signaling mechanisms (two component sensor-regulator system in bacteria and plants); sugar-sensing and signaling in plants (hexose, sucrose and trehalose signaling).

Unit: III

Plant photoreceptors: light-oxygen- voltage "LOV" sensors, xanthopsins, phytochromes, blue- light sensors using flavin adenine dinucleotide "BLUF", cryptochromes and rhodopsins (A brief overview). phytochromes and cryptochromes: discovery, structure, photochemical and biochemical properties, cellular localization and responses.

Unit: IV

Plant growth regulators and elicitors: mechanism of action and physiological effects of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroides, polyamines, jasmonic acid and salicylic acid.

The control of flowering: floral evocation (internal and external cues), endogenous clock and its regulation; photoperiodic control of flowering; vernalization and its significance.

Name of the course/Code: BOT-21402CR: PLANT TISSUE CULTURE AND GENETIC ENGINEERING

Learning objectives: To enable the students to achieve the skills of growing plants using tissue, cell and organ culture under in vitro conditions and to acquaint students about genetic Engineering techniques for the devolvement of genetically improved plants.

Learning outcome: The students will understand the basic knowledge of plant cell and tissue culture, will apply their knowledge of plant tissue culture in various for conservation of economically and medicinally important plants, and will understand various genetically engineering techniques for the development of genetically improved plants

Unit: I

Introduction: historical perspective and scope

Cellular totipotency: concept, cytodifferentiation and its mechanism

Cell culture and cell cloning : isolation of single cells from plant organs and cultured tissues; cell suspension culture, culture of single cells; organogenesis-processes and controlling factors, shoot- bud differentiation and somatic embryogenesis

Unit: II

Haploids: androgenic and gynogenic; ontogeny of androgenic haploids, applications of haploids in plant breeding.

Somatic hybridization: isolation, culture and fusion of protoplasts; selection, regeneration and utility of hybrids and cybrids.

Industrial applications: production of secondary metabolites and their applications, hairy root cultures and bioreactors

Germplasm conservation: cryopreservation of plant cells and organs, short term and long term storage.

Unit: III

Recombinant DNA technology: gene cloning principles, restriction enzymes characteristics and utility, cloning vehicles and their properties (plasmids, phages,
phagemids and cosmids), artificial chromosomes (YAC), construction of recombinant DNA.

Isolation of gene of interest - gel electrophoresis, southern blotting, genomic and cDNA libraries, bacterial transformation and selection of recombinants, polymerase chain reaction (PCR) – principle, technique and applications.

Unit: IV

DNA sequencing: Maxam-Gilbert's chemical degredation and Sanger's chain termination method, molecular markers (RAPD, AFLP, SSR & SNP) – concept and utility.

Genetic engineering of plants: Agrobacterium the natural genetic engineer, Ti plasmids, mechanism of gene transfer, applications of transgenic plants.

Direct methods of gene transfer (electroporation and biolistics), biosafety - possible ecological risks and ethical concerns of GM crops.

Genomics and proteomics: concept and applications, microarray technology and its applications. Brief account of gene silencing; antisense RNA technology and RNA interference (RNAi).

Name of the course/Code: BOT-21403CR: PLANT RESOURCE UTILIZATION

Learning objectives: To impart students knowledge about the concept, utilization and role of plant diversity and to acquaint them about the origin, domestication, use and cultivation of economically important plants and to make them understand about the use of these plants for food, fodder and medicine

Learning outcome: The students will understand concept, role and utilization of plant diversity and critically understand the origin, evolution, domestication, cultivation practices, and uses of food plants, fodder plants, spices, legumes, a oil and starch yielding plants, increase the awareness and appreciation of plants and plant products as food, beverages, rubbers medicines, etc. and get knowledge about traditional medicines

Unit: I

Plant biodiversity: concept, utilization and concerns

Ethnobotany and archaeo-ethnobotany: concept, scope, and role in tracing origin and evolution of domesticated plants.

Origin of agriculture: time and place of origin, archaeological and other evidences

World centres of origin and domestication of cultivated plants: Vavilov's and de Candolle's concept, centres and non-centres, secondary centres, plant introduction

Unit: II

Green revolution: concept, concerns, benefits and adverse consequences.

Origin, evolution, domestication and uses of: food plants **(**maize and buckhwheat), fodder **(**alfalfa), fibre plants **(**cotton**),** Spices **(s**affron), legumes **(**sources of food), oil yielding plants **(m**ustard and groundnut)

Unit: III

Beverages: origin, evolution, domestication and processing of tea and coffee

Sugars and starch: origin, evolution, domestication, extraction and utilization of cane sugar and beet sugar; general account of starch yielding plants.

Rubber: origin, distribution, production, extraction, processing and utilization of rubber.

Paper making: sources of raw material and processing of paper

Unit: IV

Agricultural innovation for meeting food demands: agricultural bio-technology, synthetic crops, agriculture in arid zones.

Psychoactive drugs: sources, chemistry of action, use and misuse of *Papaver somniferum* and *Cannabis sativa*

General account of NWFP's: paper, gums, resins, tannins, dyes, bamboo, rattans.

Rosaceous fruits of Kashmir: general account, botany and uses with special reference to apple, pear, plum, cherry, almond and apricot.

Name of the course/Code:BOT-21404CR: PRACTICAL-4

Laboratory Exercises based on BOT-21401CR:

- Determination of water potential of potato tuber tissues by gravimetric method.
- Determination of water potential of potato tuber tissues by Chardakov's falling drop method.
- Determination of osmotic potential of onion epidermal peels by plasmolytic method.
- Determination of Q10 of water absorption of a given plant material.
- Determination of stomatal frequency and stomatal index of a given leaf material.
- Determination of effect of organic solvents on membrane permeability of plant tissues.
- Study of effect of temperature on membrane permeability of plant tissues.
- To study the physiological effects of auxins, gibberellins and cytokinins.
- Estimation of membrane permeability of a given plant tissue by measuring conductivity of leacheates.

Laboratory Exercises based on BOT-21402CR:

- Washing and sterilization of glassware.
- Techniques for establishment of callus cultures and study of different types of calli viz. Comp act, friable and nodular types.
- Establishment of zygotic embryo cultures.
- In vitro differentiation of roots and shoots in suitable explants.
- Demonstration of rhizogenesis in *Glycine max.*
- DNA extraction protocol and its quantification by UV- spectrophotometric method.
- Restriction digestion of DNA and its analysis by Agarose gel electrophoresis
- Demonstration of DNA sequencing by Sanger's dideoxy method.
- Demonstration of RAPD, SSR and AFLP analysis.
- Isolation of gene of interest using genomic and cDNA library.
- Demonstration of PCR, centrifuge, deep freezer, and gel electrophoresis apparatus
- Gel electrophoresis techniques and analysis

Laboratory Exercises based on BOT-21403CR:

- To study the morphology of the part used of various representative crops like rice, wheat, maize, potato, pulses and fruits
- Study of viability of various crop seeds using germination and T.Z Test
- Study of seed vigour using standard methods
- Study of source spice and condiments (source, part used, active components)
- Study of any five important fodder and forage crops
- Study of various types of fibres viz. cotton. coir, hemp etc.
- Morphology, microscospic study of oil yielding tissues and test for oil (mustard, groundnut, soybean, linseed, coconut, sunflower, castor, sesame and cashew nut)
- Study of comparative characteristics of the grains of cereals, millets and pulses.
- Study of food reserves in different food crops using microchemical tests.
- Study of methods of cultivation, processing and uses of various rosaceous fruits of Kashmir
- Study of ethnobotanical aspects of various local products.

