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

CHOICE BASED CREDIT BASED COURSE STRUCTURE TO BE IMPLEMENTED FROM ACADEMIC SESSION 2017 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 2017 and onwards is as under:

Core Courses (CR): There are 3 Core Courses per semester i.e 12 courses for 4 semesters. Each course comprises 4 credits. A student has to take 3 Core courses per semester to obtain 12 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 has to obtain 4 credits from GE and OE courses per semester. A student can take 2 or 4 credits from GE and 0 or 2 credits from OE 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:

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

Examination Scheme: The examination in Core and Discipline Centric Electives shall constitute three components viz Assessment-I, Assessment-II and Practical Examination. Assessment-I is based on unit I & II will be held internally at the Departmental level and shall comprise of 25 marks, Assessment II is based on Unit-III & IV and will be an external examination and shall comprise of 50 marks. Practical examination shall comprise of 25 marks and will be held at the end at the Departmental level. 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 **8credits** 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.

CORE COURSES (Bot-CR) SEMESTER WISE

Course Code	Course Name	Hours			Credits
		L	T	P	
SEMESTER 1st					
BOT-17101CR	Plant Taxonomy	3	0	2	3+1 = 4
BOT-17102CR	Microbiology, Fungi and Plant Pathology	3	0	2	3+1 = 4
BOT-17103CR	Algae and Bryophyta	3	0	2	3+1 = 4
SEMESTER 2nd					
BOT-17201CR	Pteridophyta and Gymnosperms	3	0	2	3+1 = 4
BOT-17202CR	Ecology	3	0	2	3+1 = 4
BOT-17203CR	Cell and Molecular Biology	3	0	2	3+1 = 4
SEMESTER 3rd					
BOT-17301CR	Reproductive and Developmental Biology of Angiosperms	3	0	2	3+1 = 4
BOT-17302CR	Cytogenetics and Genetics	3	0	2	3+1 = 4
BOT-17303CR	Plant Metabolism	3	0	2	3+1 = 4
SEMESTER 4th					
BOT-17401CR	Plant Physiology	3	0	2	3+1 = 4
BOT-17402CR	Plant Tissue Culture and Genetic Engineering	3	0	2	3+1 = 4
BOT-17403CR	Plant Resource Utilization	3	0	2	3+1 = 4

Discipline Centric Elective Courses					
BOT-17104DCE	Biostatistics and Biotechniques	3	0	2	3+1 = 4
BOT-17105DCE	Mushroom Cultivation Technology	3	0	2	3+1 = 4
BOT-17106DCE	Medicinal Plants and Herbal Resource Management	3	0	2	3+1 = 4
BOT-17204-DCE	Biodiversity and Conservation Biology	3	0	2	3+1 = 4
BOT-17205-DCE	Applied Phycology	3	0	2	3+1 = 4
BOT-17206-DCE	Applied Plant Pathology	3	0	2	3+1 = 4
BOT-17304-DCE	Applied Ecology	3	0	2	3+1 = 4
BOT-17305-DCE	Invasion Biology	3	0	2	3+1 = 4
BOT-17306-DCE	Plant Stress Biology	3	0	2	3+1 = 4
General Elective Courses					
Bot-17001GE	Principals of Genetics	2	0	0	2
Bot-17002GE	Urban Ecology	2	0	0	2
Bot-17003GE	Basics in Plant Biology	2	0	0	2
Bot-17004GE	Commercial Plant Propagation	2	0	0	2
Bot-17005GE	Weed Management	2	0	0	2
Bot-17006GE	Aquatic Ecosystem Management	2	0	0	2
Bot-15408GE	Techniques in Life Science	2	0	0	2
	Biological Systematics and Biodiversity	2	0	0	2
Open Elective Courses					
Bot-17001OE	Biogeography	2	0	0	2
Bot-17002OE	Commercial Floriculture	2	0	0	2
Bot-17003OE	Bioenergy	2	0	0	2
Bot-15407OE	Basics in Life Science	2	0	0	2

Examination Scheme

4 Credit Courses with Credit breakup 3L+1P

i. Continuous Assessment 25 Marks
ii. End of Semester Examination 50 Marks
iii. Practical 25 marks

4 Credit Courses with Credit breakup 3L+1T

i. Continuous Assessment I 25 Marks
ii. Continuous Assessment II 25 Marks
iii. End of Semester Examination 50 Marks

2 Credit Course (GE and OE)

i. End of Semester Examination 50 Marks

Examination with Max. Marks = 25

Section A:Question carrying one mark each- 08 objectives questions=08 marks
Section B:Question carrying 04 mark each- 02 questions=08 marks
Section C:Question carrying 09 mark each- 02 questions –only one to be attempted=09 marks

Examination with Max. Marks = 50

Section A:Question carrying one mark each- 16 objectives questions=16 marks
Section B:Question carrying one mark each- 04 questions=16 marks
Section C:Question carrying one mark each- 02 questions –only 2 to be attempted=18 marks

