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

**CHOICE BASED CREDIT BASED COURSE STRUCTURE TO BE IMPLEMENTED FROMACADEMIC SESSION 2024 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 2024 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 ownstudents.**

**Generic Elective Courses (GE):** General Elective Courses shall have two credits. The GE Courses are meant for the students of the sister departments underthe 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 ofBiological 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:**

**L -LECTURE**

**T -TUTORIAL**

**P -PRACTICALWORK**

**CR -CORE COURSE**

**DCE -DISCIPLINE CENTRIC ELECTIVE GE -GENERALELECTIVE**

**OE -OPENELECTIVE**

**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 end semester 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 4th core course based on practicals in each semester shall comprise of50marks (10 internal + 40 end semester practical).In case of OE and GE there will beonlyoneexaminationattheendofsemesterwhichshallcompriseof50marks.

**Project work**: Project work **(Bot-Proj.)** worth **8 credits** 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 theDepartment.

***Project Evaluation:***Projects will be evaluated by a committee consisting of 3 faculty members, one external member and Head of the Department as chairman. The 3 faculty members will be included in the committee on rotation basis.

The marks breakup shall be as:

**Internal……………40**

**External……………160**

 Dissertation……80

Presentation……40

 Viva Voce………40

**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 semesterto

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 theendofthesemesterwhereinTaxonomyisacorecourse.

|  |  |
| --- | --- |
| **CORE COURSES** |  |
| **COURSE CODE** | **COURSE NAME** | **HOURS** | **CREDITS** |
| **L** | **T** | **P** |
| **SEMESTER 1ST** |
| **BOT- 24101CR** | Plant Taxonomy | 4 | 0 | 0 | 4 |
| **BOT- 24102CR** | Microbiology, Fungiand Plant Pathology | 4 | 0 | 0 | 4 |
| **BOT- 24103CR** | Algae and Bryophyta | 4 | 0 | 0 | 4 |
| **BOT-24104CR** | Practical-1 | 0 | 0 | 6 | 2 |
| **SEMESTER 2nd** |
| **BOT- 24201CR** | Pteridophyta andGymnosperms | 4 | 0 | 0 | 4 |
| **BOT- 24202CR** | Ecology | 4 | 0 | 0 | 4 |
| **BOT- 24203CR** | Cell and MolecularBiology | 4 | 0 | 0 | 4 |
| **BOT- 24204CR** | Practical-2 | 0 | 0 | 6 | 2 |
| **SEMESTER3rd** |
| **BOT- 24301CR** | Reproductive and Developmental Biology ofAngiosperms | 4 | 0 | 0 | 4 |
| **BOT- 24302CR** | Cytogenetics andGenetics | 4 | 0 | 0 | 4 |
| **BOT- 24303CR** | Plant Metabolism | 4 | 0 | 0 | 4 |
| **BOT- 24304CR** | Practical-3 | 0 | 0 | 6 | 2 |
| **SEMESTER 4th** |
| **BOT- 24401CR** | Plant Physiology | 4 | 0 | 0 | 4 |
| **BOT- 24402CR** | Plant Tissue Culture andGeneticEngineering | 4 | 0 | 0 | 4 |
| **BOT- 24403CR** | Plant ResourceUtilization | 4 | 0 | 0 | 4 |
| **BOT- 24404CR** | Practical-4 | 0 | 0 | 6 | 2 |

|  |
| --- |
| **Discipline Centric Elective Courses(DCE)** |
| **BOT-24105-DCE** | Biostatistics and Biotechniques | 3 | 0 | 2 | 3+1 = 4 |
| **BOT-24106-DCE** | Mushroom Cultivation Technology | 3 | 0 | 2 | 3+1= 4 |
| **BOT-24107-DCE** | Medicinal Plants and Herbal Resource Management | 3 | 0 | 2 | 3+1= 4 |
| **BOT-24205-DCE** | Biodiversity and Conservation Biology | 3 | 0 | 2 | 3+1 = 4 |
| **BOT-24206-DCE** | Applied Phycology | 3 | 0 | 2 | 3+1 = 4 |
| **BOT-24207-DCE** | Applied Plant Pathology | 3 | 0 | 2 | 3+1 = 4 |
| **BOT-24305-DCE** | Applied Ecology | 3 | 0 | 2 | 3+1 = 4 |
| **BOT-24306-DCE** | Invasion Biology | 3 | 0 | 2 | 3+1 = 4 |
| **BOT-24307-DCE** | Plant Stress Biology and Molecular Genetics | 3 | 0 | 2 | 3+1 = 4 |
| **BOT-24308-DCE** | Crop Genetics and Molecular Breeding | 3 | 0 | 2 | 3+1 = 4 |
| **BOT-24309-DCE** | Applied Crop Pyhsiology | 3 | 0 | 2 | 3+1 = 4 |
| **BOT-24310-DCE** | Soil Science and Plant Nutrition | 3 | 0 | 2 | 3+1 = 4 |
| **BOT-24311 DCE** | Advanced Sustainable Crop and Medicinal Plant Management |  3 |  0 |  2 |  3+1=4 |
| **Bot-24405-Project** | **PROJECT WORK**  |  |  8 |
| **General Electives (GE)** |
| **BOT-24001GE** | Principles of Genetics | 2 | 0 | 0 | 2 |
| **BOT-24002GE** | Global Environmental Change | 2 | 0 | 0 | 2 |
| **BOT-24003GE** | Basics in Plant Biology | 2 | 0 | 0 | 2 |
| **BOT-24004GE** | Commercial Plant Propagation | 2 | 0 | 0 | 2 |
| **BOT-24005GE** | Weed Management | 2 | 0 | 0 | 2 |
| **BOT-24006GE** | Aquatic Ecosystem Management | 2 | 0 | 0 | 2 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
| **BOT-24007GE** | Techniques in Life Science | 2 | 0 | 0 | 2 |
| **BOT-24008GE** | Biological Systematics and Biodiversity | 2 | 0 | 0 | 2 |
| **BOT-24009GE** | Biofertilizers and Organic Farming for Sustainable Agriculture | 2 | 0 | 0 | 2 |
| **BOT-24010GE** | R for Everyone: A Beginner's Guide to Data Analysis | 2 | 0 | 0 | 2 |
| **Open Elective Courses** |
| **BOT-24001OE** | Basics of Biodiversity | 2 | 0 | 0 | 2 |
| **BOT-24002OE** | Commercial Floriculture | 2 | 0 | 0 | 2 |
| **BOT-24003OE** | Bioenergy | 2 | 0 | 0 | 2 |
| **BOT-24004OE** | Basics in Life Science | 2 | 0 | 0 | 2 |
| **BOT-24005OE** | Biopesticides and Integrated PestManagement | 2 | 0 | 0 | 2 |
| **BOT-24006OE** | Herbal Cosmetic Technology | 2 | 0 | 0 | 2 |

**Examination Scheme**

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

1. Internal Assessment : 20Marks
2. Semester Examination: 80Marks

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

1. Internal Assessment: 10Marks,
2. Practical examination: 40Marks

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

1. Internal Assessment- 15 Marks
2. Semester Examination: 60 Marksand
3. Practical Examination: 25Marks.

**2 Credit Course (GE and OE)(50 Marks)**

1. Internal Assessment: 10Marks,
2. Semester Examination:40Marks

**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 = 40**

Section A: Question carrying 2 mark each- 04 questions=08marks

Section B: Question carrying 8 marks each- 02 questions=16 marks

Section C: Question carrying 16 mark each- 02 questions –only 01 to be attempted=16 marks

# SEMESTER 1st

## Name of the course/Code: BOT-24101CR: PLANT TAXONOMY

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

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

## Unit: I

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

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

### Unit: II

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

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

### Unit: III

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

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

### Unit: IV

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

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

**Suggested Readings**

1.       Pandey, AK and Kasana, S. (2021) *Plant Systematics*(1st edition). Jaya Publishing House, New Delhi.

2.       Singh, G. (2021)  *Plant Systematics: An Integrated Approach* (4th edition)*.* CRC Press, India

3.       Simpson, MG (2010). *Plant Systematics* (2nd edition). Elsevier, California, USA.

4.       Judd, WS et al (2016). *Plant Systematics: A Phylogenetic Approach* (4th edition). Sinauer Associates, Inc. Sunderland, USA.