Name of the course/Code: Bot-Proj.: PROJECT WORK WORTH 8 CREDITS

Learning objectives: To enable the students learn about various fields of Botany related to their courses of specialization through survey, literature, experimentation and observation, and to inculcate in them the aptitude of research in plant sciences.

Learning outcome: The students will be able to develop skill of writing dissertation, thesis, reviews, scientific research papers, monographs in different, etc. in different fields of specialization in Botany

Project work worth 8 credits is compulsory for the students and will be assigned in 3rd semester as component of 3rd semester based on choice of the student and space availability in relation to his/her choice as well as choice of the teacher's concerned. However, the number of students per teacher should not exceed five. The project has to be submitted prior to the conduct of 4th semester examination so that it can be evaluated and viva voce be conducted prior to declaration of the results.

DISCIPLINE CENTRIC ELECTIVE (Bot-DCE)

Name of the course/Code: BOT-21105DCE: BIOSTATISTICS AND BIOTECHNIQUES

Learning objectives: The objectives of the course are to impart to the students an in-depth understanding and training of collection, analysis, interpretation and presentation of data; hypothesis testing through statistical tests, sampling techniques, designing of experiments and the correlation and regression; and the applications of various bio-techniques.

Learning outcome: The students will be able to comprehend the types , collection and analyze the data, learn the sampling techniques, will be able to design experiments in biology, test the hypothesis through statistical tests and will be able to understand the principles and application of various scientific techniques like chromatography, electrophoresis, centrifugation etc. in biology

Unit: I

Data types and collection: data types- data on ratio, interval, ordinal and nominal scales; continuous and discrete data; methods of primary and secondary data collection and their limitations; frequency and cumulative frequency distributions.

Processing and analysis of data: measures of central tendency- arithmetic mean, mode, median; measures of dispersion- mean deviation, variance, standard deviation, coefficient of variation.

Unit: II

Sampling techniques: principles and various steps in sample survey; procedures and practices involved in simple, systematic, stratified, cluster and multistage random sampling.

Design and analysis of experiments: principles of experimentation; experimental designs- layout, analysis of variance and comparison of treatments in completely randomized design, randomized complete block design and factorial experiments.

Unit: III

Testing of hypothesis: basic concepts, procedure for hypothesis testing; test difference between two means (-independent and paired samples); test of proportions and test of goodness of fit.

Simple correlation and regression: basic idea, scatter diagram, calculation of an estimated correlation coefficient, significance tests for correlation coefficients; simple linear regression- calculation of regression coefficient, standard errors and significance test.

Unit: IV

Chromatography: principles and applications of paper, thin layer, HPLC, ion exchange and gas liquid chromatographic techniques.

Electrophoretic and Centrifugation Techniques: Gel electrophoresis; ultra-centrifugation

Biophysical methods: concepts of spectroscopy, laws of photometry, Beer-Lambert's law, use of various spectroscopic techniques like UV-Visible in biology

Radio-labeling Techniques: properties of different radio-isotopes and their applications in biology, Safety guidelines.

Laboratory Exercises:

- Collection of raw data on different parameters and classification of ungrouped data into grouped data (discrete and continuous series) i.e. frequency distribution

- Frequency distribution table and Construction of Simple bar chart, Histogram and Scatter plot.
- To find the various measures of central tendency (mean, mode and median) of the given data.
- To find the various measures of dispersion (mean deviation, standard deviation, variance and coefficient of variation) of the given data.
- Drawing of a sample from a given population by various sampling techniques (simple random, systematic and stratified sampling)
- Drawing of a sample from a given population by lottery method and random number table method
- To perform the t-test of two paired and independent samples
- To perform One-way ANOVA and Two-way ANOVA of the given data sets.
- To estimate the correlation (though scatter diagram and correlation coefficient) and linear regression between variables
- Gel electrophoresis techniques and analysis.
- Paper and thin layer (TLC) chromatography.

Name of the course/Code: BOT-21106DCE: MUSHROOM CULTIVATION TECHNOLOGY

Learning objectives: To provide students knowledge of biology and diversity of Mushroom flora of Kashmir Himalaya and to acquaint students about nutritional, medicinal and commercial value of mushrooms and train them in cultivation of some edible or medicinal mushrooms.

Learning outcome : The students will be able to identify various types and categories of mushrooms, demonstrate various types of mushroom cultivation technologies for edible and medicinal mushrooms, and will examine various types of processing food technologies associated with mushroom industry and mushroom economics

Unit: I

Mushroom: introduction; general morphology of mushrooms; magnitude of mushroom species; mushroom biology: components of applied mushroom biology: mushroom science, mushroom biotechnology and mushroom mycorestoration

Nutritional and medicinal value of mushrooms : poisonous and non-poisonous mushrooms; edible mushrooms and cultivation in India and world; Medicines from mushrooms; mushroom production and consumption; world mushroom development industry movements

Unit: II

Mushroom cultivation technology : steps in mushroom cultivation: compost: materials used in composting and different formulation used in composting; compost preparation, methods of compost preparation

Spawn: definition, kinds of spawn, spawning and spawning technique, spawn running, post spawning management and handling during spawn running; equipment used for spawn production laboratory; Preservation and maintenance of mushroom culture

Unit: III

Casing: raw materials used for casing, preparation and sterilization of casing materials, qualities of an ideal casing material, care after casing, mushroom crop management: management at different stages of crop

Pests and pathogens of mushrooms and their management : management of pests and diseases of button mushroom and Oyster mushroom; important sanitation during various stages of mushroom cultivation

Unit: IV

Cultivation of important mushrooms : general process for the cultivation of the white button mushroom (*Agaricus bisporus*), the oyster mushroom (*Pleurotus sajor-caju*), paddy straw mushroom (*Volvariella* sp.), black ear mushroom (*Auricularia* sp.)

Medicinal mushrooms : general process for the cultivation of shitake mushroom (*Lentinus* sp.) and reishi mushroom (*Ganoderma lucidium);* harvesting, postharvest handling, preservation and processing of mushrooms, and marketing of mushrooms

Laboratory Exercises:

- Morphological studies and identification of the local mushroom flora and of preserved specimen of mushrooms
- Sterilization of media and glass ware, preparation of culture of some local mushroom fungal species
- Preparation of culture media/substrate: Potato dextrose agar(PDA), Rice bran medium**,** Richard's solution, Grain spawn substrate, Sawdust spawn substrate, preparation of Agar slants
- Preparation of different types of compost and some compost formulations.
- Preparation of different types of spawns
- Cultivation procedures for Button mushroom and Oyster mushroom Picking and haunting of Mushrooms.
- Study of fungal pathogens and nematode pests of mushrooms

Name of the course/Code BOT-21107DCE: MEDICINAL PLANTS AND HERBAL RESOURCE MANAGEMENT

Learning objectives: To help the students to understand diversity, conservation, uses and applications of medicinal plants of Kashmir Himalaya.

