

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

### **CHOICE BASED CREDIT BASED COURSE STRUCTURE TO BE IMPLEMENTED FROM ACADEMIC SESSION 2018 AND ONWARDS**

The revised syllabi for PG programme in Botany as per the Modified Choice Based Credit System (CBCS) Scheme adopted by the University for Implementation at Post-Graduate level from academic session 2018 and onwards is as under:

**Core Courses (CR):** There are 4 Core Courses per semester, i.e. 16 courses for 4 semesters. The first three core courses in each semester are theory courses comprises of 4 credits each, while the fourth core course in each semester is the practical course based on the practicals of 3 theory courses of the respective semesters with 2 credits each. A student has to take 4 Core courses per semester to obtain 14 credits per semester.

**Discipline Centric Electives Courses (DCE):** Each Discipline Centric Electives course shall have 4 credits. A student has to obtain 8 credits per semester from DCE courses.

**The Core Courses (CR) and Discipline Centric Electives Courses (DCE) are exclusively meant for the Department's own students.**

**Generic Elective Courses (GE):** General Elective Courses shall have two credits. The GE Courses are meant for the students of the sister departments under the school of Biological Sciences.

**Open Elective Courses (OE):** OE courses shall have 2 credits. OE courses are meant for students of all the other departments, except those falling under School of Biological Sciences.

A student shall have to earn 08 credits in the entire programme from the Generic elective /Open elective courses

The course structure and credit breakup has been given in tabulated form as follows. One credit means one hour of teaching/tutorial or two hours of practical work/field work per week, for 16 weeks in a semester equivalent to 90 actual teaching days.

#### **Abbreviations:**

<b>L</b>	<b>-LECTURE</b>
<b>T</b>	<b>-TUTORIAL</b>
<b>P</b>	<b>-PRACTICAL WORK</b>
<b>CR</b>	<b>-CORE COURSE</b>
<b>DCE</b>	<b>-DISCIPLINE CENTRIC ELECTIVE</b>
<b>GE</b>	<b>-GENERAL ELECTIVE</b>
<b>OE</b>	<b>-OPEN ELECTIVE</b>

**Examination Scheme:** The examination in 3 Core courses based on theory in each semester shall constitute two components, viz. internal assessment of 20 marks and external examination of 80 marks while the examination in Discipline Centric Electives shall constitute internal assessment of 15 marks, end semester examination of 60 marks and practical examination of 25 marks. The 4<sup>th</sup> core course based on practicals in each semester shall comprise of 50 marks. In case of OE and GE there will be only one examination at the end of semester which shall comprise of 50 marks.

**Project work:** Project work (**Bot-Proj.**) worth **8 credits** is compulsory for the students and will be allotted in 4<sup>th</sup> 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 4<sup>th</sup> 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.

<b>CORE COURSES</b>					
<b>COURSE CODE</b>	<b>COURSE NAME</b>	<b>HOURS</b>			<b>CREDITS</b>
		<b>L</b>	<b>T</b>	<b>P</b>	
<b>SEMESTER 1<sup>ST</sup></b>					
<b>BOT- 18101CR</b>	Plant Taxonomy	4	0	0	4
<b>BOT- 18102CR</b>	Microbiology, Fungi and Plant Pathology	4	0	0	4
<b>BOT- 18103CR</b>	Algae and Bryophyta	4	0	0	4
<b>BOT-18104CR</b>	Practical-1	0	0	6	2
<b>SEMESTER 2<sup>ND</sup></b>					
<b>BOT- 18201CR</b>	Pteridophyta and Gymnosperms	4	0	0	4
<b>BOT- 18202CR</b>	Ecology	4	0	0	4
<b>BOT- 18203CR</b>	Cell and Molecular Biology	4	0	0	4
<b>BOT- 18204CR</b>	Practical-2	0	0	6	2
<b>SEMESTER 3<sup>RD</sup></b>					
<b>BOT- 18301CR</b>	Reproductive and Developmental Biology of Angiosperms	4	0	0	4
<b>BOT- 18302CR</b>	Cytogenetics and Genetics	4	0	0	4
<b>BOT- 18303CR</b>	Plant Metabolism	4	0	0	4
<b>BOT- 18304CR</b>	Practical-3	0	0	6	2
<b>SEMESTER 4<sup>TH</sup></b>					
<b>BOT- 18401CR</b>	Plant Physiology	4	0	0	4
<b>BOT- 18402CR</b>	Plant Tissue Culture and Genetic Engineering	4	0	0	4
<b>BOT- 18403CR</b>	Plant Resource Utilization	4	0	0	4
<b>BOT- 18404CR</b>	Practical-4	0	0	6	2