5.       Stuessy, TF (2009) *Plant Taxonomy* (2nd edition). Coulmbia University Press.  New York

6.       Soltis D. et al. (2018). *Phylogeny and Evolution of the Angiosperms* (2nd Edition). The University of Chicago Press.

7.       Stace, C.V., (1989) *Plant Taxonomy & Biosystematics*. Cambridge University Press.

8.       Hickey, M. and King, C. (2000). *The Cambridge illustrated Glossary of Botanical Terms*. Cambridge University Press.

9.       Beentje, H. (2016) *The Kew Plant Glossary* (2nd edition). Kew Publishing, London

## Name of the course/Code: BOT-24102CR: MICROBIOLOGY, FUNGI AND PLANT PATHOLOGY

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

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

### Unit: I

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

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

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

### Unit: II

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

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

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

### Unit: III

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

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

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

### Unit: IV

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

**Symptoms, etiology, epidemiology and control of following plant diseases**: paddy blast, powdery mildew of cucurbits, black stem rust, apple scab, peach 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 biocontrolagent

**Suggested readings**

1. Willey, J. M. Sgerwood, L. M. and Woolverton, C. J. (2017). Prescotts Microbiology, 10 th ediction, McGraw Hill, USA
2. Ingraham, R. Y, Wheels, J. L. and Painter, M. L. (1976). General Microbiology. The Macmillan Press Ltd.

3. Pelczer M. J. Chan E. C. S. and Kreig, N. R. (1997). Microbiology, Tata Mac Graw Hill

4. Alexopolus, C.J., C.W. Mims and M. Blackwell. 1992. Introductory Mycology, 4th edition. John Wiley and Sons Inc. Asia Pvt. Ltd

5.. Webster, J. 1986. Introduction to Fungi, 3rd edition, Cambridge University Press

6. Gow, N. A. R. and Gadd, G. M. 1996. The growing Fungus, 3rd Edition, Chapman and Hall London and Madras.

7.. Mehrotra, R.S. and Aneja, R.S. 1996. An introduction to Mycology, 3rd Edition. New Age Intermediate Press, N. Delhi.

8. Singh, R. S. 1996. Plant Diseases. 6th edition, Oxford and IBH Publishers Co. Pvt. Ltd

9. Singh, R. S. 1996. Introduction to Principles of Plant Pathology, 6th edition. Oxford and IBH Publishers Co. Pvt. Ltd

10. Agrios, G. N. 2000. Plant Pathology. Academic Press

11. Cooke, R. 1977. The Biology of Symbiotic fungi. Wiley-Blackwell

## Name of the course/Code: BOT-24103CR: ALGAE AND BRYOPHYTA

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

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

### Unit: I

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

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

### Unit: Il

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

### Unit III

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

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

### Unit: IV

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

**Bryophytes in bioindication:** direct and biomonitoring

**Suggested readings**

1. Fritsch, F.E. 1979. The structure and reproduction of algae. Vols. I and II.    Cambridge University Press.

**2.**     Prescott, G.W. 1984. The Algae: A Review. Otto Koeltz Science Publishers,        Germany.

**3.**     Bold and Wynne. 1985. Introduction to the Algae. Prentice Hall, USA.

**4.**     Kumar, H.D. 199. Introductory Phycology. East-west Press New Delhi.

**5.**     Watson, Eric Vernon. 1971. The Structure and life of Bryophytes. Hutchinson and       co Publishers Ltd.

**6.**     Shaw, A. J. and Goffenel, B. 2000 Bryophyte Biology. Cambridge University, Press.

**7.**     Rashid, A. 2003. Text Book of Bryophyta. Vikas Publishers N. Delhi.

## Name of the course/Code:BOT-24104CR: PRACTICAL-1

### Laboratory Exercises based on BOT24101CR:

* Preparation of herbaria of different types of leaves, inflorescences andfruits.
* Taxonomicdescriptionofvariousbotanicalfamilies: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 afamily.
* Construction of dichotomous keys foridentification.
* Preparation of similarity matrix and construction of dendrograms.
* Preparation of character-taxon matrix and construction ofcladograms.

### Laboratory Exercises based BOT24102CR:

* Learning methods of sterilization and techniques ofinoculation.
* Preparation of culture media and aseptic transfer of pure cultures.
* Differential staining of microorganisms to study their morphology and stainingreactions.
* 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 andFusarium*
* Preparation of fungal cultures of *Rhizopus, Mucor, Aspergillus, Penicillium, Trichoderma, Alternaria,Verticillium*
* Sterilization methods (physical and radiation), Preparation of media (PDA, Soilextract Agar, Richards solution, peptone dextrose agarmedium.
* 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 mosaicvirus.

### Laboratory Exercises based on BOT24103CR:

* 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

## Name of the course/Code: BOT-24201CR:PTERIDOPHYTA AND GYMNOSPERMS

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

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

### Unit: I

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

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

### Unit: II

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

### Unit: III

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

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

### Unit: IV

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

**Suggested Readings**

1. Rashid, A. An Introduction to Pteridophyta. Vikas Publishers N. Delhi
2. Parihar N.S. The biology and Morphology of Pteridophytes. Central Book Depot. Allahabad.

**3.**  Sporne, K. R. The Morphology of Pteridophytes. Hutchinson & CO. Publisher.

4. Chamberlain, C. J. 1966. Gymnosperms: structure and evolution. Chicago, Ill.,   The University of Chicago Press.

5. Sporne, K. R. 1974. The morphology of gymnosperms: the structure and evolution       of primitive seed-plants. Hutchinson Co Ltd.

6. Bierhorst, D. W. 1971. Morphology of vascular plants.MacMillan Pub Co, New York.

7. Stewart, W. N. and Rothwell, G. W. 1993.Paleobotany and the evolution of         plants.Cambridge University Press.

8. Foster, A. S. and Gifford, E. M. 1974. Comparative morphology of vascular        plants.W. H. Freeman and Co.

9. Foster, A. S. and Gifford, E. M. 1989. Morphology and evolution of vascular      plants.W.H. Freeman and Co.

10. Taylor, T. N; Taylor, E. L. and Krings, M. 2009.Paleobotany: The Biology and   Evolution of Fossil Plants. Academic Press.

11. Beck, C. B. 1988.Origin and evolution of gymnosperms. Columbia University    Press.

**12.**  Singh, V. P. 2006. Gymnosperm (naked Seeds Plant).Sarup and Sons, New Delhi.

## Name of the course/Code: BOT-24202CR: ECOLOGY

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

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

### Unit: I

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

**Habitat and niche:** concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; characterdisplacement.

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

### Unit: II

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

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

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

### Unit: III

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

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

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

### Unit: IV

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

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

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

**Biomes:** types (terrestrial and aquatic), distribution and uniquefeatures

**Suggested readings**

**1.**     Odum, E. and Barrett, G. W. 2004. Fundamentals of Ecology (4th Ed.). Brooks   Cole

**2.**     Krebs, C.J. 2000. Ecology: The Experimental Analysis of Distribution and Abundance. Benjamin-Cummings

**3.**     Smith, R.L., Smith, Thomas M., Hickman, Graham C. and Hickman, Susan M..    2002. Elements of Ecology (5th Ed.). Benjamin-Cummings.

**4.**     Kormondy, E. J. Concepts of Ecology. Printice Hall of India.

**5.**     Chapin III, Stuart, F., Mooney, Harold A., Chapin, Melissa C. and Pamela Matson.         2002. Principles of Terrestrial Ecosystem Ecology. Springer Verlag.