Learning outcome : The students will understand origin, evolution, domestication, cultivation and utilization of economically important plants for food, fodder, spices, condiments and medicines, and will understand use of plants and plant products encountered in everyday life and appreciate the diversit y of plants and plant products in human use

Unit: I

History of herbal medicine: documentary and archaeological evidences supporting the traditional theme of plants as a natural herbal resource

Herbal systems of medicine: world scenario with emphasis on- concept, status and potential at Regional, National and International level:

- European
- American
- African
- Chinese and Tibetan
- Unani

- Ayurvedic
- Sidhi

Traditional usage of ethno-medicine in Jammu and Kashmir: history, status and potential

Unit: II

Diversity and distribution of medicinal plants (MP's) in J & K

Different threats: causes and concerns of Kashmir Himalayan MP diversity

Assessment of population status: MP's of J & K in accordance with IUCN guidelines

Data collection: methods, documentation and exchange, importance of threat assessment of MP's.

Unit:III

Commercial potential of MP's in Kashmir Himalaya **Role of MP's** in World pharmaceutical industry

Assessment of status of genetic diversity and its role in conservation of MP'S

Linkage between traditional knowledge holders, policy makers and industry: NGO's and their role in commercialization of MP's based on traditional knowledge

Unit: IV

Spices and condiments: medicinal aspects in relation to modern theme of herbalism

Economic valuation: techniques used to estimate the monetary values and to educate the tribals and locals for facilitating herbal medicine commercialization

Bio-prospecting: the systematic search for new sources of chemical compounds, genes, proteins, microorganisms that have potential medicinal value as a biotic resource

Labotaoratory Exercise

- Studies on MP's of Kashmir with respect to status, distribution pattern, adaptability and threats, if any
- Survey of various tribal areas of Kashmir valley to compile an inventory of important medicinal plant species of the region (name, local name, part used, uses, method of use, degree of popularity and precautions, if any)
- Assessment of resource allocation and resource partitioning of important MP's of Kashmir Himalaya
- Assessment of reproduction biology as a means of domestication and conservation of MP's
- Analysis of active components in relation to commercial usage of important MP's of Kashmir
- Developing vegetative and sexual parametres for commercialization of important
- MP's of Kashmir
- Preparing a herbarium of atleast 30 important medicinal plants with all detailes related to habit, habitat, density and diversity and status

Name of the course/Code: BOT-21205DCE: BIODIVERSITY AND CONSERVATION BIOLOGY

Learning objectives: To acquaint the students about the concept, concerns and conservation of biodiversity; to understand the values of biodiversity for human welfare; and to get knowledge about the hitherto untapped potential of biodiversity in sustainable regional development

Learning outcome : The students will get familiarized with local biodiversity, its economic and ecological value for regional sustainable development and will be trained in quantitative metrics of biodiversity, conservation strategies for threatened biodiversity, policy tools and sustainable management of bioresources

Unit: I

Biodiversity: concept of biodiversity (a historical perspective); components of biodiversity (species richness and evenness); levels of biodiversity – organizational (genetic, species and ecosystem), spatial (alpha, beta, gamma); values of biodiversity (direct use, indirect use, option and existence values); magnitude of biodiversity (global, national, J&K)

Unit: II

Conservation biology: principles and characteristics; genetic variation (magnitude, loss and its consequences); concept of species extinction, causes of species extinction - ultimate and proximate; the IUCN scheme of threatened species, summary of latest IUCN Red list; IUCN scheme of threatened ecosystems; ecosystems at risk (tropical rain forests, coral reefs, wetlands).

Unit: III

Conservation strategies and policies: in-situ conservation strategies (concept of protected areas network); IUCN's scheme of protected area management categories; National Parks and Wildlife Sanctuaries in India (an overview); Biosphere Reserve (concept, design and distribution in India); ex-situ conservation strategies (botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks, DNA banks); biodiversity hotspots (concept, criteria and conservation implications)

Unit: IV

Monitoring and management of biodiversity: biodiversity measurement (sampling unit shape, size and number); phylogenetic and functional diversity (concept and scope); biodiversity surrogates (types and use); role of remote sensing and GIS in biodiversity management; biodiversity informatics (concept and applications), Global Biodiversity Information Facility (GBIF); global conservation efforts (organizations & conventions); Indian conservation efforts (organisations & legislations)

Laboratory Exercises:

- Preparation of an inventory of RET (Rare, Endangered and Threatened plants) in KUBG.
- Measurement of species diversity by using various biodiversity indices.
- Measurement of species evenness and similarity index.
- Measurement of alpha, beta and gamma diversity.
- Field demonstration of GPS (Global Positioning System) and its utility in biodiversity studies
- Study of various economically and ethno-botanically important plants ofKashmir Himalaya
- Field study of various threatened endemic plants of Kashmir Himalaya.
- Field demonstration of *in situ* and *ex situ* conservation strategies through visit to the national parks, sanctuaries, botanical garden, herbaria, zoos, museums.

Name of the course/Code: BOT-21206DCE: APPLIED PHYCOLOGY

Learning objectives: To impart understanding to students about exploitation of algae for production of bio-fertilizers, bio-fuels, food, fodder and in pharmaceutical industries

Learning outcome: The students will develop understanding about the cultivation of fresh water algae, cyanobacteria and will understand the role of algae as a source of bio-energy, indicators of pollution, phytoremediation, will learn about the role of algae as source of biomolecules, polysaccharide and in pharma industry

Unit: I

Algal biomass: Monod and Droop models of nutrient-regulated phytoplankton growth; culture and cultivation of economically important freshwater algae; mass cultivation of cyanobacteria under outdoor and indoor conditions.

Unit: II

Algal biofuels and biofertilizers: energy and chemicals; biodiesel and hydrogen production- mechanism, progress and prospects; mechanism of biological nitrogen fixation by cyanobacteria; cyanobacteria as bio fertilizer for paddy cultivation; reclamation of usar lands.

Unit: III

Algae and pollution: eutrophication and pollution; algae as indicator of pollution; high rate algal ponds for the treatment of waste waters and sewage, immobilized and inactivated algal biomass for metal and nutrient removal.

Unit: 1V

Algae as a source of food, fodder and its role in industry : algae as source of carbohydrates, proteins, vitamins, lipids and minerals, as as cattle fodder and poultry fodder, polysaccharides (agar agar, carageenan and alginic acid); algae in pharmaceutical industries.