CORE COURSES
(Each worth 4 credits)

SEMESTER 1st

Bot-17101CR: PLANT TAXONOMY

Unit: I

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

Unit: II

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: III

Taxonomic characters and sources: characters (kinds and criteria); sources (morphology, cytology, palynology, phyto-chemistry, molecular biology)**;** taxonomic categories (supra-specific, species & infra-specific); taxonomic hierarchy (structure & properties)

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

Unit: IV

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

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; 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, flowers, 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-17102CR: MICROBIOLOGY, FUNGI AND PLANT PATHOLOGY

Unit I

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

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

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

Unit II

i. 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

ii.Structural diversity and mode of reproduction in Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina; Role of fungi with respect o food and medicine; mycorrhizae-types and role

Unit III

i. Viruses: general characteristics. Origin of viruses; chemical nature and ultrastructure.

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

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

Unit IV

i.Plant Pathology- Introduction, definition of terms used in plant pathology; plant diseases: concept, nature and classification of plant diseases

ii. 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, Cauliflower mosaic virus disease; 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-17103 CR: 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).

Unit: II

Origin of Bryophytes- evolution of gametophyte and sporophyte

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

Unit: IlI

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

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 IV

Hornworts: classification, morphology, anatomy and reproduction of Anthocerotales.

Mosses: classification, morphology, anatomy and reproduction of Funariales, Sphagnales and Polytrichales,

Bryophytes in bioindication: direct and indirect biomonitoring**.** Ecological and microbial importance of bryophytes

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-17201CR: PTERIDOPHYTA AND GYMNOSPERMS

Unit: I

Pteridophytes: classification; economic importance
Fossil pteridophytes: structural features and evolutionary significance of Psilophytales Lepidodendrales, Calamitales

Unit: II

Gymnosperms: origin and evolution, classification (Sporne, Christenhuez);
Fossil gymnosperms: structural features and evolutionary significance of Pteridospermales, Cycadeoidales, Cordiatales.

Unit: III

Pteridophytes origin and evolution, telome theory; stelar evolution
Diversity, morphology, anatomy and reproduction in: Psilopsida (Psilotales), Lycopsida (Lycopodiales, Selaginellales, Isoetales),Sphenopsida (Equisetales), Ophioglossales, Eusporangiate ferns (Marattiales), Leptosporangiate ferns (Filicales, Marsileales, Salviniales).

Unit: IV

Gymnosperms: Diversity and distribution in India; gymnosperms of J & K state (an overview) economic importance
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-17202CR: 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-17203CR: 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-17301CR: 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

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

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

Unit: III

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: IV

.**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

Wood development in relation to environmental factors

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

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

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-17302CR: 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-17303CR: 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

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: III

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: 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-17401CR: 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.

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-17402CR: 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

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: III

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: 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-17403CR: 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, 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; 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,

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 COURSES
(Each worth 4 credits)

BOT-17104DCE: 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-17105DCE: 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-17106DCE: 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 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-17204-DCE : 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

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).

Unit: III

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: IV

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)

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-17304-DCE : 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_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

i. **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

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-17305-DCE : 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
Invasions and global environmental change: Effect of change in temperature, atmospheric CO_2 concentration, nitrogen deposition, disturbance regimes, and habitat fragmentation on species invasions

Unit III

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
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

Practical:

- 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-17306-DCE PLANT 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

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

GENERIC ELECTIVE COURSES
(Each worth 2 credits)

BOT-17001GE: 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-17002GE: 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-17005 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- 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-17001OE: 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-17003OE: 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; Bioalchols; Bioethanol and biodiesel
Gaseous biofuels: Introduction, Biogas production; landfill gas;
Introduction to biofuel policy; Biofuel and biodiesel in India; Global biofuel projections

BOT-15310- OE- BIOPESTICIDES AND INTEGRATED PEST MANAGEMENT

Unit I

i. **Pesticides:** definition, and types of pesticides, limitations of using pesticides
ii. **Biopestidides**: Definition, types, advantages and limitations
iii. **Bio-fungicides**; fungal or myco-fungicides, bacterial fungicides. Bacterial fungicides, and fungal nematicides with emphasis on their role and application, Preventive and safety measures required in using bio-pesticides
vi. **Bio-insecticides**: bacterial insecticides, fungal and viral insectidies
vi. **Bioherbicide**s: a brief concept, current status and prospects, examples of bio-herbicides

Unit II

i. **Integrated Pest management**: Definition, concept, applications, principles, process, new challenges and future prospects, Integrated pest management for sustainable agriculture.

ii. **Components of IPM**: Physical methods, Requlatory 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 biocontrol agents; Integrated pest management in rice in India.

iii. Integrated management of fungal diseases of crop plants.

iv. Integrated pest management in groundnut diseases and vegetable crops

v. Integrated nematode management: definition and concept