P. G. DEPARTMENT OF BOTANY, UNIVERSITY OF KASHMIR, SRINAGAR

CHOICE BASED CREDIT BASED COURSE STRUCTURE TO BE IMPLEMENTED FROM ACADEMIC SESSION 2015-16

The revised syllabi and courses of study for Post-graduate programme in Botany is to be adopted for all the semesters from the Academic session 2015 onwards.

Course Structure: There will be 12 core courses (theory and lab. Combined together) in all with each semester covering 3 core courses referred as **Bot- CR**. Each core course will be worth 4credits with theory covering 3 credits and practical component 1 credit. There will be Discipline Centric Elective (DCE) courses (mainly for Department's own students) worth 5credits referred to as **Bot-DCE**. Students can opt for atleast one to earn five credits. Further, in addition to **CR** and **DCE** courses there will be Generic Elective courses referred to as **Bot-GE** which will be open to students from other sister subjects (From Biological Faculty for Botany) and Open Elective courses referred to as **Bot-OE** which will be open to students from other faculties (other than biological faculty) so that they seek knowledge from unrelated subject which will nurture student's proficiency and /skill. The total course of M. Sc. Botany comprises of **96credits out of which 48 are core while other credit combination floated by the Board of PG Studies is as under**.

Credits	Core/Sem.	DCE/Sem.	GE/Sem.	OE/Sem.
Per semester	12	6	3	3

Each **CR** course will be worth of **100 marks** and **4credits** each. **75 marks (3credits)** for theory component and **25 marks (1credit)** in each course are for practical component. Theory component will comprise of **internal assessment of 15marks** and **external examination of 60marks**. Each **DCE** course will be worth **150 marks** and **6credits** each. **125 marks (5credits)** will be for theory component and **25 marks (1credit)** in each course for practical component. Theory component will comprise of Internal Assessment of **25 marks** and external examination of **100 marks**. Internal assessment of theory papers will be based on quiz tests, assignments, seminars, etc. The practical component will be evaluated based on the conduct of practical's by a student and their evaluation by the concerned teacher(s) on a day-to-day basis as well as conduct of common practical examination at the end of each semester to finalize awards for the same. The students will

be required to submit their lab. work records at the end of each semester examination for evaluation by the teacher(s) concerned.

Each **GE** and **OE** course will be worth **75 marks (3credits).** Out of these 60 marks for theory and 15 internal assessment except for Biostatistics where it will be 40 for theory and 35 for practical.

Bot-DCE, Bot-GE, and Bot-OE will be floated as cluster courses wherein the selection will be based on the choice of the teacher concerned in terms of feasibility/availability as well as number of vacancies available based on the choice of the concerned teacher. However, on the basis of the recommendations of Departmental committee maximum number of seats under these courses should not exceed **20** in any such course.

Project work: Project work **(Bot-Proj.)** worth **6credits** is compulsory for the students and will be allotted in 4th semester based on choice of the student and space availability in relation to his/her choice. The project has to be submitted prior to the conduct of 4th semester examination so that it can be evaluated and open viva voce be conducted prior to declaration of the results. The students for project work will be evenly distributed among faculty members of the Department.

Botanical Trips: To make on-field observations and impart on-site training in the subject botany, the Department will ensure that a minimum of one field trip is organized during each semester to acquaint the students with the flora of the region and also to collect, properly preserve, and prepare at least 50 plant specimens following standard herbarium techniques. The students will, however, avoid collection of rare and threatened plant species. The herbarium will have to be submitted at the end of the semester wherein Taxonomy is a core course.

In the Table below the terms refer to:

L – Lecture
T – Tutorial;
P – Practical Work;
CR – Core Course;
DCE - Discipline Centric Elective
GE - General Elective
OE - Open Elective