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<b>Discipline Centric Elective Courses(DCE)</b>					
<b>BOT-18105-DCE</b>	Biostatistics and Biotechniques	3	0	2	3+1 = 4
<b>BOT-18106-DCE</b>	Mushroom Cultivation Technology	3	0	2	3+1 = 4
<b>BOT-18107-DCE</b>	Medicinal Plants and Herbal Resource Management	3	0	2	3+1 = 4
<b>BOT-18205-DCE</b>	Biodiversity and Conservation Biology	3	0	2	3+1 = 4
<b>BOT-18206-DCE</b>	Applied Phycology	3	0	2	3+1 = 4
<b>BOT-18207-DCE</b>	Applied Plant Pathology	3	0	2	3+1 = 4
<b>BOT-18305-DCE</b>	Applied Ecology	3	0	2	3+1 = 4
<b>BOT-18306-DCE</b>	Invasion Biology	3	0	2	3+1 = 4
<b>BOT-18307-DCE</b>	Plant Stress Biology	3	0	2	3+1 = 4
<b>BOT-18308-DCE</b>	Crop Genetics and Molecular Breeding	3	0	2	3+1 = 4
<b>General Electives (GE)</b>					
<b>BOT-18001GE</b>	Principals of Genetics	2	0	0	2
<b>BOT-18002GE</b>	Urban Ecology	2	0	0	2
<b>BOT-18003GE</b>	Basics in Plant Biology	2	0	0	2
<b>BOT-18004GE</b>	Commercial Plant Propagation	2	0	0	2
<b>BOT-18005GE</b>	Weed Management	2	0	0	2
<b>BOT-18006GE</b>	Aquatic Ecosystem Management	2	0	0	2

<b>BOT-18407GE</b>	Techniques in Life Science	2	0	0	2
<b>BOT-18408GE</b>	Biological Systematics and Biodiversity	2	0	0	2
<b>Open Elective Courses</b>					
<b>BOT-18001OE</b>	Biogeography	2	0	0	2
<b>BOT-18002OE</b>	Commercial Floriculture	2	0	0	2
<b>BOT-18003OE</b>	Bioenergy	2	0	0	2
<b>BOT-18004OE</b>	Basics in Life Science	2	0	0	2
<b>BOT-18005OE</b>	Biopesticides and Integrated Pest Management	2	0	0	2

### Examination Scheme

#### 4 Credit Courses based on theory (100 Marks)

- i. Internal Assessment : 20 Marks
- ii. Semester Examination: 80 Marks

#### 2 Credit Courses based on Practicals (50 Marks)

- i. Internal Assessment: 10 Marks,
- ii. Practical examination: 40 Marks

#### 4 Credit courses of DCE (100 Marks)

- i. Internal Assessment- 15 Marks
- ii. Semester Examination: 60 Marks and
- iii. Practical Examination: 25 Marks.

#### 2 Credit Course (GE and OE) - End of Semester Examination: 50 Marks

#### Examination with Max. Marks = 80

Section A: Question carrying two mark each- 08 objectives questions=16 marks

Section B: Question carrying 08 mark each- 4 questions= 32marks

Section C: Question carrying 16 marks each- 04 questions –only two to be attempted=32 marks

#### Examination with Max. Marks = 60

Section A: Question carrying 1.5 marks each- 08 objectives questions=12 marks

Section B: Question carrying 06 mark each- 4 questions= 24marks

Section C: Question carrying 12 marks each- 02 questions –only two to be attempted=24 marks