**6.**     Lambers, H. Chapin III, F.S. and Pons, T.L. 2008. Plant Physiological Ecology.   Springer Verlag.

**7.**     Gurevitch, J., S. Scheiner, M. and Fox, G.A. 2006. The Ecology of Plants. Sinauer Associates, Inc.

**8.**     Putman, R and Wratten, D. 1984. Principles of ecology. Taylor & Francis.

**9.**     Harper, J.L. and Townsend, C. R. 1996. Ecology: Individuals, populations, and communities, Wiley-Blackwell.

**10.**   Townsend, C. R. Begon, M. and Harper, J.L. 2003. Essentials of Ecology. Wiley-Blackwell.

**11.**   Miller, G.T. and Spoolman, S. E. 2008. Essentials of Ecology . Cengage Learning.

**12.**   Cotgreave, P and Forseth, I. 2002. Introductory Ecology. John Wiley & Sons.

**13.**   Dodson, S.I. 1999. Readings in Ecology. Oxford University Press.

**14.**   Lomolino, M.V. and Brown, J.H. 2004. Foundations of biogeography. University of Chicago Press.

**15.**   Cain, M.L., Bowman, W.D. and Hacker, S.D. 2008. Ecology. Sinauer Associates.

**16.**   Latham, D. 2009. Ecology. Raintree

**17.**   Molles, M.C. 1999. Ecology: Concepts and Applications. WCB/McGraw-Hill.

**18.**   Stiling, P.D. 1999. Ecology: Theories and applications. Printice Hall.

## Name of the course/Code: BOT-24203CR: CELL AND MOLECULAR BIOLOGY

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

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

### Unit: I

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

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

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

### Unit: II

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

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

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

### Unit: III

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

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

**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).

**Suggested readings**

**1.**                  Albert, B., Bray, D., Lewis, J., Raff, M., Robert, K. and Walter. 1989.Molecular.
 Biology of the Cell (Second Edition) Garland Publishing Inc, New York. Allard R. W. 1960. Principles of Plant Breeding John Wiley and Sons New York.

**2.**                  Allard, R.W. 1995. Principles of Plant Breeding. John Wiley and Sons, Inc.

**3.**                  Brown, T.A. 2007. Genomes. Garland Science House, New York.

**4.**                  Chahal, G.S and Gosal S.S. 2002. Principles and Procedures of Plant Breeding, Narosa Publishing House, New Delhi.

**5.**                  Cooper, G.M. and Hausman R.E. 2007. The Cell A Molecular Approach Sinauer Associate, Inc, Suderland (USA).

**6.**                  DeR obertis and De Robertis. 2005. Cell and Molecular Biology, Lippincott Williams, Philadelphia. [B.I Publications Pvt. Ltd. New Delhi].

**7.**                  Gupta, P. K. 2005. Elements of Biotechnology. Rastogi Publications Meerut.

**8.**                  Gupta, P.K. Genetics and Cytogenetics. Rastogi Publications, Meerut.

**9.**                  Hartk, D.L. and Jones, E.W. 1998 Genetics: Principles and Analysis (Fourth Edition). Jones and Bartlett Publishers, Massachusetts, USA.

**10.**             Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4th edition). Jones & Bartlett Publishers, Massachusetts, USA.

**11.**             Hays H. K., Immer F.R. and Smith D.C. 1955. Methods of Plant Breeding. McGraw Hill Book Company Inc New York.

**12.**             Karp, G. 1999. Cell and Molecular Biology: Concept and Experiments. John Wiley and Sons, Inc., USA.

**13.**             Khush, G.S 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.

**14.**             Lewin, B. 2009. Gene x. Oxford University Press, New York, USA.

**15.**             Lodish et al. 2004. Molecular Cell Biology, W H Freeman and Company, New York.

**16.**             Malacinski G.M. 2006. Freifelders Essentials of Molecular Biology, Narosa Publishing House, New Delhi.

**17.**             Murray, P. 1994. Recombinant DNA Technology. Portland Press Ltd. USA.

**18.**             Old, R.W. and Primrose, S.B. 2002. Principles of Gene Manipulation. Blackwell Science.

## Name of the course/Code: BOT-24204CR : PRACTICAL-2

**Laboratory Exercises based on BOT-24201CR:**

* 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*.

**Laboratory Exercises based on BOT-24202CR:**

* Types of quadrats (sampling units) and theirutility.
* Determination of minimum size and number of quadrats for phytosociologicalstudies.
* 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 differentcommunities.
* Estimation of species diversity anddominance.
* Comparison between protected and unprotected grasslands using communityco-efficient

**Laboratory Exercises based on BOT-24203CR:**

* Study of DNA replicationmechanism
* Demonstration of cell cycle, mitosis andmeiosis.
* Identification of different stages of mitosis and meiosis from temporary and permanentslides.
* Study of morphology of metaphase chromosomes from onion rootmeristems.
* Study of various cell organelles using prepared slides andmodels
* Cell wall staining withcalcoflour
* Preparation of various types of stains for chromosomeanalysis.
* Demonstration of microscopes (Simple compound microscope, phase contrast, fluorescence,SEM).
* Isolation of plant DNA and its quantification by spectrophotometricmethod.
* Plant DNA extraction using standardprotocols.

# SEMESTER3rd

## Name of the course/Code: BOT-24301CR: REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY OF ANGIOSPERMS

**Learning objectives**: Toimpartstudentknowledge aboutthe morpho-anatomical features of plant organs, acquaint them about the flower development, microsporogenesis and megasporogenesis, pollination, seed developments and other processes and tomake them understand the molecular mechanisms behind development of plant organs, seed development, seed germination and flowering

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

### Unit: I

**Flowering and flower formation:** Major pathways of induction of flowering, flower organ formation (ABC and ABCDE models), flowering in perennials (seasonal flowering, polycarpy and biennial bearing).Floral ground plan among angiosperms (merism, phyllotaxy, symmetry).

**Development of male and female gametophyte:** Anther: regulation of anther development; Role of tapetum in specification of microspores and tapetum; microsporogenesis; 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 and progamic phase:** Major pollination syndromes and their attributes, compatible pollen pistil interactions, Self-incompatibility mechanisms in Brassicaceae, Solanaceae and Papavaraceae. Pollen tube growth and guidance.

**Embryo, endosperm, seed and fruit development:** Double fertilization, developmental regulation of endosperm, embryogenesis (landmarks of embryo pattern formation), apomixis, polyembryony, transcriptional and hormonal network in fruit development, importance and types of dormancy, seed dormancy, overcoming seed dormancy.

### Unit: III

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

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

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

### Unit: IV

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

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

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

**Suggested Readings:**

1. Cresti, M., Blackmore, S., & Heslop-Harrison, J. E. (Eds.). (2020). Sexual Reproduction in Flowering Plants. Springer.
2. Cronk, Q. C. B., Bateman, R. M., & Hawkins, J. A. (Eds.). (2018). **Plant Development and Evolution**. CRC Press.
3. Jordan, B. R. (2006). **Molecular Biology of Flowering.** CABI Publishing.
4. Pua, E. C., & Davey, M. R. (Eds.). (2010). Plant Developmental Biology – Biotechnological Perspectives. Springer.
5. Raghavan, V. (1997). Molecular Embryology of Flowering Plants, Cambridge Univ. Press.

## Name of the course/Code: BOT-24302CR: CYTOGENETICS AND GENETICS

**Objectives:** To give knowledge to the student about Mendelian and non-Mendelian inheritance, structural and functional aspects of genes and chromosomes, consequences of gene and chromosomal mutations etc. The course is aimed at providing insight into the structure and functions of chromosomes, helping students to develop their analytical, quantitative and problem solving skills from classical to modern genetics.

**Learning outcome:**

* Understanding the principles of inheritance and gene interaction.
* Basic concepts of the genes and chromosomes.
* Understanding the fundamentals of gene and chromosomal aberrations.
* Use of cytogenetic and molecular tools for genome analysis.

**Unit: I**

 **(15h )**

**Heredity and variation:** Principles of inheritance (Mendel's laws); Multiple alleles,Gene interactions (epistasis).

**Sex determination:** Chromosome theory &genic balance theory of sex determination;sex determination in plants and animals, sex-linked inheritance (drosophila, humans).

**Linkage & crossing over:** Concept and types of linkage, crossing over & genetic recombination, recombination frequencies, chromosome mapping (Three point test crosses – maize **or** drosophila).

**Concept of Gene and Allele:** Allelic complementation, genetic fine structure analysis (Lozenge, r-II locus), split genes, overlapping genes, Pseudogenes.

**Unit: II (15h)**

**Chromosomes:** Chromosome structure and packaging of DNA (nucleosome), euchromatin & heterochromatin.

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

**Karyotype-**concept and evolution; B-chromosomes – origin, characteristics and distribution.

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

**Insitu-hybridization:** Brief account of FISH, GISH, scope and utility.

**Unit: III (15h)**

**Structural changes in chromosomes:**Origin, meiotic behavior and consequences of deletion, duplication,inversions and translocation; Robertsonian translocations – origin and consequences.