CORE COURSES (Bot-CR) SEMESTER WISE

Course Code	Course Name	Hours			Credits	MARKS: Max. (Min)		
						Theory		Practical/ Tutorial
		L	T	P		Ex.	Int.	Int.
SEMESTER 1ST								
Bot-CR 15101	Plant Taxonomy	3	0	2	**3+1**	**60(24)**	**15(6)**	**25(10)**
Bot-CR 15102	Microbiology, Fungi and Plant Pathology	3	0	2	**3+1**	**60(24)**	**15(6)**	**25(10)**
Bot-CR 15103	Algae and Bryophyta	3	0	2	**3+1**	**60(24)**	**15(6)**	**25(10)**
SEMESTER 2nd								
Bot- CR 15201	Pteridophyta and Gymnosperms	3	0	2	**3+1=4**	**60(24)**	**15(6)**	**25(10)**
Bot-CR 15202	Ecology	3	0	2	**3+1=4**	**60(24)**	**15(6)**	**25(10)**
Bot-CR 15203	Cell and Molecular Biology	3	0	2	**3+1=4**	**60(24)**	**15(6)**	**25(10)**
SEMESTER 3rd								
Bot-CR 15301	Reproductive and Developmental Biology of Angiosperms	3	0	2	**3+1=4**	**60(24)**	**15(6)**	**25(10)**
Bot-CR 15302	Cytogenetics and Genetics	3	0	2	**3+1=4**	**60(24)**	**15(6)**	**25(10)**
Bot-CR 15303	Plant Metabolism	3	0	2	**3+1=4**	**60(24)**	**15(6)**	**25(10)**
SEMESTER 4th								
Bot-CR 15401	Plant Physiology	3	0	2	**3+1=4**	**60(24)**	**15(6)**	**25(10)**
Bot-CR 15402	Plant Tissue Culture and Genetic Engineering	3	0	2	**3+1=4**	**60(24)**	**15(6)**	**25(10)**
Bot-CR 15403	Plant Resource Utilization	3	0	2	**3+1=4**	**60(24)**	**15(6)**	**25(10)**

Project work

Bot-Proj.	**Project Work**	**12**	**6**	**150(60)**

Discipline Centric Elective (Bot-DCE) Courses

Bot-DCE 001	Applied Crop Physiology	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 002	Applied Ecology	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 003	Applied Phycology	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 004	Applied Plant Pathology	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 005	Biodiversity and Conservation Biology	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 006	Crop Genetics and Molecular Breeding	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 007	Invasion Biology	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 008	Medicinal Plants and Herbal Resource Management	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 009	Molecular and Microbial Ecology	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 010	Molecular Genetics	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 011	Mushroom Cultivation Technology	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 012	Plant Systematics and Phylogenetics	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 013	Postharvest Technology of cut flowers	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**
Bot-DCE 014	Stress Biology	3	2	2	**3+2+1= 6**	**100(40)**	**25(10)**	**25(10)**

Generic Elective (Bot-GE) Courses

Bot-GE 01	Aquatic Ecosystem Management	2	1	0	**2+1= 3**	**60(24)**	**15(6)**
Bot-GE 02	Biological Systematics and Biodiversity	2	1	0	**2+1=3**	**60(24)**	**15(6)**
Bot-GE 03	Biostatistics	2	0	1	**2+1=3**	**40(16)**	**35(14)**

Bot-GE 04	Biotechniques	2	1	0	**2+1=3**	**60(24)**	**15(6)**
Bot-GE 05	Commercial Plant Propagation	2	1	0	**2+1=3**	**60(24)**	**15(6)**
Bot-GE 06	Principles of Genetics	2	1	0	**2+1=3**	**60(24)**	**15(6)**
Bot-GE 07	Seed Technology	2	1	0	**2+1=3**	**60(24)**	**15(6)**
Bot-GE 08	Urban Ecology	2	1	0	**2+1= 3**	**60(24)**	**15(6)**

Open Elective (Bot-OE) Courses

Bot-OE 01	Agricultural Botany	2	1	0	**2+1=3**	**60(24)**	**15(6)**
Bot-OE 02	Bioenergy	2	1	0	**2+1=3**	**60(24)**	**15(6)**
Bot-OE 03	Biogeography	2	1	0	**2+1= 3**	**60(24)**	**15(6)**
Bot-OE 04	Biopesticides and integrated Pest Management	2	1	0	**2+1=3**	**60(24)**	**15(6)**
Bot-OE 05	Commercial Floriculture	2	1	0	**2+1=3**	**60(24)**	**15(6)**
Bot-OE 06	Fruits of Kashmir	2	1	0	**2+1=3**	**60(24)**	**15(6)**
Bot-OE 07	Weed Management	2	1	0	**2+1=3**	**60(24)**	**15(6)**