Laboratory Exercises:

- Preparation of temporary mounts and Identification of phytoplankton belonging to different classes of algae
- Culture of some important micro-algae
- Cultivation of cyanobactaria under indoor conditions
- Preparation of biodiesal from vegetable oils

Name of the course/Code: BOT-21207DCE: APPLIED PLANT PATHOLOGY

Learning objectives: To provide students knowledge about principles of plant pathology and acquaint them about the biology, epidemiology, etiology and management of plant diseases caused by different plant pathogens.

Learning outcomes: The students will be able to understand principles of plant pathology and pathogenesis, role of enzymes, microbial toxins in pathogenesis, mechanism of defense mechanisms in plants against pathogen attack, develop an understanding about diagnosis, etiology, epidemiology and management of plant diseases caused by microbial pathogens and will be able to demonstrate skills in laboratory, field and glasshouse work related plant pathology

Unit: I

Pathogenecity and nature of disease : pathogens and pathogenesis. Koch,^{s} postulates, disease: definition and classification; mode of development: inoculum and inoculation, penetration and colonization of pathogen within infected plant

Plant disease epidemiology : elements of plant disease epidemics, host factors and pathogen fac tors affecting epiphytotic development; diseases forecasting in plant epidemics, examples of disease forcasting system and farmers warning system

Unit: II

Pathogens attack on host: role of enzymes and toxins in pathogenesis; aflatoxins, major types and

importance

Plant defense against pathogens : structural or morphological defense and metabolic or biochemical defence induced by attaching pathogens; Phytoalexins

Unit: III

Plant diseases: symptomology of fungal and bacterial infections of plants; fungal diseases: symptoms, etiology and control of club root of crucifers, *Rhizopus* rot of fruits and vegetables, loose smut of wheat; bacterial disease: general characteristics; etiology and control of citrus canker, fire blight of apples and pears

Viral and viroid disease: general characteristics of viruses; cucumber mosaic virus, cauliflower mosaic virus, potato spindle tuber; nematodes disease: general characteristics of plant-parasitic nematodes; symptoms, biology and control of root knot disease of plants, ufra disease of rice: mycoplasma diseases: general characteristics of MLO´S; symptoms, causal organism and transmission of sandle spike disease

Unit: IV

Pest management: regulatory methods: quarantine and inspection; cultural methods; physical methods; chemical methods: types of chemicals, inorganic and organic chemicals, antibiotics

Biological methods : use of fungi, bacteria, entomopathogenic nematodes, organic amendments and antagonistic plants as biocontrol agents; biopesticides, types, advantages and limitations, general concept of integrated pest management (IPM) in disease control

Laboratory Exercises:

- Morphological studies and identification of the following fungi through temporary and permanent mounts- *Peronospora, Mucor, Rhizopus, Penicillium, Aspergilus* and *Alternaria, Albugo, Polyporus, Phoma*
- Symptomology and studies of some local diseased plant materials through temporary and permanent mounts: powdery mildew of cucurbits and composites, smuts, leaf spot diseases
- Sterilization of media and glass ware, preparation of culture of some local fungal flora
- Preparation of culture media, peptone dextrose agar (PDA), soil extract agar, Richard's solution Czepek's solution, Coon's medium ,noculation of fungi by dilution plate method
- Isolation of plant pathogens from infected tissue by tissue segment method
- Preparation of some fungal stains
- Demonstration of cell wall degrading enzyme production by *Rhizopus and Mucor* on potato tuber
- Acquaintance with fungicides, bio-control agents and spray equipments
- Isolation of nematodes by Cobb's sieving and decanting techniques
- Isolation and purification of viruses by density gradient centrifugation

Name of the course/Code: BOT-21305DCE: APPLIED ECOLOGY

Learning objectives: To extend the knowledge of ecology for its application in monitoring, managing and mitigating the environmental problems such as habitat degradation biodiversity depletion, pollution and climate change

Learning outcome: After learning this course the students are expected to have first-hand understanding of major ecological and environmental problems, regionally and globally, and prompt them for a better approach towards their mitigation

Unit: I

Environmental monitoring: Environmental monitoring - importance and approaches; microbes in relation to monitoring and mitigation of organic pollution and metal pollution, biosensors - types and role in pollution

monitoring; microbes as bio-indicators, standards and criteria for indicators

Environmental pollution: Kinds and sources of pollutants; impact of SO_2 on plants; eutrophication of aquatic ecosystems- sources and impacts; Ozone depletion; ozone hole, UV radiation and their impact, response of plants to tropospheric ozone; acid precipitation- components and impacts.

Unit: II

Global climate change: Climate change (causes and consequences); greenhouse gases- sources, trends and role; global warming, CO_2 fertilization; Climate change mitigations- methods and means, costs and benefits, international treaties and strategies

Ecosystem management: nature of environmental problems and societal response; environmental impact assessment (EIA) conceptual framework, contents, methodology and role in environmental conservation- and of EIA

Unit: III

Bioremediation: bioremediation (principles and strategies); Phytoremediation - process of phytoremediation (phytoextraction, phytostabilization, phytotransformation) ; applications of phytoremediation.

Microbes and waste management: microorganisms and wastewater treatment; commercial blends of microbes and enzymes in wastewater treatment; role of microbes in solid waste management

Unit: IV

Restoration ecology: concept, concerns, strategies and planning; biodiversity- ecosystem function relationship (BEF)

Sustainable development and Environmental ethics : concept of sustainable development and indicators of sustainability**;** Environmental ethics - introduction to environmental ethics; ecological footprint analysis (an overview); traditional ecological knowledge (context, practices and challenges)

Name of the course/Code: BOT-21306DCE: INVASION BIOLOGY

Learning objectives: To acquaint students about the biology, ecology and management of invasive species

Learning outcome: The students will have better understanding of the mechanism of plant invasions, their environmental impacts and idea about their management.

Unit: I

Introduction to invasion biology: Historical perspective of invasion biology, critique of invasion Biology (SPRED ecology – Species REDistribution)

Process of invasion: Introduction (intentional and accidental), Pathways and vectors, Rapid evolution, Hybridization, Biotic resistance, Propagule pressure, Residence time, Tens rule, Establishment, Naturalization, Spread, Invasion meltdown

Unit: II

Species invasiveness: Allelopathy, Phenotypic plasticity, Escape from enemy, Evolution of Increased Competitive Ability, Darwin's naturalization hypothesis

Community invasibility: Empty niche hypothesis, Diversity–invasion dilemma and predator relationship, Intermediate disturbance hypothesis

Unit: III

Invasions and global environmental change: Effect of change in temperature, atmospheric CO_2 concentration, nitrogen deposition, disturbance regimes, and habitat fragmentation on species invasions

Ecological and economic impacts: Biotic homogenization, impact of invasions on community structure,

trophic levels, Nutrient cycling, Hydrology and Fire regimes, Invasion debt and alteration in total economic value (TEV) of biodiversity

Unit: IV

Invasion prediction and risk assessment: Prediction of invasive species, Weed Risk Assessment, Species distribution modeling (GARP, MaxEnt), Quarantine measures

Management of invasive species: Early detection and rapid response, Physical, Chemical and Biological control (advantages and disadvantages), Indicators and policy

Laboratory Exercises:

- Determine the stage of invasion of the particular plant species in the given area.
- Determine allelopathic potential of the given plant species by point quadrat method
- Demonstrate the effect of leachate of an invasive species on seed germination of a native species
- Determine the risk of invasion using WRA

Name of the course/code: BOT-21307DCE: Plant Stress Biology and Molecular Genetics

Learning objectives: To acquaint the students with knowledge about how different how plants respond to different environmental cues at morphological, physiological and molecular levels.