**Euploidy:** Origin, meiosis and breeding behaviour of haploidy, autopolyploids andallopolyploids.

**Aneuploidy:** Origin, meiosis and breeding behaviourof aneuploids; aneuploid aberrations in humans.

**Crop improvement:** Economic importance of autopolyploids (triploids and tetraploids); role ofallopolyploidy in evolution of crop plants (wheat, cotton, triticale, Brassica).

**Unit: IV (15 h)**

**Mutations-** Spontaneous and induced mutations; types of point mutations, molecularbasis of point mutations;pleiotrophy, back mutations and suppressor mutations.

**Mutagen:** Physical and chemical mutagens (gamma rays and EMS) – brief account.

**Epigenetics:** Introduction, DNA methylation, Histone modification, role in regulation (brief idea);

**Gene editing**-CRISPR-Cas9 system –principle and applications.

**Suggested Readings**

1. Gupta, P.K. Genetics and Cytogenetics. Rastogi Publications, Meerut.
2. Gardner E.J., Simmons M.J., Snustad D.P. (1991). Principles of Genetics. John Wiley & Sons.
3. Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4th edition). Jones & Bartlett Publishers, Massachusetts, USA.
4. Khush, G.S 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
5. Peter J Russell (2010). iGenetics: A Mendelian Approach-, Pearson.
6. Russel P.J. (2010). Genetics – A Molecular Approach, Pearson Education Inc.
7. Sharma, A. K. and Sharma, A. 1980. Chromosome techniques- Theory and practice. Butterworth and Co. (Publishers) Ltd., London.
8. Singh B.D.2004. Genetics. Kalyani Publication, Ludhiana.
9. Singh R.J. (2002). Plant Cytogenetics. CRC Press.
10. Sinha U. and Sinha S. 1998. Cytogenetics, Plant Breeding and Evolution. Vikas Publishing house Pvt. Ltd. New Delhi.
11. Strickberger2005. Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
12. Swaminathan M. S., Gupta P. K. and Sinha U. 1974. Cytogenetics of Crop Plants. MacMillan India Ltd. New Delhi.
13. Swanson C. P., T. Merz, and W.J. Young – 1982 : Cytogenetics ; Prentice – Hall of India Pvt. Ltd., New Delhi.
14. Sybenga, J. 1975. Meiotic configurations. Springer Verlag, Berlin, Germany.

## Name of the course/Code: BOT-24303CR: PLANT METABOLISM

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

**Learning outcomes: T**he students will be able to comprehend different thermodynamic principles in relation to various biological processes,enzyme catalysisand the metabolism of nitrogen and sulphur, understand the unique aspects of electron transport system, phosphorylation and role of lipid metabolism with particular reference to plants and learn the photochemistry of photosynthesis and the assimilation of carbon through various pathways

**Unit: I**

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

**Enzymes:** kinetics of single-substrate enzyme catalyzed reactions- Michaelis-Menton equation and its significance; Lineweaver-Burk Plot & determination of Km and Vmax; mechanism of enzyme catalysis;enzyme inhibition; 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, nod factors and nod genes; 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-Bensen cycle (C3 cycle), C4 Cycle,CAM pathway; characteristics of C3, C4 and CAM plants; photorespiration and its energetics.

**Suggested Readings:**

Berg, J.M., Gatto, G.J., Hines, J.K., Tymoczko, J.L., and Stryer, L. 2023. Biochemistry (10th edition). W.H. Freeman and Company, New York, USA.

Berg, J.M., Tymoczko, J.L., Gatto, G.J. and Stryer, L. 2015. Biochemistry (8th edition). W.H. Freeman and Company, New York, USA.

Bowsher, C. and Tobin, A. 2021. Plant Biochemistry (2nd Edition). Garland Science.

Buchanan, B. B., Gruissem, W. and Jones, R. 2002. Biochemistry and Molecular Biology of Plants (1st Edition.)**.** John Wiley and Sons, Inc. USA.

Bugg, T. 2012. Introduction to Enzyme and Coenzyme Chemistry (3rd Edition). John Wiley and Sons, Inc. UK.

Heldt, H.W. and Piechulla, B. 2021. Plant Biochemistry (5th Edition). Academic Press Inc.

Nelson, D.L., Cox, M.M. and Hoskins, A.A. 2021. Lehninger Principles of Biochemistry (8th Edition). W.H. Freeman and Company, New York, USA.

Taiz, L., LincolnMoller, M., Murphy, A. and Zeiger, E. 2022. Plant Physiology and Development (7th Edition). Sinauer Associates, Inc. Publishers, USA.

Voet, D., Voet, J. G. and Pratt, C. W. 2016. Fundamentals of Biochemistry: Life at the Molecular Level (5th Edition). John Wiley and Sons, Inc. USA.

Voet, D., Woski, S., Voet, J. G., Pratt, C. W. and Heilman, D. 2024. Fundamentals of Biochemistry: Life at the Molecular Level (6th Edition). John Wiley and Sons, Inc. USA.

## Name of the course/Code:BOT-24304CR: PRACTICAL-3

### Laboratory Exercises based on BOT-24301CR:

* + Study of living shoot apex of*Hydrilla*
	+ Study of cytological zonation in the shoot apical meristem in double stained permanent slidesof
	+ any suitable plant.



* + Study of different leaf arrangements
	+ Study of C. S. of typical dicot and monocotleaves
	+ Study of epidermal peels of leaves of appropriate to study various stomataltypes
	+ Study of anatomy of dicot and monoct roots and stems using appropriatematerials
	+ Study of microsporogenesis and gametogenesis in appropriatematerials
	+ Estimation of pollen germination and average pollen tube length *invitro*
	+ Study of different types of ovules, embryo sacs through examination of permanentslides
	+ Isolation of monocot and dicot embryos from suitablematerials

### Laboratory Exercises based on BOT-24302CR:

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

**Laboratory Exercises based on BOT-24303CR:**

* 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
* Determination of Vmax and Km value.
* Study of enzyme kinetics with respect to the effect of pH.
* Extraction and separation of chloroplast pigments in the plant material by partitioninginto different solvent systems.
* Separation of chloroplast pigments by thin layer chromatography.
* Determination of rate of photosynthesis in an aquatic plant by Winkler’s method.
* Determination of succinate dehydrogenase activity.
* To study principles of colorimetry and spectrophotometry.
* Extraction of chloroplast pigments from leaves and preparation of absorption spectrum of photosynthetic pigments and anthocyanins.
* Determination of activity of polyphenol oxidase and peroxidase.

**4th Semester**

**Name of the course/Code: BOT-24401CR: PLANT PHYSIOLOGY**

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

**Learning outcomes:** The students will be able to understand the water relations of plants, mechanisms of various transport processes and the complexities of various aspects of signal transduction mechanisms and their crosstalk in plants, appreciate the role and properties of various photoreceptors and the physiological effects of plant growth regulators and comprehend the underlying control of the process of flowering and the role of endogenous clock in various physiological processes

**Unit: I**

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

**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.

**Suggested Readings:**

Davies, P J. 2010. Plant Hormones: Biosynthesis, Signal Transduction, Action (3rd Edition). Springer, Dordrecht, The Netherlands.

Duca, M. 2015. Plant Physiology. Springer.

Epstein, E. Emanuel Epstein (Author)

1. ›[Visit Amazon's Emanuel Epstein Page](http://www.amazon.com/Emanuel-Epstein/e/B001HCRYFY/ref%3Dntt_athr_dp_pel_pop_1)
2. Find all the books, read about the author, and more.
3. See [search results](http://www.amazon.com/exec/obidos/search-handle-url/ref%3Dntt_athr_dp_sr_pop_1?%5Fencoding=UTF8&sort=relevancerank&search-type=ss&index=books&field-author=Emanuel%20Epstein) for this author
4. Are you an author? [Learn about Author Central](http://authorcentral.amazon.com/gp/landing/ref%3Dntt_atc_dp_pel_1)
5. and Bloom, A.J. 2004. Mineral Nutrition of Plants: Principles and Perspectives.

Sinauer Associates.

Hopkins, W. G. and Huner, N. P. A. 2009. Introduction to Plant Physiology (4th Edition). John Wiley and Sons, Inc. USA

Marschner, P. 2012. Marschner's Mineral Nutrition of Higher Plants, (3rd edition). Academic Press, London, UK.

Mohr, H. &Schopfer, P. 1995. Plant Physiology. Springer-Verlag, Berlin Heidelberg

Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th ed.). Wadsworth Publishing Company, Belmont, California.