CORE COURSES (Bot-CR) EACH WORTH 4 CREDITS

SEMESTER 1ST

Bot-CR 15101: PLANT TAXONOMY

Unit: I

Introduction to taxonomy: taxonomy, systematics, classification; role of taxonomy in biodiversity science; taxonomic impediment and global taxonomic initiative

Approaches to plant classification: artificial, natural and evolutionary approaches (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, phyto-chemistry, molecular biology)

Taxonomic categories and hierarchy: taxonomic categories (supra-specific, species & infra-specific); taxonomic hierarchy (structure & properties)

Unit: III

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

Plant identification: methods of identification; dichotomous keys (kinds and construction); polyclaves (a brief account); cybertaxonomy (concept and scope), e-floras and e-herbaria

Unit: IV

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

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

Laboratory Exercises:

- 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.

Bot-CR 15102: MICROBIOLOGY, FUNGI AND PLANT PATHOLOGY

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 plant 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: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina; 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 leaf 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

Laboratory Exercises:

- 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, Clletotrichum 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.

Bot-CR 15103: ALGAE AND BRYOPHYTA

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 Polytrichales,

Bryophytes in bioindication: direct and indirect biomonitoring**.**

Laboratory Exercises:

- 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*.

SEMESTER 2nd

Bot-CR 15201: PTERIDOPHYTA AND GYMNOSPERMS

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

Laboratory Exercises:

- Study of morphological, anantomical and reproductive structures of the representative Pteridophytes viz: *Azolla*, *Lycopodium, Psilotum, Ophioglossum*, *Selaginella*, *Dryopteris, Equistem, Marsilea* and *Pteris*.
- Study 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*.

Bot-CR 15202: ECOLOGY

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)

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

Laboratory Exercises:

- 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

Bot-CR 15203: CELL AND MOLECULAR BIOLOGY

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 (role of promoters, activators, repressors and DNA methylation).

Laboratory Exercises:

- 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

Bot-CR 15301: REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY OF ANGIOSPERMS

Unit: I

Flower 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 development, 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.

Laboratory Exercises:

- 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.
- Study 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

Bot-CR 15302: CYTOGENETICS AND GENETICS

Unit: I

Chromosomes: chromosome structure and chromatin organization,

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

Molecular organization of centromere and telomere; euchromatin and heterochromatin,

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

Concept of split genes, overlapping genes and pseudo genes.

Unit: II

Karyotype – concept, essential features and evolution of karyotype;

B chromosomes – origin, characteristics and distribution of B- chromosomes

Structural changes: types of structural changes in chromosomes-deletion, duplication, inversion and translocation, origin and meiotic behaviour of structural heterozygotes

Robertsonian translocation, B-A translocation.

Unit: III

Euploidy: origin, meiosis and breeding behaviour of haploidy, autopolyploids and allopolyploids.

Chromosome and chromatid segregation in autopolyploids

Role of polyploidy in crop improvement and evolution of crop plants.

Aneuploidy: types of aneuploids, origin, 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, concept of pleiotrophy, back mutations and suppressor mutations

Alien addition and substitution line: concept, development and utility

Population genetics: Hardy-Weinberg equilibrium and factors affecting allelic frequencies

Flow cytometry (concept and utility).

Laboratory Exercises:

- Study of mitotic index from suitable plant material.
- 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.
- Working out the effect of mono- and tri-somy on plant phenotype, fertility and meiotic behavior.
- Induction of polyploidy using colchicine in different ways.
- Study of PMC-meiosis in different materials.
- Karyotype analysis and preparation of kario-idiogram.

Bot-CR 15303: PLANT METABOLISM

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; photorespiration and its energetics.

Laboratory Exercises:

- 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 by partitioning 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.

SEMESTER 4th

Bot-CR 15401: PLANT PHYSIOLOGY

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.

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Laboratory Exercises:

- 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.

Bot-CR 15402: PLANT TISSUE CULTURE AND GENETIC ENGINEERING

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).