Learning outcome: The students will have better understanding of environmental impact on plants, will learn how resistant crops/plants tolerate different environmental stresses and biotic stresses and will understand the role of transcription factors in stress tolerance

Unit: I

Introduction to different stresses and effect on crop productivity : Physiologcical response by plants to different stress: Osmotic adjustments; role of Glycine betaine, mannitol, proline, polyamines; Reactive oxygen species (ROS) and antioxidant pathway; Role of phytochromes; Acquired and innate immunity in plants; Hypersensitive response; Systemic acquired resistance; Pathogenesis related proteins;

Unit: II

Role of transcription factors in stress tolerance ; Role of proteins in stress tolerance in plant: Late Embryogenesis proteins (LEA), Heat shock proteins, Dehydrins, antifreeze proteins, etc. Role of phytohormones in plant stress; ethylene response pathway; the abscisic and regulatory network;

Unit: III

Genetics of plant-microbe interaction: genetic transformation, conjugation and transduction and their role in mapping of bacterial genes Plasmids – general properties and regulation of replication (control of copy number) Genetic engineering approaches for insect resistance (Bt approach);

Unit: IV

Interaction of Plants with Viruses – RNA-interference and viral infections; Virus- induced gene silencing; Development of transgenic virus resistance in crops. molecular basis of lytic and lysoge nic life cycle; genetic recombination in phage; deletion mapping Concept of gene and allele, Cis-Trans/complementation test, genetic fine structure (r-II locus)

Name of the course/Code: BOT-21308 DCE: CROP GENETICS AND MOLECULAR BREEDING

Learning objectives: To aware students about the basic techniques and methods of crop improvement and learn about the production of desirable transgenic plants using basic and advanced molecular techniques and Genetic Engineering techniques.

Learning outcome: The students will understand role of plant breeding in crop improvement in cross pollinated and self pollinated plants and have critical understanding about the concept, development and application of transgenic plants

Unit: I

Aims and Objectives of plant breeding: concept of germplasm and gene pool, mechanisms promoting self and cross pollination, genetic and cytoplasmic male sterility.

Methods of crop improvement in self pollinated crops: genetic composition of self-pollinated crops, progeny test, pureline theory, mass selection, pure line selection, backcross method, merits and demerits, achievements.

Unit: II

Methods of crop improvement in cross pollinated crops : heterosis and inbreeding depression - genetic basis, wide hybridization and its utility in crop improvement.

Population improvement method - progeny selection (ear to row method), recurrent selection for general and specific combining ability, production of hybrid varieties - concept and utility,

Quantitative traits: polygenic inheritance and role of environment.

Unit: III

Concept and development of transgenic plants–agrobacterium mediated gene transfer, direct gene transfer (particle bombardment)

Applications of transgenic plants in crop improvement - disease and insect resistance, drought tolerance, nutritional quality, male sterility, edible vaccines, golden rice

Biosafety: ecological risks and ethical concerns of genetically modified crops.

Unit: IV

Molecular markers: types and utility of molecular markers in genetic diversity analysis in crop plants (RAPD,AFLP, SSR and SNP)

Marker assisted selection in crop plants- marker assisted back cross breeding,

QTL mapping and its applications in crop plants

Laboratory Exercises:

- Field demonstration of self and cross pollinated plants with suitable examples.
- Study of hybridization techniques in the field.
- Study of floral modifications that favour inbreeding and out breeding.
- Mitotic chromosome analysis using suitable plant material (onion)
- Meiotic chromosome analysis using suitable plant material.
- Induction of polyploidy by colchicine treatment.
- Karyotype analysis and preparation of kario- idiogram.
- Analysis of pollen to ovule ratio as an index of the nature of breeding system in some crops.
- Study of different chromosomal aberrations and their effect on fertility.
- Demonstration of Restriction digest analysis, RAPD and SSR analysis

Name of the course/Code: BOT-21309 DCE: APPLIED CROP PHYSIOLOGY

Learning objectives: To impart students knowledge about basic and applied concept of water relations and mineral nutrition of plants, different processes and mechanisms of photosysthesis, principles and practices of plant growth analysis and to acquaint them about chemical control of growth regulators in agriculture and horticulture

Learning outcome: The students will be able to understand the water relation of crops, transpiration, plant nutrition, effect of environmental factors on photosynthesis and will also understand and analyze the relationship between growth and yield and appreciate the role of growth regulators in agriculture and horticulture

Unit: I

Water relations and mineral nutrition: Movement of water through soil-plant-atmosphere continuum; stomatal transpiration, role of transpiration; water use efficiency and crop productivity; plant nutrient responses.

Unit: II

Photosynthesis and crop productivity: Photosynthesis in crop plants at organ, plant and canopy level; improving photosynthetic efficiency for greater yield; effect of environmental factors on photosynthesis (light, temperature, carbon dioxide); leaf factors and photosynthesis; photorespiration and its significance in crop plants.

Unit: III

Growth analysis and crop yield: Principles and practices of plant growth analysis; concepts & computation of growth analytical parameters: net assimilation rate (NAR), leaf area ratio (LAR), leaf weight ratio (LWR), relative growth rate (RGR), leaf area index (LAI), crop growth rate (CGR) and specific leaf area (SLA); dry matter partitioning into various parts of plant and its impact on source-sink relationship; relation between growth and yield (harvest index).

Unit: IV

Chemical control of plant growth: Role of plant growth regulators (PGRs) (auxins, gibberellins, cytokinins and ethylene) in agriculture and horticulture; plant growth retardants (mode of application and their uses in ornamental horticulture)

Laboratory Exercises:

- Preparation of calibration curves for the estimation of following tissue constituents in the plant material:
- reducing sugars b.) total starch content c.) soluble proteins d.) α-amino acids
- e.) total phenolics f.) inorganic phosphorus
- Separation and estimation of photosynthetic pigments (chlorophyll-a, chlorophyll-b, total chlorophyll, carotenoids) and anthocyanins.
- Analysis of growth and yield:
- Dry matter partitioning into roots, leaves and branches.
- Computation, assessment and comparison of important growth parameters: a.) net assimilation rate (NAR) b.) leaf area ratio (LAR) c.) leaf weight ratio (LWR) d.) relative growth rate (RGR) e.) harvest index (HI) f.) biomass duration (BMD) g.) leaf area duration (LAD)
- Study of the physiological effects of the following growth regulators: auxins ii.) gibberellins iii.) cytokinins

Name of the course/Code: BOT-21310 DCE: SOIL SCIENCE AND PLANT NUTRITION

Learning objectives: The objective of the course is to build the fundamental knowledge and skills of students within the different areas of Soil Science and Plant Nutrition to enhance their understanding of the soil and its management for better plant growth

Learning outcome: The students will understand and appreciate the processes that lead to formation of soil from various kinds of parent materials, would get to know the morphological, physical, chemical/colloidal and biological properties of soils and their role in plant growth, would have an understanding of macro- and micronutrients required by plants and factors that influence their availability and will also be able to relate the knowledge about soil with soil testing and development of an appropriate nutrient management plan

Unit: I

Soil definition: Pedological and edaphological approaches; Soil formation: Nature and classification of parent materials; Weathering-Physical, chemical and biological weathering; factors affecting weathering; soil formation.