#### Examination with Max. Marks = 50

Section A: Question carrying one mark each- 16 objectives questions=16 marks

Section B: Question carrying 4 marks each- 04 questions=16 marks

Section C: Question carrying 09 mark each- 04 questions –only 2 to be attempted=18 marks

## SEMESTER 1<sup>ST</sup>

### Bot-18101CR: 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.

## **Bot-18102CR: MICROBIOLOGY, FUNGI AND PLANT PATHOLOGY**

### **Unit: I**

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

**Archaeobacteria:** 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, transmission 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 biotrophic); 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

## Bot-18103CR: 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: II

**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

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

**Bryophytes in bioindication:** direct and biomonitoring

## Bot-18104CR : 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*, *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.

#### **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*.

## **SEMESTER 2<sup>nd</sup>**

### **Bot-18201CR: 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, Salviniiales).

#### **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, Cordiales

#### **Unit: IV**

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



## Bot-18202CR: 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

## Bot-18203CR: 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).

## Bot-18204CR : PRACTICAL-2

### Laboratory Exercises based on BOT-18201CR:

- Study of morphological, anatomical and reproductive structures of the representative Pteridophytes viz: *Azolla*, *Lycopodium*, *Psilotum*, *Ophioglossum*, *Selaginella*, *Dryopteris*, *Equisetum*, *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*.

### Laboratory Exercises based on BOT-18201CR:

- 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-18203CR:**

- 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 3<sup>rd</sup>**

### **BOT-18301CR: 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; secretory structures and laticifers

**Wood development** in relation to environmental factors.

**BOT-18302CR: 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).

## **BOT-18303CR: 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 (C<sub>3</sub> cycle), C<sub>4</sub> Cycle, CAM pathway; characteristics of C<sub>3</sub>, C<sub>4</sub> and CAM plants; photorespiration and its energetics.

## **BOT-18304CR: PRACTICAL-3**

### **Laboratory Exercises based on BOT-18301CR:**

- 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 monocot 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-18302CR:**

- 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 trisomy 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.

#### **Laboratory Exercises based on BOT-18303CR:**

- 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  $K_m$  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 4<sup>th</sup>**

#### **BOT-18401CR: 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.

**BOT-18402CR: 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 degradation 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).

## **BOT-18403CR: 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 buckwheat), fodder (alfalfa), fibre plants (cotton), Spices (saffron), legumes (sources of food), oil yielding plants (mustard 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.

## **BOT-18404CR: PRACTICAL-4**

### **Laboratory Exercises based on BOT-18401CR:**

- 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-18402CR:**

- 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

**Laboratory Exercises based on BOT-18403CR:**

- 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, microscopic 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 8 credits is compulsory for the students and will be assigned in 3<sup>rd</sup> semester as component of 4<sup>th</sup> 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 4<sup>th</sup> semester examination so that it can be evaluated and viva voce be conducted prior to declaration of the results.**

## DISCIPLINE CENTRIC ELECTIVE (Bot-DCE)

### BOT-18105DCE: BIOSTATISTICS AND BIOTECHNIQUES

#### Unit: I

- 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.
- ii. 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

- i. Sampling techniques:** principles and various steps in sample survey; procedures and practices involved in simple, systematic, stratified, cluster and multistage random sampling.
- ii. Biophysical methods:** concepts of spectroscopy, laws of photometry, Beer-Lambert's law, use of various spectroscopic techniques like UV-Visible, NMR, and Mass spectroscopy in biology
- Radio-labeling Techniques:** Properties of different radio-isotopes and their applications in biology, Safety guidelines.