Laboratory Exercises:

- Washing and sterilization of glassware.
- Techniques for establishment of callus cultures and study of different types of calli viz. Compact, 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

Bot-CR 15403: PLANT RESOURCE UTILIZATION

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.

Laboratory Exercises:

- 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.

Bot-Proj.: PROJECT WORK WORTH 8 CREDITS

Project work worth 8credits is compulsory for the students and will be assigned in 3rd semester as component of 4th 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) COURSES EACH WORTH 6 CREDITS

Bot-DCE 001: APPLIED CROP PHYSIOLOGY

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; availability of ions in soil, absorption and assimilation of mineral nutrients (N, P and K) by crops; 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 (nomenclature, 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:
  a.) 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:
  i.) Dry matter partitioning into roots, leaves and branches.
  ii.) 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:
  i.) auxins ii.) gibberellins iii.) cytokinins

Bot-DCE 002: APPLIED ECOLOGY

Unit: I

Environmental monitoring microbes and organic pollution; microorganisms 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, factors 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)

Laboratory Exercises:

- To determine the soil texture, aggregate stability, porosity and bulk density of various soil samples collected from different sites
- To determine the moisture content and water holding capacity of soil samples collected from different locations
- To find out the percentage organic carbon and organic matter content in soils of cropland, grassland and forests
- To determine the carbon stock in different plant systems.
- To estimate the dissolved oxygen content in different water samples
- To use the BOD test for assessment of the level of organic pollution in water samples

Bot-DCE 003: APPLIED PHYCOLOGY

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

Bot- DCE 004: APPLIED PLANT PATHOLOGY

Unit: I

Pathogenecity and nature of disease: pathogens and pathogenesis. Kochs 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 factors 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
- Inoculation of media 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 discs
- 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

Bot-DCE 005: BIODIVERSITY AND CONSERVATION BIOLOGY

Unit: I

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

Unit: II

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

Unit: III

Biodiversity conservation: *in situ* conservation strategies (concept of protected areas network); IUCN's scheme of PA 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); global conservation efforts (organizations & conventions); Indian conservation efforts (legislations and policies)

Unit: IV

Measurement and resources of biodiversity: sampling unit – shape, size and number, issue of scale; phylogenetic and functional diversity (concept and applications); biodiversity surrogates (types and use); role of remote sensing and GIS in biodiversity assessment and monitoring; biodiversity informatics (concept and applications); global informatics initiatives - Global Biodiversity Information Facility (GBIF), Encyclopedia of Life (EoL); Biodiversity Heritage Library (BHL).

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 of Kashmir 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.

Bot-DCE 006: CROP GENETICS AND MOLECULAR BREEDING

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, pureline 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.

Bot- DCE 007: INVASION BIOLOGY

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), biological invasions (indicators and policy)

Laboratory Exercises:

- Determine the stage of invasion of a 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
- Study the abundance of common pests of an invasive plant species

Bot- DCE 008: MEDICINAL PLANTS AND HERBAL RESOURCE MANAGEMENT

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 and Middle eastern
- 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

Role of 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

Laboratory Exercises:

- 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

Bot-DCE 009: MOLECULAR AND MICROBIAL ECOLOGY

Unit: I

Molecular ecology: introduction to molecular ecology - scope and limitations; molecular identification – importance and approaches, types of molecular markers in ecology; DNA barcoding - concept, criteria and applications.

Population genetics - genetic diversity in natural populations, population structure and effective population size, genetics of metapopulations, population bottlenecks.

Unit: II

Conservation genetics - loss of genetic diversity as a conservation concern, genetic load, conservation units, genetic restoration; molecular genetics in conservation biology, molecular markers in conservation genetics.

Phylogeography - concept and scope; genetic variation in space and time - vicariance, dispersal; Molecular markers in phylogeography- microsatellite markers and mtDNA; applications of phylogeography - determining species natural range and tracing source populations of introduced species.