Soil profile: Master and transitional horizons, subordinate distinctions of horizons.

Soil physical properties-Soil texture, soil structure, soil porosity, soil aggregate stability in relation to plant growth.

Soil classification (characteristics of various types of soil orders)

Unit: II

Soil water: Structure and related properties of water, types of soil water movement, factors affecting soil water movement and retention; soil water and plant growth

Soil air and temperature: Soil aeration, factors affecting soil aeration; soil temperature, specific heat of soils, soil temperature and plant growth.

Soil reaction: Acidity and alkalinity, classification of soil acidity, sources of soil acidity, colloidal control of soil reaction, buffering and use of lime; soil reaction and nutrient availability

Unit: III

Types of soil colloids; layer silicate clays and their structure; constant and pH dependent charge.

Ion exchange: Cation and anion exchange; mechanism of ion exchange in soils, factors affecting ion exchange.

Ion exchange and nutrient availability for plant uptake

Unit: IV

Soil Biology: Microorganism and macroorganisms in soil-types and functions, microbial toxins; role of microorganism in nitrogen, carbon and sulphur transformations in soil.

Biochemical composition and biodegradation of soil organic matter, humus formation-theories of human biosynthesis.

Organic wastes and their use for production of manures in the soil; biofertilizers-definition, classification, and role in plant growth.

Soil degradation: Causes and consequences

Laboratory Exercises

- Soil texture and particle size distribution analysis of soils
- Measurement of aggregate stability, bulk density and porosity of soils.
- Measurement of soil-water content by different methods.
- Measurement of soil pH

- Measurement of cation exchange capacity
- Study of various types of organisms in the soil
- Analysis of soil samples for nutrient analysis

GENERIC ELECTIVE COURSES
(Each worth 2 credits)

Name of the course/Code: BOT-21001GE: PRINCIPLES OF GENETICS

Learning objectives: To provide basic knowledge to students about inheritance of traits and genes and structural features about genetic material and it function

Learning outcome : The students will understand basics of cell cycle, laws of inheritance, structure of chromosome, structural and numerical changes in chromosome, DNA structure and will learn about the concept of gene and gene mutation and its significance

Unit: I

Beginning of genetics: cell cycle – mitosis and meiosis, difference between mitosis and meiosis.

Concepts of inheritance- chromosomal theory of inheritance

Mendel's laws of inheritance - principle of segregation and independent assortment, concept of monohybrid and dihybrid cross

Multiple alleles- gene interactions (complimentary, duplicate, epistatic interactions
Concept of linkage- sex linked traits.

Structural and numerical changes in chromosomes – brief concept

Unit: II

Morphology and organization of eukaryotic chromosome
Genetic material: DNA as genetic material (experimental proof)

Structure of DNA (Watson & Crick model), mechanism of DNA replication (Semi- conservative).
Concept of gene and allele, euchromatin and heterochromatin, genetic code and its properties
Gene mutations – concept and types of point mutations, molecular basis of gene mutation

C-value paradox and its significance.

Name of the course/Code: BOT-21002GE: URBAN ECOLOGY

Learning objectives: To provide knowledge about different types of ecosystems, ecosystem services emanating thereof and approaches towards sustainable cities

Learning outcome : The students are expected to develop basic understanding of the ecological fallouts of urbanization and enable them think critically about how to make our cities sustainable and healthy for larger human wellbeing

Unit: I

Urban Ecology: Definition; Principles of urban ecology; urban population growth and urbanization; effect of urbanization on climate, urban heat island effect

Urban Soils: Characterization and characteristics; urban biodiversity, urban green spaces – types and benefits effect of urbanization on water cycle and hydrology

Unit: II

Urban biodiversity and Ecosystem services: Urban biodiversity, urbanization and biological invasions; conservation in an urbanization context; impact of urbanization on ecosystem services

Urbanization and sustainability: sustainable urban design; green infrastructure; smart and healthy cities in relation to human wellbeing; People's participation in monitoring and management of urban environment

Name of the course/Code: BOT-21003 GE: BASICS IN PLANT BIOLOGY

Learning objectives: To provide knowledge to students about basics of plant biology and different metabolic and physiological process in plants

Learning outcome : The students will understand the structure, organization, different processes, and mechanisms operative in plants. The information provided will set a platform for the preparation of students for further studies and appearing in different competitive exams

UNIT I

Plant form and function: organization of plant body, plant tissues, roots as anchoring and absorption structures, external and internal structure of stem, role of modified stems, leaf: structure and importance.

Transport in plants: transport mechanisms, water and mineral absorption, xylem transport, rate of transpiration, water stress responses, and phloem transport.

UNIT II

Plant Reproduction: Floral meristem, floral evocation, floral developmental genes, range of breeding system, cross and self-fertility, separation of floral organs, control of sex expression, self-incompatibility.

Sensing and responding to the environment: Phytochrome, photoperiodism and photomorphogenesis, tropisms, nastic responses, abscission, stress avoidance and adaption.

Name of the course/Code: BOT-21004 GE: COMMERCIAL PLANT PROPAGATION

Learning objectives: To enable students to know about the various techniques in plant propagation and its commercial utility

Learning outcomes: Students will understand about the propagation of plants through various methods like vegetative propagation, propagation through seeds and other plant propagules and will learn about the propagation of high yield and virus free plants through tissue culture techniques and will also get to know about the application of in-vitro micropropogation

Unit: I

Vegetative propagation

Propagation by cuttings, layering, grafting and budding : stem cuttings, leaf cuttings, leaf bud cuttings, root cuttings, factors influencing the rooting of cuttings; layering types: tip layering, simple layering, mound layering, air layering grafting types, graft incompatibility, effect of rootstock on growth and development of the scion cultivar

Micropropagation (Tissue Culture)

Clonal propagation: Introduction, Orchid propagation, General techniques of micropragation, Factors affecting in vitro stages of microprogation, applications of micropropagation

Production of virus free plants : introduction, virus elimination by meristem- tip Culture. Factors affecting virus eradication by meristem-tip culture

Unit:II

Propagation through seeds and other propagules

Seed production and storage : breeder seed, foundation seed, registered seed, certified seed; seed storage and viability tests: Cut test, Float test, X-ray photographs

Seed germination and dormancy : germination tests (tetrazolium and excised embryo test), environmental factors influencing seed germination; types and methods of overcoming seed dormancy

Other plant propagules: propagation by- runners, suckers, crowns, bulbs, corms, stem tubers, tuberous roots, rhizomes.