Srivastava, L. M. 2002. Plant Growth and Development: Hormones and Environment (1st edition). Academic Press, USA.

Taiz, L., Moller, M., Murphy, A. and Zeiger, E. 2022. Plant Physiology and Development (7th Edition). Sinauer Associates, Inc. Publishers, USA.

Taiz, L., Zeiger, E., Moller, M. and Murphy, A. 2018. Plant Physiology and Development (6th Edition). Sinauer Associates, Inc. Publishers, Massachusetts, USA.

## Name of the course/Code: BOT-24402CR: PLANT TISSUE CULTURE AND GENETIC ENGINEERING

**Objective:** To impart knowledge and practical skills to use biotechnological tools and techniques in crop improvement.

**Learning Outcomes:** Students will acquire understanding of:

* Growing plants using tissue, cells and organ culture under in vitro conditions for micropropagation and product synthesis.
* Basic principles and fundamentals of genetic engineering.
* Know about the modern age applications of recombinant DNA technology.
* Development of transgenic plants and genetic diversity analysis through use of molecular markers.

### Unit: III 15 h

**Recombinant DNA technology:** gene cloning principles, restriction enzymes characteristics and utility; Gel Electrophoresis, Southern Blotting, Genomic and cDNA libraries,

**Cloning vectors: P**lasmids, phages, phagemids and cosmids), artificial chromosomes (YAC), construction of recombinant DNA; bacterial transformation and selection of recombinants.

**PCR:** polymerase chain reaction (PCR) – principle, technique and applications, qrt-PCR (brief idea).

**DNA sequencingmethods:(**chain termination method, chemical degradation method), Next Generation Sequencing (brief concept)

### Unit: IV 15 h

**Molecular markers** (RAPD, AFLP, SSR, ESTs& SNP) – concept and utility.

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

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

**Transgenic plants** for crop improvement - Insect resistance, quality improvement, golden rice, edible vaccine, male sterility, terminator seed.

**Omics technologies:** Concept and applications of Genomics, Proteomics, Transcriptomics and Metablomics

**Gene silencing mechanisms** - antisense RNA technology and RNA interference (RNAi).

**Suggested Readings:**

1. Brown, T.A. (2016). Gene Cloning and Analysis: An Introduction. Seventh edition. Wiley-Blackwell Publishing, UK.
2. Dale J.W., Schantz M.V. and Plant N. (2011). From Genes to Genomes: Concepts and Applications of DNA Technology. Third edition. John Wiley & Sons, UK.
3. Glick, B.R., Pasternak, J.J. and Patten, C.L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Fourth edition. ASM Press, USA.
4. Green, M.R. and Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual. Fourth edition. CSHL Press, USA.
5. Metzler, D.E. (2003). Biochemistry. Second edition. Academic Press, USA.
6. Primrose, S.B. and Twyman, R.M. (2006). Principles of Genetic Manipulation and Genomics. Seventh Edition. Blackwell Publishing, UK.
7. Voet, D., Voet, J.G. and Pratt, C.W. (2012). Principles of Biochemistry. Fourth edition. John Wiley & Sons, UK.
8. Wilson, K. and Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, Seventh edition, Cambridge University Press, USA.
9. Daniel, C.L. (2002). Introduction to Proteomics-Tools for New Biology. Humana Press, Totowa, NJ.
10. Twyman, R. (2014). Principles of Proteomics. Second edition. Garland Science, Taylor and Francis group, UK
11. Comai, L., Katz, J. and Mallick, P. (2017) Proteomics-Methods and Protocols, Springer Protocols, Springer New York
12. Nelson, D.L., and Cox, M.M. (2008). *Lehninger Principles of Biochemistry* (5th ed.). W.H. Freeman & Co., New York.

## Name of the course/Code: BOT-24403CR: PLANT RESOURCE UTILIZATION

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

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

**Unit: I**

**Plant biodiversity**: concept, utilization and concerns

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

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

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

### Unit: II

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

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

### Unit: III

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

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

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

**Paper making**: sources of raw material and processing of paper

### Unit: IV

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

**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.

**Suggested Readings**

1. Wikens, G. E. 2004. Economic Botany- Principles and Practices by. Kluwer       Publisher Academy, Netherlands

**2.**     Gonsalves, J. 2007. Economic Botany and Ethnobotany by. Vedam Books

**3.**     Pursglove, J. W. 1995. Tropical Crops- Monocotyledons and Dicotyledons. English     Language Book Society.

**4.**     Vavilov, N. I. 1992. Origin and Geography of Cultivated Plants. Translated by Doris    Love. 1992. Cambridge University Press

**5.**     Frankel, O.H. and Hawkes, J. G. 2006. Crop Genetic Resources for Today and    Tomorrow by Cambridge University Press

**6.**     Simpson, B.B. and Ogorzally, M.C. 2003. Economic Botany by. McGraw Hill     International Publishers.

**7.**     Chalam G.V. and Venkateshwarlu, J. 2007. Agricultural Botany in India. Venkatesh         Publishers.

**8.**     Anonymous. 2009. Hand Book of Agriculture, Revised Edition 2009.,ICAR New   Delhi.

**9.**     Good, R. 1983. The Geography of Flowering Plants by. Longman Publishers.

**10.**   Schultes, R. E. and Siri Von Reis. 1995. Ethnobotany- Evolution of a Discipline.   Timer Press.

**11.**   Frankel, O.H. and Hawkes, J. G. 2006. Crop Genetic Resources for Today and    Tomorrow. Cambridge University Press

**12.**   Wood, C. and Habgood, N. 2010. Why People Need Plants by. Kew Books

**13.**   Wikens, G. E. 2004. Economic Botany- Principles and Practices. Kluwer Publisher       Academy, Netherlands

**14.**   Gonsalves, John. 2007. Economic Botany and Ethnobotany. Vedam Books

**15.**   Poehlman, J. H. 2001. Breeding Field Crops. Avi publishing Company

**16.**   Raju, A. J. Solomon. 2009. Bioresource Conservation and Management. Today and     Tomorrow Publishers.

**17.**   Singh, Prithipal. 2007. Biodiversity Conservation and Systematics. Scientific     Publishers.

**18.**   Govil, J. N. 1998. Current Concept of Multi-discipline approach to Medicinal    Plants. Vol 1 & 2. Today and Tomorrow Publishers.

**19.**    Pursglove, J. W. 1995. Tropical Crops- Monocotyledons and Dicotyledons. English     Language Book Society.

**20.**   Love, D. 1992. Origin and Geography of Cultivated Plants by N. I. Vavilov,        Cambridge University Press.

## Name of the course/Code:BOT-24404CR: PRACTICAL-4

### Laboratory Exercises based on BOT-24401CR:

* 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-24402CR:

* DNA extraction protocol and its quantification by UV- spectrophotometricmethod.
* Restriction digestion of DNA and its analysis by Agarose gelelectrophoresis
* Demonstration of DNA sequencing by Sanger’s dideoxymethod.
* Demonstration of RAPD, SSR and AFLPanalysis.
* Isolation of gene of interest using genomic and cDNAlibrary.
* Demonstration of PCR, centrifuge, deep freezer, and gel electrophoresisapparatus
* Gel electrophoresis techniques and analysis.

### Laboratory Exercises based on BOT-24403CR:

* + To study the morphology of the part used of various representative crops likerice,

wheat, maize, potato, pulses and fruits

* + Study of viability of various crop seeds using germination and T.Z Test
	+ Study of seed vigour using standardmethods
	+ Study of source spice and condiments (source, part used, activecomponents)
	+ Study of any five important fodder and foragecrops
	+ Study of various types of fibres viz. cotton. coir, hempetc.
	+ Morphology, microscospic study of oil yielding tissues and test for oil ( mustard, groundnut, soybean, linseed, coconut, sunflower, castor, sesame and cashewnut)
	+ Study of comparative characteristics of the grains of cereals, millets andpulses.
	+ Study of food reserves in different food crops using microchemicaltests.
	+ Study of methods of cultivation, processing and uses of various rosaceous fruitsof

Kashmir

* + Study of ethnobotanical aspects of various local products.

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

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

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

Project work **(Bot-Proj.)** worth **8 credits** 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 theDepartment.