Unit: III

Microbial ecology: ubiquity of microorganisms, microbial habitats – soil, air and water as microbial habitats, microbial life in extreme environments; indicator microorganisms (concept, standards and examples)

Microbial diversity: amazing diversity of microbes, methods of assessment of microbial diversity - culture-dependent and culture-independent approaches. microbes and global environmental change:

Unit: IV

Microbial mediated remediation: microorganisms and organic pollution – organic pollutants (sources and types), process of biodegradation (contaminant structure, toxicity and biodegradability). microorganisms and metal pollution – definition and sources of heavy metals, metal solubility and bioavailability, metal toxicity, Microbial metal resistance, detoxification and remediation.

Microorganisms and waste management: wastewater microbiology – composition of wastewater, modern wastewater treatment (primary, secondary, tertiary treatment), commercial blends of microbes and enzymes in wastewater treatment; Solid waste management.

Laboratory Exercises:

- Sterilization of glassware, growth medium and other materials
- Preparation of various culture media
- Techniques of inoculation and characterization of colony morphologies
- Measurement of microbial growth rate
- Assessment of symbiotic associations with plant (Mycorrhiza and Rhizobia)
- Extraction of genomic DNA from mycorrhizas, plants and soil
- Amplification of DNA by PCR
- Quantification of DNA content
- Use of molecular markers such as RFLP, RAPD
- Analysis of the RFLP pattern for identification of OTUs
- Inference of phylogenetic relatedness, phylogenetic distance and evolutionary histories from molecular data

- Calculation of allele frequencies from phenotypic data
- Estimation of Hardy-Wienberg equilibrium
- Determining the effective population size

Bot-DCE 010: MOLECULAR GENETICS

Unit: I

Recombination in bacteria, genetic transformation, conjugation and transduction and their role in mapping of bacterial genes

Plasmids – general properties and regulation of replication (control of copy number)

Unit: II

Genetics of phages – molecular basis of lytic and lysogenic life cycle; genetic recombination in phage; deletion mapping

Concept of gene and allele, Cis-Trans/complementation test, genetic fine structure (r-II locus)

Unit: III

Mutations: types of mutations; molecular basis of gene mutation; site directed mutagenesis

Transposable elements in prokaryotes and eukaryotes, transposon induced mutations. Concept of proto-oncogenes and oncogenes

Unit: IV

DNA recombination mechanisms, molecular mechanism of recombination; Multigene families and their evolution

Chromosome mapping in eukaryotes: genetic and physical mapping of genes/chromosomes, restriction mapping- concept and applicability.

Laboratory Exercises:

- Aseptic culture techniques for establishment and maintenance of cultures
- Isolation of plant DNA and its quantification by spectrophotometric method.
- DNA check run by Agarose Electrophoresis
- Preparation of different growth media for bacteria.
- Estimation of growth rate in different bacteria and preparation of growth curve.
- Isolation of different bacterial colonies by streaking method.
- Preparation of bacterial colonies by plating method.

- Preparation of competent cells of *E. coli*.
- Small scale plasmid preparation from *E. coli.*
- Restriction digestion of insert plasmid.

Bot-DCE 011: MUSHROOM CULTIVATION TECHNOLOGY

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

Bot-DCE 012: PLANT SYSTEMATICS AND PHYLOGENETICS

Unit: I

Plant systematics: systematics, biosystematics, phylogeny; contributions of systematics to biology; relevance of systematics to human society

Major species concepts (an overview); isolating mechanisms (pre-mating and post-mating); process of speciation (allopatric, parapatric and sympatric)

Unit: II

Systematics as a synthetic field: population biology (sources and kinds of variation); ecotypes (origin, types and taxonomic treatment); plant breeding systems (types and their taxonomic significance); pollination biology (modes of pollination, co-evolution between plants and pollinators).

Molecular systematics - sources of DNA-based characters (mitochondrial, chloroplast and nuclear genomes); use of various molecular markers in plant systematics citing relevant examples; DNA barcoding (concept, applications and limitations)

Unit: III

Phylogenetics: concept and terminology used; history of phylogenetics**;** methodology of phylogenetics (Parsimony, Maximum likelihood, Bayesian analysis); applications of phylogenetics; diversity and phylogeny of land plants (bryophytes, pteridophytes, gymnosperms and angiosperms); angiosperm phylogeny; group classification (an overview); biocode and phylocode (an elementary idea); phylogeography (concept and scope)