#### Unit: III

- i. 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.
- ii. 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

- i. 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.
- ii. Chromatography:** principles and applications of paper, thin layer, column chromatography, HPLC, ion exchange, affinity and gas liquid chromatographic techniques;
- Electrophoretic and Centrifugation Techniques:** gel electrophoresis; ultra centrifugation

## **BOT-18106DCE: 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-18107DCE: 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
- 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

**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 parameters for commercialization of important MP's of Kashmir
- Preparing a herbarium of atleast 30 important medicinal plants with all details related to habit, habitat, density and diversity and status

**BOT-18205DCE: 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**

**Conservation strategies and policies:** *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 monitoring 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-18206DCE: 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 cyanobacteria under indoor conditions
- Preparation of Biodiesel from vegetable oils

## **BOT-18207DCE: APPLIED PLANT PATHOLOGY**

### **Unit: I**

**Pathogenicity 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 forecasting 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 sandal 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*, *Aspergillus* 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 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 equipment<sup>s</sup>
- Isolation of nematodes by Cobb's sieving and decanting techniques
- Isolation and purification of viruses by density gradient centrifugation

## **BOT-18305DCE : APPLIED ECOLOGY**

### **Unit: I**

- 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
- ii. Environmental pollution:** Kinds and sources of pollutants; impact of SO<sub>2</sub> 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**

- i. Global climate change:** Climate change (causes and consequences); greenhouse gases- sources, trends and role; global warming, CO<sub>2</sub> fertilization; Climate change mitigations- methods and means, costs and benefits, international treaties and strategies
- ii 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**

- i Bioremediation:** bioremediation (principles, factors and strategies); Phytoremediation process of phytoremediation (phytoextraction, phytostabilization, phytotransformation) ; applications of phytoremediation,
- ii 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**

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

## **BOT-18306DCE: 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<sub>2</sub> 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
- Study the abundance of common pests of an invasive plant species

## BOT-18307DCE: PLANT STRESS BIOLOGY

### Unit: I

**Stress:** Abiotic and biotic stress – overview; Osmotic adjustments; role of Glycine betaine, mannitol, proline, polyamines; Changes in carbohydrate metabolism, Reactive oxygen species (ROS)

### Unit: II

**Resistance, Tolerance and Susceptibility** - Acquired and innate immunity in plants; Hypersensitive response; Systemic acquired resistance; Pathogenesis related proteins; Phytoalexins.

**Role of transcription factors;** DREB, dehydration-responsive element (DRE) binding protein; Role Late Embryogenesis proteins (LEA), Heat shock proteins, Dehydrins, antifreeze proteins, etc.

### Unit: III

**Signal transduction,** 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.

#### 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

## **Bot-18308 DCE: 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.

## GENERIC ELECTIVE COURSES

(Each worth 2 credits)

### BOT-18001GE: 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.

### BOT-18002GE: 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.

## **BOT-18003 GE: BASICS IN PLANT BIOLOGY**

### **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.

## **BOT-18004 GE: 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 micropropagation, Factors affecting in vitro stages of micropropagation, 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.

## **BOT-18005 GE: WEED MANAGEMENT**

### **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

## **BOT-18006GE: 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 strategies; ecosystem approach to management; monitoring, prediction and management of invasive aquatic plants.

## **BOT-18007GE: TECHNIQUES IN LIFE SCIENCE**

### **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.

## **BOT- 18008 GE : 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

### **Unit: II**

**Biodiversity**: concept of biodiversity (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); values of biodiversity; terrestrial biomes; biodiversity hotspots; biogeographical zones of India; threats to biodiversity; conservation strategies (*in situ* & *ex-situ*); non-formal conservation efforts

## OPEN ELECTIVE COURSES

(Each worth 2 credits)

### BOT-18001OE: BIOGEOGRAPHY

#### Unit: I

**Fundamentals of biogeography:** historical perspective of biogeography; principles of biogeography; 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).

#### Unit: II

**Biogeographic patterns:** cosmopolitanism and endemism; disjunctions and relicts; range size and shape; species-area relationship; theory of island biogeography.

**Biogeographic classification:** terrestrial biomes; phytogeographic and zoogeographic realms; biogeographic classification of India.

**Biodiversity-** definition, components and levels; magnitude of biodiversity; gradients in biodiversity (latitudinal, elevational); biogeographic surveys and monitoring.

### BOT-18002OE: 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).

### BOT-18003OE: BIOENERGY

#### 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

## BOT-18004OE: BASICS OF LIFE SCIENCE

### 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.

## BOT-18005OE: BIOPESTICIDES AND INTEGRATED PEST MANAGEMENT

### 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 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