Name of the course/Code: BOT-21005 GE: WEED MANAGEMENT

Learning objectives: To aware students about biology of weeds and their management through cultural, biological, mechanical and chemical methods

Learning outcomes : The students will understand different types of weeds that hamper the growth of plants and will learn about the management of weeds through integrated and coordinated weed management strategies

Unit: I

Terminology: Definition, concept and characteristics of invasive, naturalized, causal, indigenous weeds

Physical and cultural weed control: Smoother crops, crop rotation, hand pulling, hoeing, water management, machine tillage for weed control.

Biological control: Definition, history and development; ecological basis for biological control; Biotic agents for weed control, biological control of some terrestrial and aquatic weeds.

Chemical Control: Brief History, classification, herbicide families-their characteristics and practical importance, Entry of herbicide into plants and mode of action

Unit: II

Prediction and risk assessment: Weed risk assessment, species distribution modeling (GARP, MaxEnt), quarantine measures; early detection and rapid response

Revegetation of weed-infested landscapes: Determining revegetation needs based on site characteristics; approaches for revegetation and restoration; selecting species for revegetation; methods for establishing weed resistant communities

Integrated and coordinated weed management strategies: Integrated weed management; interdisciplinary requirements; making plans - setting goals; monitoring progress; coordinated weed management planning and coordinated weed management areas; weed management in CRMP (Coordinated Resource Management Planning) context

Name of the course/Code: BOT-21006GE: AQUATIC ECOSYSTEM MANAGEMENT

Learning objectives: To provide knowledge to students about types of freshwater ecosystems, ecology and zonation pattern of lakes and wetlands, threats, challenges and management of aquatic ecosystem

Learning outcome : The students will understand the concept of structure and function of lakes and wetlands of Kashmir Himalaya, will learn about the valuation of aquatic ecosystems, will know about the threats and challenges to lakes and welt lands of Kashmir Himalaya and will be able to work out strategy for the restoration and management of these wet lands and lakes

Unit: I

Structure and function: lakes and wetlands (definition, types and distribution); zonation (principles and patterns); aquatic plants (growth forms and distribution pattern); hydrology, trophic status and nutrient dynamics of lakes and wetlands with special reference to Kashmir Himalaya.

Values and valuation: economic goods and ecosystem services (provisioning, regulating, cultural, supporting); valuation of aquatic ecosystems - framework and approaches of valuations, types of values (ecological, socio-cultural, economic).

Unit: II

Threats and challenges: threats to lake and wetland ecosystems with special reference to Kashmir Himalaya; biological invasion in lakes and wetlands; aquatic invasive plants (traits and impacts); eutrophication, catchment deterioration; climate change and aquatic ecosystems.

Restoration and management: ecosystem resilience and stability; restoration strategie s; ecosystem approach to management; monitoring, prediction and management of invasive aquatic plants.

Name of the course/Code: BOT-21007GE: TECHNIQUES IN LIFE SCIENCE

Learning objectives: To aware students about scientific, analytical techniques and methods and to aware them about the use of microscope and it types in everyday life

Learning outcome : The students will learn about different basic and advanced techniques and their application in the estimation and characterization of biomolecules and will learn about plant tiss ue culture techniques for development of improved desired plants

UNIT I

Chromatographic Techniques : Principles and applications of Thin Layer Chromatography, Ion exchange chromatography, Adsorption Chromatography, Gas Chromatography, HPLC, Gel Chromatography.

Electrophoresis : Principles and types of Electrophoresis and their applications for proteins, nucleic acids, including gradient gel and pulse- field gel electrophoresis, gel matrices-polyacrylamide, agarose etc. critical parameters for optimum separation and resolution.

Microscopic Techniques : Resolving power of different microscopes, Principles and applications of Light microscope, scanning and transmission microscopes, fixation and staining techniques for electron microscope.

UNIT II

Radiolabelling Techniques : Detection and measurement of different types of radioisotopes, Nature of radioactivity and its interaction with matter, applications and safety aspects of radioisotopes.

Centrifugation: Principles and types, simple and differential, Ultracentrifugation-preparative and analytical.

Plant Tissue Culture Techniques : General techniques of Plant Tissue Culture, Tissue Culture Media, Applications of plant tissue culture, Ovule Culture, Ovary Culture, Embryo Cloning, Somatic embryogenesis, synthetic seed production, factors affecting synthetic seed production.

Name of the course/Code: BOT- 18008 GE: BIOLOGICAL SYSTEMATICS AND BIODIVERSITY

Learning objectives: To acquaint the students about the basic concepts of systematics, modern trends and its crucial role in biodiversity science; and to understand the emerging issues and challenges in biodiversity at regional, national and global level.

Learning outcome: The students will get familiarized with the basic tools of systematics (classification, identification, nomenclature) and its relevance for biological sciences; and also get to know the local biodiversity, its values, conservation strategies and policy planning for sustainable management of bioresources

UNIT: I

Biological Systematics : biological classification (a historical account); phases of systematics (alpha, beta, gamma, omega); taxonomic categories and hierarchy; concepts of species; speciation (sympatric and allopatric); scientific identification; scientific nomenclature (princ ipals & practice); phylogenetic systematics; molecular systematics, DNA barcoding; cybertaxonomy (concept and scope); relevance of systematics to human society; role of systematics to biodiversity.

UNIT: II

Biodiversity: concept of biodiversity (a historical overview), magnitude of biodiversity (global, India, J & K); current status of biodiversity (IUCN Red List), values of biodiversity (direct and indirect use values);; biogeographical zones of India; threats to biodiversity; conservation strategies (in situ & ex-situ); biosphere reserves (concept & design); biodiversity hotspots (concept, criteria & distribution); global conservation efforts (organizations & conventions); Indian conservation efforts (organisations & legislations)

Name of the course/Code: BOT-21009GE: BIO-FERTILIZERS AND ORGANIC FARMING IN SUSTAINABLE AGRICULTURE

Learning objectives: To impart knowledge to the students about significance of using organic farming and bio-fertilizers for sustainable agriculture

Learning outcome: The students will be able to understand use and concept of organic farming and bio-fertilizers and will be about to learn about types of biofertilizers, vermocomposts and different methods of their preparation

Unit: I

Biofertilizers: Concept, potentials and prospects and types of Biofertilizers.

Fungal and Bacterial bio-fertilizers: Morphology, life cycle, isolation, cultivation, taxonomy, association, role and methods of application of Mycorhizae, *Rhizobium*

Blue green algae and Azolla as biofertilizers: Introduction, types, occurence, morphology,

taxonomy, life cycle, association, cultivation, inoculation and scope Mass production and quality control of bio-fertilizers.