**DISCIPLINE CENTRIC ELECTIVE (Bot-DCE)**

**Name of the course/Code: BOT-24105DCE: BIOSTATISTICS AND BIOTECHNIQUES**

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

**Learning outcomes:** At the end of the course, the students will be able to

* Comprehend the types, collection and analysis of data and determine the various measures of central tendency and dispersion
* Undertake the sampling and design and analysis of common experiments in biology
* Test the hypothesis through statistical tests and find the correlation and regression of two variables
* Appreciate the principle and applications of various techniques (such as chromatographic, electrophoretic, centrifugation, biophysical and radio-labeling techniques)in biology

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

**Unit: III**

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

**Electrophoretic and Centrifugation Techniques:** gel electrophoresis; ultra-centrifugation

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

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

**Laboratory Exercises:**

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

**Suggested Readings:**

Cochran, W.G. (1977).  Sampling Techniques. John Wiley and Sons, New York.

Cochran, W.G. and Cox, D.R. (1987). Experimental Designs. John Wiley and Sons, New York.

D'Agostino, S. R., Sullivan, L. and Beiser, A. 2005. Introductory Applied Biostatistics (1st edition). Brooks Cole.

Dean, A.M. and Voss, D. (1999). Design and Analysis of Experiments. Springer Texts in Statistics, Springer-Verlag, New York.

Gupta, S.C.and Kapoor, V.K. 2007. Fundamentalas of Applied Statistics (4th edition). Sultan Chand and Sons.

Jayaraman, K. 1999. A Statistical Manual For Forestry Research. Food And Agriculture Organization of The United Nations, Regional Office for Asia and The Pacific, Bangkok.

Khan, I. A., Khanum, A. and Khan, S. 2018. Fundamentalas of Biostatistics (6th edition). Ukaaz Publications.

Le, C.T. 2003. Introductory Biostatistics (1st edition).Wiley-Interscience.

Rosner, B. 2005. Fundamentals of Biostatistics (6th edition). Duxbury Press.

Zar, J.H. 2010. Biostatistical Analysis (5th edition). Prentice Hall, Inc. New Jersey.

Hollas, J.M. 1996. Modern Spectroscopy John Wiley & Sons.

Rapley, R. 2000. The Nucleic Acid Protocols Handbook (Methods in Molecular Biology). Humana Press.

Simpson, R.J., Adams, P.D. and Golemis, E.A. 2008. Basic Methods in Protein Purification and Analysis: A Laboratory Manual. Cold Spring Harbor Laboratory Press.

Spector, D.L. and Goldman, D. 2006. Basic Methods in Microscopy Protocols and Concepts from Cells: A Laboratory Manual. Cold Spring Harbor Laboratory Press.

Westermeier, R. 2001. Electrophoresis in Practice. Wiley-VCH

### Name of the course/Code:BOT-24106DCE: MUSHROOM CULTIVATION TECHNOLOGY

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

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

**Unit: I**

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

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

### Unit: II

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

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

### Unit: III

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

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

### Unit: IV

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

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

### Laboratory Exercises:

* + Morphological studies and identification of the local mushroom flora andof preserved specimen ofmushrooms
	+ Sterilization of media and glass ware, preparation of culture of some localmushroom fungalspecies
	+ Preparation of culture media/substrate: Potato dextrose agar(PDA), Rice bran medium**,** Richard’s solution, Grain spawn substrate, Sawdust spawn substrate, preparation of Agarslants
	+ Preparation of different types of compost and some compostformulations.
	+ Preparation of different types ofspawns
	+ Cultivation procedures for Button mushroom and Oystermushroom Picking and haunting ofMushrooms.
	+ Study of fungal pathogens and nematode pests ofmushrooms

**Suggested Readings**

**1.**     Singh, R. S. 1996. Plant Diseases, 6th edition. Oxford and IBH Publishers Co. Pvt.         Ltd.

**2.**     Singh, R. S. 1996. Introduction to Principles of Plant Pathology, 6th edition. Oxford    and IBH Publishers Co. Pvt. Ltd.

**3.**     Agrios, G. N. 2000. Plant Pathology, 3rd edition. Academic Press, London.

**4.**     Schaad, N. W. 1988. Plant Pathogenic Bacteria: Laboratory guide for identification     of plant pathogenic bacteria. Academic Press, London

**5.**     Wood, R.L. S. 2002. Encyclopaedia of Plant Pathology Series. Vol. 6

**6.**     Smith, K. M. 2001. Introduction to Virology. 3rd edition. Academic Press, London.

**7.**     Mandahar, C.L. 1978. Introduction to Plant Virus. S. Chand and Co. Ltd., Delhi

**8.**     Marmorosch, K. and Raychaudari, S. P. 1989. Mycoplasma diseases of plants: Basic and Applied Aspects. Oxford and IBH Publishers Co. Pvt. Ltd.

**9.**     Roger and Hull. 2002. Mathew”s Plant Pathology. Acedemic Press.

**10.**   Mahy, B.W. J. and Van Regen mortel, M. H. V. 2010.  Desk Encycopedia of Plant and Fungal Virology. Academic Press.

**11.**   Synder, Daniel. 2002. Plant parasitic nematodes. Webmaster, N.S. State University

**12.**   Oei,P., and  van Nieuwenhuijzen,B. de Feijter, J.  2005. Small-scale mushroom Cultivation of oyster, shiitake and wood ear mushrooms. The Netherlands. ISBN, Agromisa Foundation and CTA: 90-8573-038-4

**13.**   Hall, I. et al.  2003. Edible and poisonous mushrooms of the world.  Institute for Crop and Food Research, New Zealand. ISBN 0-478- 10835-4. 370

**14.**   Chang S.T. and Miles,  P.G. 2004. Mushrooms: Cultivation, Nutrional Values, Medical Effects and Environmental Impact.  Second edition, CRC Press (www.crcpress.com) ISBN  49310431.

**15.**   Oei, Peter.  2003. Mushroom Cultivation, Appropriate technology for mushroom growers, Third edition, Backhuys Publishers, Leiden, 3rd Edition, The Netherlands. ISBN 90-5782-137-0

**16.**   Stamets,  P.2000.  Growing Gourmet and Medicinal Mushrooms, Third edition,  Ten Speed Press, Berkely, United States.(www.tenspeed.com) ISBN 00-0242584

**17.**   Peng,  J.T, et al. 1990. The atlas of cultivated Pleurotus mushrooms . ISBN 957-9055-03-3.

**18.**   Ryvarden,  L., Piearce,  G.D. and Masuka, A.J.1994. An introduction to the larger fungi of South Central Africa.  Published by Baobab, Zimbabwe. ISBN 0-908311-52-4

**19.**   Hailling R.E. 1996. Recommendations for collecting mushrooms for scientific study. *In*: Alexiades MN and Sheldon JW (eds.), Selected Guide lines for Ethnobotanical Research: A field manual the New York Botanical Garden Press, Bronx, pp.135-141.

**20.**   Phillips, R. 2006.  Mushrooms. Pub. McMilan, ISBN 0-330-44237-6. P. 266.

**21.**   Chang, Shu-Ting; Chang, S., and Miles, P.G.  2004. . Mushrooms, Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact. CRC Press. pp. 15,17,69,73,139. ISBN 0-8493-1043-1.

**22.**   Jean Mara-Polese. 2005. Pocket guide to mushrooms. Tandem Verloag GmH (Konemann)

**23.**   MushWorld (www.mushworld.com) Obtainable from Mushworld. 2004. Mushroom Growers' Handbook 1 : Oyster Mushroom Cultivation.