Unit: IV

Plant diversity: plant diversity in India - present status and conservation concerns; biogeographical classification of India; forest types of India; plant diversity in Kashmir Himalaya - present status and utilization, current threats and conservation needs

Laboratory Exercises:

- Herbarium (each student has to prepare a herbarium comprising of at least 50 plant specimens from their area of residence).
- To study pollination mechanisms in some suitable plants.
- Demonstration on various internet resources on plant systematic, phylogenetics and diversity.
- To describe the plant species by using a comprehensive morphological character list.
- To draw the illustration of various plant parts, such as whole plant, leaves, whole flower, flower parts etc.
- To determine the synonymy of plant taxa by using taxonomic literature.
- To study inter-population, inter-specific, inter-generic character variation.
- To study the floral morphology of suitable plant species showing different sex types.
- To study cleistogamy and heterostyly in some suitable plants.
- To construct phylogenetic trees of sample taxa using the freeware softwares.

Bot- DCE 013: POSTHARVEST TECHNOLOGY OF CUT FLOWERS

Unit: I

Flower senescence: types of senescence; relation between aging and senescence; senescence in flowers; programmed cell death in relation to petal senescence in ornamental plants; ephemeral flowers as model systems for studying senescence;

ethylene sensitive and insensitive flower senescence; ethylene and polyamines as modulators of flower senescence.

Unit: II

Pre and postharvest approaches in cut flower industry: cut flower trade (international and national scenario); factors affecting pre and postharvest quality of cut flowers; stage, time and mode of harvest of cut flowers; role of temperature, light, humidity and moisture on postharvest performance of cut flowers.

Unit: III

Postharvest storage of cut flowers: dry and wet storage of cut flowers; controlled atmospheric storage (CAS); modified atmospheric storage (MAS); low pressure storage (LPS); rehydration and pulsing during storage; role of cold chain in maintaining postharvest quality.

Unit: IV

Packaging, transportation and marketing of cut flowers: packaging for efficient transportation; simulation of transportation protocols; consumer preferences; marketing practices. Techniques for improving longevity/vase life of cut flowers -pretreatments (conditioning or hardening, pulsing and bud opening treatments); vase treatments

Laboratory Exercises:

- To study the visible effects and pattern of flower senescence at various stages under field and laboratory conditions
- To study the changes in membrane permeability of petal discs at various stages of flower development and senescence
- To study the changes in soluble protein content and protease activity at various stages of flower development and senescence
- To study the changes in carbohydrate fractions at various stages of flower development and senescence
- To study the effect of ethylene antagonists/growth regulators in the improvement of vase life in some important cut flowers
- To study the implication of postharvest storage in the improvement of vase life in some important cut flowers

Bot- DCE 014: STRESS BIOLOGY

Unit: I

Stress: abiotic and biotic stress – overview

Osmotic adjustments: role of Glycine betaine, mannitol, proline, polyamies

Changes in carbohydrate metabolism, Reactive Oxygen Species (ROS)

Unit: II

Role of transcription factors; DREB, dehydration-responsive element (DRE) binding protein; COR/CBF regulon; Role Late Embryogenesis proteins (LEA), heat shock proteins, Dehydrins, antifreeze proteins, etc.

Unit: III

Signal transduction in response to stress: role of calcium and G-proteins; Role of phytohormones in plant stress; ethylene response pathway; the abscisic and regulatory network; Biotic stress signalling (calcium mediated pathogen defence programme)

Unit: IV

Bioengineering plants for stress tolerance: genetic engineering approaches for insect resistance (Bt approach); gene silencing; RNAi – role in biotic stress management; concerns about GM crops; regulation of GM crops.

Laboratory Exercises:

- Changes in biochemical parameters in response to biotic/abiotic stress
- Estimation of changes in amino acids response to stress
- Changes in superoxide dismutase in response to stress
- Changes in catalase in response to biotic/abiotic stress
- Changes in ascorbate peroxidase in response to stress
- Changes in glutathione reductase in response to stress
- Changes in protein in response to biotic stress by SDS- PAGE
- Changes in protein levels in response to cold stress by SDS-PAGE

GENERIC ELECTIVE (Bot-GE) COURSES EACH WORTH 3 CREDITS

Bot-GE 01: AQUATIC ECOSYSTEM MANAGEMENT

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; ecosystem approach to management; monitoring, prediction and management of invasive aquatic plants.