Unit: II

Organic farming: Basic concepts, principles, perspective and components of organic farming,
organic farming verses conventional farming and need for organic farming.

Vermicompost: Methods of vermicomposting, vermicomposting materials, Advantages of vermicomposting;

Method of preparation of different types of solid composts: Vermiculture Phospho composting, Microbe mediated composting, Dal weed composting

OPEN ELECTIVE COURSES

(Each worth 2 credits)

Name of the course/Code: BOT-21001OE: BASICS OF BIODIVERSITY

Learning objectives: To introduce the students to the basic concepts of biodiversity, to make them understand its precious values for humanity, to create awareness about the conservation strategies and policies in order to mainstream biodiversity for sustainable development.

Learning outcome : The students with diverse background from different Schools in the University will get familiarized with the basic concepts of biodiversity, and become aware about the issues and challenges for mainstreaming biodiversity in public policy

Unit: I

Fundamentals of biodiversity: concept of biodiversity (historical account); components of biodiversity; levels of biodiversity; magnitude of biodiversity (global, India, J & K); threats to biodiversity (habitat loss, invasive species, overexploitation, climate change); values of biodiversity (direct and indirect values); current status of biodiversity (IUCN Red List)

Unit: II

Management of biodiversity : conservation strategies (in-situ & ex-situ); non- formal conservation efforts; biodiversity hotspots (concept, criteria and distribution); Mega-biodiverse Countries; convention on biological diversity; national Biodiversity Act, 2002, National biodiversity authority, Biodiversity management committees, People's biodiversity register; National biodiversity action plan (India); Biodiversity and sustainable development Goals; Post-2020 Global biodiversity framework

Name of the course/Code: BOT-21002OE: COMMERCIAL FLORICULTURE

Learning objectives: To impart student knowledge about the aesthetic, economic and environmental role of ornamentals, and the importance of advanced technology in the commercial cultivation, handling and marketing of quality flowers to get better returns. The main aim is to train students about nursery management practices and pre and post-harvest technology of cut flowers, and encourage them to grow floral crops for commercial purpose.

Learning outcome: The students will be able to appreciate the role of ornamentals in improving environment and quality of life, evaluate the economic importance of flowers and the role of advanced technology in the cultivation and marketing of quality flowers and will be able to learn various nursery management practices and pre and post-harvest technology of cut flowers

Unit: I

Floriculture industry: lifestyle horticulture, ornamental floriculture in improving the environment and quality of life, global floriculture (international scenario and trade),status and scope of commercial floriculture in India and J&K, loose flower market in India, dried flowers and flower parts, potted flowers for indoor gardening, bedding and landscape plants, oils and natural dyes from flowers.

Unit: II

Hi-tech floriculture : concept, fertilizers and manures for commercial floriculture, methods and efficiency of fertilizer application, use of organic manures and biofertilizers in floriculture, ornamental plant nursery and seed production, production of bulbous plants, cut flower production and trade (storage, packaging, transport and marketing of cut flowers).

Name of the course/Code: BOT-21003OE: BIOENERGY

Learning objectives: To impart students knowledge about the different resources of bioenergy and acquaint them how to develop different bio-based energy resources such as biodiesel, biofuel, bioalcohol, bioethanol, etc. from plant bioresources

Learning outcome: The students will get awareness about the concept of producing alternate ecofriendly liquid and gaseous biofuels from plant bioresources and get to know about the importance of using these biofuels in protection of environment

Unit: I

Sources of Energy - Renewable energy, Non-renewable Energy;

Short supply of fossil fuels: Global energy outlook; Environmental impact of fossil fuels

Biofuels : Introduction, history, classification of biofuels

Unit: II

Bio-renewable liquid fuels: Bioalcohols; Bioethanol and biodiesel

Gaseous biofuels: Introduction, Biogas production; landfill gas;

Introduction to biofuel policy : Biofuel and biodiesel in India; Global biofuel projections

Name of the course/Code: BOT-21004OE: BASICS OF LIFE SCIENCE

Learning objectives : To make the students understand the basic structure of unit of life and aware them about various forms of life like bacteria , virus and plants and their role in human life

Learning outcome : The students from a non-science background will be enlightened about structure and organization of different levels of life; processes and mechanisms occurring within living organisms, will know about different diseases and human disorders caused by microbial agents and will get knowledge about the pros and cons of pathogenic microbes

UNIT:I

In Search of Truth: conflict between science and religious orthodoxy. Science and steps scientific research.

From Molecules to Cell: cell structure, prokaryotic and eukaryotic cells.

From Inanimate to Animate : origin of life.

The Mother of All Cells: fertilization and cleavage of zygote, stem cells and their importance.

Cells out of Control: characteristics of cancer cells, forms of cancer, treatment and preventive measures.

On Life's Fringes: viruses, criteria for classification of viruses, viral life cycle. transmission. examples of viral diseases.

UNIT: II

A Friend and Foe: bacterial cell structure, bacteria as friend and a foe, transmission of bacteria.

The Mouldy World: fungi, general structure, reproduction, human diseases caused by fungi.

Do Microbes Possess Consciousness: basic idea of consciousness, examples of consciousness beyond "brain consciousness" paradigm,

Nature's Clocks: basic idea of chronobiology, internal clocks of humans (basic idea), importance of internal clocks.

The Plant Kingdom: life cycle of a flowering plant, importance of plants for sustenance of life on earth, plants and medicine.

The End Game: concept of cell death (apoptosis), importance of apoptosis. Basic idea of Ageing.

Name of the course/Code: BOT-21005OE: BIOPESTICIDES AND INTEGRATED PEST MANAGEMENT

Learning objectives: To acquaint the students with the knowledge of biology of different microbes and their role in the development and formulations of biopesticides and biofertilizers and to aware them about the practical application of IPM in the management of plant disease for sustainable agriculture

Learning outcome : the students will understand basic concepts about pesticides, limitation of using pesticides and will get knowledge about significance of biopesticides, IPM and their application for management of microbial pathogens causing plant diseases

Unit: I

Pesticides: definition, and types of pesticides, limitations of using pesticides

Biopesticides: definition, types, advantages and limitations

Bio-fungicides; fungal or myco-fungicides, preventive and safety measures required in using bio-pesticides. bacterial fungicides, and fungal nematicides with emphasis on their role and application,

Bio-insecticides: bacterial insecticides, fungal and viral insecticides

Bioherbicides: a brief concept, current status and prospects, examples of bio-herbicides

Unit: II

Integrated pest management (IPM): definition, concept, applications, principles, process, new challenges and future prospects; IPM for sustainable agriculture

Components of IPM : physical methods, regulatory control, mechanical control, cultural control, breeding of plant resistance, pesticide resistance, chemical control; biological control: definition, use o f fungi, bacteria, insects, parasitoids, nematodes and antagonistic plants as bio-control agents; integrated pest management of rice in India **Integrated management** of fungal diseases of crop plants.

Integrated pest management in fruits (Apple) and vegetable crops

Integrated nematode management: definition and concept