### Name of the course/CodeBOT-24107DCE: MEDICINAL PLANTS AND HERBAL RESOURCE MANAGEMENT

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

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

**Unit: I**

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

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

* + - European
		- American
		- African
		- Chinese andTibetan
		- 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 threatassessment ofMP’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 traditionalknowledge

### Unit: IV

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

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

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

**Labotaoratory Exercise**

* Studies on MP’s of Kashmir with respect to status, distributionpattern, adaptability and threats, ifany
* 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, ifany)
* Assessment of resource allocation and resource partitioning of important MP’sof KashmirHimalaya
* Assessment of reproduction biology as a means of domestication and conservation ofMP’s
* Analysis of active components in relation to commercial usage of important MP’sof Kashmir
* Developing vegetative and sexual parametres for commercialization ofimportant
* MP’s ofKashmir
* Preparing a herbarium of atleast 30 important medicinal plants with all detailes relatedto habit, habitat, density and diversity andstatus

**Suggested Readings**

**1.**     Wikens, G. E. 2004. Economic Botany- Principles and Practices by. Kluwer       Publisher Academy, Netherlands

**2.**     Gonsalves, J. 2007. Economic Botany and Ethnobotany by. Vedam Books

**3.**     Pursglove, J. W. 1995. Tropical Crops- Monocotyledons and Dicotyledons. English     Language Book Society.

**4.**     Vavilov, N. I. 1992. Origin and Geography of Cultivated Plants. Translated by Doris    Love. 1992. Cambridge University Press

**5.**     Frankel, O.H. and Hawkes, J. G. 2006. Crop Genetic Resources for Today and    Tomorrow by Cambridge University Press

**6.**     Simpson, B.B. and Ogorzally, M.C. 2003. Economic Botany by. McGraw Hill     International Publishers.

**7.**     Chalam G.V. and Venkateshwarlu, J. 2007. Agricultural Botany in India. Venkatesh         Publishers.

**8.**     Anonymous. 2009. Hand Book of Agriculture, Revised Edition 2009.,ICAR New   Delhi.

**9.**     Good, R. 1983. The Geography of Flowering Plants by. Longman Publishers.

**10.**   Schultes, R. E. and Siri Von Reis. 1995. Ethnobotany- Evolution of a Discipline.   Timer Press.

**11.**   Frankel, O.H. and Hawkes, J. G. 2006. Crop Genetic Resources for Today and    Tomorrow. Cambridge University Press

**12.**   Wood, C. and Habgood, N. 2010. Why People Need Plants by. Kew Books

**13.**   Wikens, G. E. 2004. Economic Botany- Principles and Practices. Kluwer Publisher       Academy, Netherlands

**14.**   Gonsalves, John. 2007. Economic Botany and Ethnobotany. Vedam Books

**15.**   Poehlman, J. H. 2001. Breeding Field Crops. Avi publishing Company

**16.**   Raju, A. J. Solomon. 2009. Bioresource Conservation and Management. Today and     Tomorrow Publishers.

**17.**   Singh, Prithipal. 2007. Biodiversity Conservation and Systematics. Scientific     Publishers.

**18.**   Govil, J. N. 1998. Current Concept of Multi-discipline approach to Medicinal    Plants. Vol 1 & 2. Today and Tomorrow Publishers.

**19.**    Pursglove, J. W. 1995. Tropical Crops- Monocotyledons and Dicotyledons. English     Language Book Society.

**20.**   Love, D. 1992. Origin and Geography of Cultivated Plants by N. I. Vavilov,        Cambridge University Press.

### Name of the course/Code: BOT-24205DCE: BIODIVERSITY AND CONSERVATION BIOLOGY

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

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

**Unit: I**

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

### Unit: II

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

**Unit: III**

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

### Unit: IV

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

**Laboratory Exercises:**

* + Preparation of an inventory of RET (Rare, Endangered and Threatened plants)in KUBG.
	+ Measurement of species diversity by using various biodiversityindices.
	+ Measurement of species evenness and similarityindex.
	+ Measurement of alpha, beta and gammadiversity.
	+ Field demonstration of GPS (Global Positioning System) and its utilityin biodiversity studies
	+ Study of various economically and ethno-botanically important plants ofKashmir

Himalaya

* + Field study of various threatened endemic plants of KashmirHimalaya.
	+ Field demonstration of *in situ* and *ex situ* conservation strategies through visit tothe national parks, sanctuaries, botanical garden, herbaria, zoos,museums.

**Name of the course/Code: BOT-24206DCE: APPLIED PHYCOLOGY**

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

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

### Unit: I

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

### Unit: II

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

### Unit: III

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

### Unit: 1V

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

**Laboratory Exercises:**

* Preparation of temporary mounts and Identification of phytoplankton belonging to different classes ofalgae
* Culture of some importantmicro-algae
* Cultivation of cyanobactaria under indoorconditions
* Preparation of biodiesal from vegetableoils

**Suggested Readings**

**1.**     Becker, S. W. 1994. Micro Algae Biotechnology and Microbiology. Cambridge University Press.

**2.**     Ignacimuthu, S. 1996. Basic Biotechnology. Tata McGraw Hill Publishing Limited.       New Delhi.

**3.**     Power, M., Van der Meer, J., Tchelat, R. 1998. Molecular based methods can      contribute to assessments of toxological risks and bioremediation strategies. J. Microbiol. Methods, 32: 107 – 119.

**4.**     Tridevi, P. C. 2001. Algal Biotechnology. Point Publisher, Jaipur, India.

**5.**      Venkatraman, G. S. 1972. Algal Biofertilizers and rice cultivation. Today and    Tomorrows Printers and Publishers, New Delhi.

**6.**     Zajic, J. E. 1970. Properties and Products of Algae. Plenum Press, New York.

**7.**     Bold, H.C. and Wynne, M.J. 1976. Introduction to Algae structure and reproduction. Prentice-hall.

**8.**     Fritsch, F.E. 1935 and 1945. Structure and reproduction in Algae Vol. I& II, Cambridge University press.

**9.**     Marris, I. 1967. An introduction to the Algae Hatchinson University Lab.

**10.**   Presott, G.W. 1970. How to know freshwater Algae W.C. Braun & Co.

**11.**   Round, F.E. 1966. The Biology of Algae Edward Arnold.

**12.**   Dodge, J.D. The fine structure of Algal cells. Academic press.

**13.**   Chapman, F.G. and Chapman, D.J. 1973. The Algae. McMillan & Co.

**14.**   Desikachary, T.V. 1972. Taxonomy and Biology of Blue Green Algae. University of Madras.

**15.**   Dixon, P.S. 1987 Biology of Rhodophyta.

**16.**   Smith and Wittick. 1987. An introduction of Algae. Blackwell Publication.

**17.**   Vanden Hoek, C., Mann, D.G., and Jahns, H.M. 2009. Algae- An introduction to Phycology.

**18.**   Vashishta, B.R., Sinha, A.k., and Singh V.P. 2010. Algae. Revised Edition.

**19.**   McCandless, E.L. 1981. Polysaccharides of seaweeds. In The Biology of seaweeds,      ed. C.S. Lobban and M.J. Wynne, pp. 559-88. Blackwell, Oxford.

**20.**   Hausmann, K and Patterson, D.J. 1984 Contractile vacuole complexes in algae. In         Compartments in algal cell and their interaction, ed. W. Wiessner, D.G. Robinson         and R.C. Starr, Springer-Verlag, Berlin.

**Name of the course/Code: BOT-24207DCE: APPLIED PLANT PATHOLOGY**

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

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

### Unit: I

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

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

### Unit: II

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

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

### Unit: III

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

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

### Unit: IV

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

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

## Laboratory Exercises:

* Morphological studies and identification of the following fungi through temporary and permanent mounts- *Peronospora, Mucor, Rhizopus, Penicillium, Aspergilus* and *Alternaria, Albugo, Polyporus, Phoma*
* Symptomology and studies of some local diseased plant materials through temporary and permanent mounts: powdery mildew of cucurbits and composites, smuts, leaf spotdiseases
* Sterilization of media and glass ware, preparation of culture of some local fungalflora
* Preparation of culture media, peptone dextrose agar (PDA), soil extract agar, Richard’ssolutionCzepek’s solution, Coon’s medium ,noculation of fungi by dilution plate method
* Isolation of plant pathogens from infected tissue by tissue segmentmethod
* Preparation of some fungalstains
* Demonstration of cell wall degrading enzyme production by *Rhizopus and Mucor* on potatotuber
* Acquaintance with fungicides, bio-control agents and sprayequipments
* Isolation of nematodes by Cobb’s sieving and decantingtechniques
* Isolation and purification of viruses by density gradientcentrifugation

### Name of the course/Code: BOT-24305DCE: APPLIED ECOLOGY

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

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

**Unit: I**

**Environmental monitoring:** Environmental monitoring - importance and approaches;microbes in relation to monitoring and mitigation of organic pollution and metal pollution, biosensors - types and role in pollution monitoring; microbes as bio-indicators, standards and criteria forindicators

**Environmental pollution:** Kinds and sources of pollutants; impact of SO2 on plants; eutrophication of aquatic ecosystems- sourcesandimpacts; Ozone depletion;ozone hole, UV radiation and their impact, response of plants to tropospheric ozone; acid precipitation- components andimpacts.