Tutorials

Bot- GE 02: BIOLOGICAL SYSTEMATICS AND BIODIVERSITY

Unit: I

Biological systematics: a historical account; relevance of biological systematics to human society; concept of species; taxonomic hierarchy; biological nomenclature (principals & practice); methods of systematics (classical and modern); molecular tools in scientific identification, classification and phylogeny; modern classification schemes of major taxonomic groups and their evolutionary relationships; importance of botanic gardens, herbaria, museums, zoos, aquaria

Unit: II

Biodiversity: emergence of biodiversity concept (a historical overview), magnitude of biodiversity (global, India, J & K); current status of biodiversity (IUCN Red List), documentation & monitoring (field sampling methods, diversity measures & indices); uses of biodiversity (direct & indirect); terrestrial biomes & biodiversity hotspots; biogeographical zones of India; major drivers of biodiversity loss (habitat loss, alien invasion, overexploitation, climate change); principals of conservation, major approaches to conservation (*in situ* & *ex-situ*); National Parks, Wildlife Sanctuaries and Biosphere Reserves in India; non-formal conservation efforts; natural capital and green economy

Tutorials

Bot-GE 03: BIOSTATISTICS

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.

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

Unit: II

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.

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

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.

Practicals

Bot-GE 04: BIOTECHNIQUES

Unit: I

Microscopic techniques: visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy.

Biophysical Methods: molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, molecular structure determination using X-ray diffraction and NMR, molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

Unit: II

Radiolabeling techniques: detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

Chromatographic techniques: principles and applications of paper, thin layer, column and chiral chromatography, HPLC, ion exchange, affinity, gas liquid chromatographic techniques, gel electrophorasis and ultracentrifugation.

Tutorials

Bot-GE 05: COMMERCIAL PLANT PROPAGATION

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.

Tutorials

Bot-GE 06: PRINCIPLES OF GENETICS

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.

Tutorials

Bot- GE 07: SEED TECHNOLOGY

Unit: I

Introduction : seed as basic input in agriculture; seed development in cultivated plants; seed quality concept and importance of genetic purity in seed production; types of cultivars, their maintenance and factors responsible for deterioration; seed production in self and cross pollinated crops.

Seed multiplication ratios: seed replacement rate, demand and supply; suitable areas of seed production and storage

Growth hormones and enzyme activities: effect of age, size and position of seed on germination.

Unit: II

Hybrid seed - methods of development of hybrids; use of male sterility and self-incompatibility and CHA in hybrid seed production; one, two and three line system; maintenance of parental lines of hybrids; planning and management of hybrid seed production technology of major field crops and vegetables.

Seed vigour and its concept: vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield.

Seed invigoration: physiological and molecular control.

Tutorials

Bot-GE 08: URBAN ECOLOGY

Unit: I

Terrestrial urban ecosystems: Urban green spaces meaning and types, composition and diversity of vegetation in urban green spaces (Patterns and controlling processes) land use and surface cover as urban ecological indicators, urban soils characterization and biodiversity in small designed landscapes.

Aquatic and wetland urban ecosystems: Hydrology of urban environments, plant communities of urban wetlands and water bodies (Patterns and controlling processes)

Ecological processes and social drivers: Human impact, spatial and meta-community processes on biodiversity and community composition. Urban climate, urban impacts on global and regional sustainability.

Unit: II

Types of ecosystem services: Types of ecosystem services provided by urban ecosystems, global effects of urbanization on ecosystem services, role of ecosystem services in contemporary urban planning.

Urbanization and citizen science: public perception, social-ecological perspective on urban biodiversity.

Approaches towards a sustainable city: Multifunctional green infrastructure planning to promote ecological services in the city, building urban biodiversity through financial incentives, regulation and targets, conservation in an urbanising world.

Tutorials

OPEN ELECTIVE (Bot-OE) COURSES EACH WORTH 3 CREDITS

Bot-OE 01: AGRICULTURAL BOTANY

Unit: I

Basic concept in agricultural botany; relevance of botany to agriculture, importance of use of climate dependent varieties, soil practices, manuring and irrigation

Plant protection, harvesting and processing of different crops under different agroclimatic conditions including cereals, legumes, pulses, vegetables

Importance and scope of vegetable production in India; classification of vegetables. types of vegetable gardens

Unit: II

Fertilizers - definition, classification, characteristics, reactions of fertilizer in soil, Important fertilizer elements- nitrogen, phosphorus, potassium, sulphur, zinc, Elementary idea of biofertilizers and vermin compost.

Integrated Nutrient Management (INM): concept, elementary idea of INM models, INM and soil health.

Practical knowledge- operations from sowing to harvesting of some kharif crops. **Judging of maturity and estimation of yields**- study of crop production techniques at different farms

Tutorials

Bot-OE 02: BIOENERGY

Unit: I

Sources of energy - renewable energy, non-renewable energy; short supply of fossil fuels; global energy outlook

Biofuels: introduction, history, classification of biofuels (solid, liquid and gaseous) environment impact of biofuels

Bio-renewable liquid fuels; bio-alcohol; bioethanol and biodiesel (history; production, advantages and disadvantages) current biodiesel technologies; microalgae as a vital source of biodiesel.

Unit: II

Gaseous biofuels: introduction, biogas production; aerobic and anaerobic conversion process; biogas processing technologies for anaerobic digestion; landfill gas; crude gases from pyrolysis and gasification of biomass.

Biofuel economy; estimation of biofuel prices; biodiesel economy; bioethanol economy;

Biofuel policy–introduction to biofuel policy; biodiesel policy; environment, protection **agency**; MOEF registration; biofuel and biodiesel in India; global biofuel projections; market penetration of biofuels; bioenergy markets

Tutorials

Bot-OE 03: BIOGEOGRAPHY

Unit: I

Fundamentals of biogeography: historical perspective of biogeography; principles and rules of biogeography; components of geographic template (climate, soil, aquatic environment)

Geological processes: theory of continental drift; plate tectonics; glaciation and biogeographic responses.

Ecological and evolutionary processes: habitat and ecological niche; plant-animal associations; speciation, diversification and extinction; dispersal (mechanisms, routes and barriers).

Biogeographic patterns: cosmopolitanism and endemism; disjunctions and relicts; range size and shape; terrestrial biomes; phytogeographic and zoogeographic realms; species-area relationship; theory of island biogeography; gradients in biodiversity (latitudinal, elevational and depth).

UNIT: II

Applied biogeography: biodiversity- definition, components and levels; magnitude of global biodiversity; Linnaean and Wallacean shortfalls; values of biodiversity; threats to biodiversity; impacts of climate change on biodiversity; conservation strategies (National Parks, Wildlife Sanctuaries, Biosphere Reserves); biodiversity hotspots (criteria and global distribution); biogeographic classification of India; phylogeography (an elementary idea); biogeographic surveys and monitoring.

Tutorials

Bot-OE 04: BIOPESTICIDES AND INTEGRATED PEST MANAGEMENT

Unit: I

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

Biopestidides: 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 of 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

Tutorials

Bot-OE 05: COMMERCIAL FLORICULTURE

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).

Tutorials

Bot-OE 06: FRUITS OF KASHMIR

Unit: 1

Introduction: scope and importance of horticulture with special reference to fruits of Kashmir

Area production and productivity of major fruits of Kashmir

Methods of propagation – concept of rootstock and scion, techniques of grafting, layering and budding for propagation of fruit crops

Concept of germplasm and genetic variability; germplasm conservation and its utility with special reference to apple.

Concept of organic fruit – prospects and limitations

Concept of germplasm and genetic variability: germplasm conservation and its utility with special reference to apple

Role of climatic factors in horticultural crop production

Unit: II

Introduction, cultivation and economic importance of – apple, apricot, almond, cherry, and walnut

Major diseases and disease symptoms in – apple, cherry and apricot
Concept of organic fruit- prospects and limitations
Concept of high density planting- merits and demerits
Processing and value addition in- apple, almond and walnut.

Tutorials

Bot-OE 07: WEED MANAGEMENT

Unit: I

Weed: 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

Tutorials