### Unit: II

**Global climate change:** Climate change (causes and consequences); greenhouse gases- sources, trends and role; global warming, CO2 fertilization; Climate change mitigations- methods and means, costs and benefits, international treaties and strategies

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

### Unit: III

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

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

### Unit: IV

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

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

**Suggested Readings**

**1.**     Odum, E. and Barrett, G. W. 2004. Fundamentals of Ecology (4th Ed.). Brooks   Cole

**2.**     Krebs, C.J. 2000. Ecology: The Experimental Analysis of Distribution and Abundance. Benjamin-Cummings

**3.**     Smith, R.L., Smith, Thomas M., Hickman, Graham C. and Hickman, Susan M..    2002. Elements of Ecology (5th Ed.). Benjamin-Cummings.

**4.**     Kormondy, E. J. Concepts of Ecology. Printice Hall of India.

**5.**     Chapin III, Stuart, F., Mooney, Harold A., Chapin, Melissa C. and Pamela Matson.         2002. Principles of Terrestrial Ecosystem Ecology. Springer Verlag.

**6.**     Lambers, H. Chapin III, F.S. and Pons, T.L. 2008. Plant Physiological Ecology.   Springer Verlag.

**7.**     Gurevitch, J., S. Scheiner, M. and Fox, G.A. 2006. The Ecology of Plants. Sinauer Associates, Inc.

**8.**     Putman, R and Wratten, D. 1984. Principles of ecology. Taylor & Francis.

**9.**     Harper, J.L. and Townsend, C. R. 1996. Ecology: Individuals, populations, and communities, Wiley-Blackwell.

**10.**   Townsend, C. R. Begon, M. and Harper, J.L. 2003. Essentials of Ecology. Wiley-Blackwell.

**11.**   Miller, G.T. and Spoolman, S. E. 2008. Essentials of Ecology . Cengage Learning.

**12.**   Cotgreave, P and Forseth, I. 2002. Introductory Ecology. John Wiley & Sons.

**13.**   Dodson, S.I. 1999. Readings in Ecology. Oxford University Press.

**14.**   Lomolino, M.V. and Brown, J.H. 2004. Foundations of biogeography. University of Chicago Press.

**15.**   Cain, M.L., Bowman, W.D. and Hacker, S.D. 2008. Ecology. Sinauer Associates.

**16.**   Latham, D. 2009. Ecology. Raintree

**17.**   Molles, M.C. 1999. Ecology: Concepts and Applications. WCB/McGraw-Hill.

**18.**   Stiling, P.D. 1999. Ecology: Theories and applications. Printice Hall.

### Name of the course/Code: BOT-24306DCE: INVASION BIOLOGY

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

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

**Unit: I**

**Introduction to invasion biology:** Historical perspective of invasion biology, critiqueof invasion Biology (SPRED ecology – SpeciesREDistribution)

**Process of invasion:** Introduction (intentional and accidental), Pathways and vectors, Rapid evolution, Hybridization, Biotic resistance, Propagule pressure, Residencetime, Tens rule, Establishment, Naturalization, Spread, Invasionmeltdown

### 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 CO2 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 givenarea.
	+ Determine allelopathic potential of the given plant species by point quadratmethod
	+ Demonstrate the effect of leachate of an invasive species on seed germination of anative species
	+ Determine the risk of invasion using WRA

**Suggested readings**

**1.**         Lockwood, J.L., Hoopes, M.F., Marchetti, M.P. (2013) Invasion Ecology. Wiley Blackwell

**2.**         Richardson, D.M. (2011) Fifty Years of Invasion Ecology: The Legacy of Charles         Elton. John Wiley & Sons

**3.**         Simberloff, D., Rejmanek, M.  (2010) Encyclopedia of Biological Invasions.      University of California Press

**4.**         Perrings, C., Mooney, H., Williamson, M. (2010) Bioinvasions and   Globalization: Ecology, Economics, Management, and Policy. OUP Oxford

**5.**         Keller, R.P., Lodge, D.M., Shogren, J.F. (2009) Bioeconomics of Invasive Species:        Integrating Ecology, Economics, Policy, and Management. Oxford University Press

**6.**         Davis, M.A. (2009) Invasion Biology Oxford University Press, USA

**7.**         Cadotte, M.W., McMahon, S.M., Fukami, T. (2006) Conceptual Ecology and      Invasion Biology: Reciprocal Approaches to Nature. Springer

**8.**         Mooney, H.A. (2005) Invasive Alien Species: A New Synthesis. Island Press.

**9.**         Elton, C.S. (2000) The Ecology of Invasions by Animals and Plants University of Chicago Press

**Name of the course/code: BOT-24307DCE: Plant Stress Biology**

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

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

**Unit: I**

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

**Unit: II**

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

 **Unit: III**

**Secondary metabolites and chemical defense**: genetic transformation, conjugation and transduction and their role in mapping of bacterial genes Plasmids – general properties and regulation of replication (control of copy number) Genetic engineering approaches for insect resistance (Bt approach);

 **Unit: IV**

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

**Suggested Readings**

**1.**                  Narenda Tuteja, Sarvajeet Singh Gill, Renu Tuteja. 2011. Omics and Plant Abiotic Stress Tolerance. Bentham Science Publishers.

**2.**                  Pareek, A; Sopory, S.K; Bohnert, H.; Govindjee, 2009. Abiotic Stress Adaptation in Plants. Springer Links Publishers.

**3.**                  Mathew A Jenks and Andrew J Wood. 2010.  Genes for Plant Abiotic Stress. Ames, Iowa : Wiley-Blackwell

## Name of the course/Code: BOT-24308 DCE: CROP GENETICS AND MOLECULAR BREEDING

Learning objectives: To **impart knowledge to the students** about **various methodsof breeding for** crop improvement **in self and** cross pollinated **crop** plants**.** The paper will also help in comprehending how genomic information is related to chromosomes and its usage in developing tools for genetics and molecular breeding.

##  Learning outcome: The students will understand,

* Genetics of self and cross pollinated crops.
* Various strategies deployed for improvement of crops based on the breeding systems.
* Phenomena such as male sterility, andself-incompatibility and their significance in crop improvement.
* Integration of molecular methods with conventional improvement strategies to accelerate plant breeding.

### Unit: I 15h

**Plant Breeding:** Introduction, objectives and activities of plant breeding.

**Gene pool** and germplasm concept; mechanisms promoting self and cross pollination.

**Male sterility:**genetic and cytoplasmic male sterility, transgenic genetic male sterility.

**Hybridization:** objectives, procedure and consequences of hybridization.

**Genetic composition** of self and cross pollinated crops.

**Unit-II 15h**

**Selection in Self-pollinated crops:** Mass selection, Pure line selection, progeny test.

**Handling of segregating generations**:Bulk method, Single seed descent method, merits and demerits.

**Backcross method of breeding**: genetic consequences, transfer of a dominant **or** recessive gene, merits and demerits.

**Quantitative traits:** Polygenic inheritance and role ofenvironment; components of genetic variation (additive, dominance and epistatic), heritability and genetic advance (brief idea).

### Unit: III 15h

**Wide hybridization**: Barriers in production of distant hybrids, methods of overcoming barriers in distant hybridization and its utility in cropimprovement.

**Heterosisand Inbreeding depression**: Genetic basis – dominance & over-dominance hypothesis, utilization in crop improvement.

**Breeding methods in cross pollinated crops:** Population improvement method–mass selection, progeny selection (ear to row method), recurrent selection for general and specific combining ability.

**Hybrids varieties:** Development of inbreds, evaluation of inbreds, production of hybrid seeds; role of male sterility in hybrid seed production, achievements.

### Unit: IV 15h

**Molecular markers: I**ntroduction and utilityin molecular breeding(brief idea).

**Marker assisted selection** (MAS): Approaches to apply MAS in Plant breeding - selection based on marker, simultaneous selection based on marker and phenotype - factors influencing MAS.

**QTL mapping:**Introduction and principles of QTL mapping; strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping.

**Population Genetics:**Gene and genotype frequencies, Hardy-Weinberg law of population genetics, factors affecting Hardy-Weinberg equilibrium.

## Laboratory Exercises:

* Field demonstration of self and cross pollinated plants with suitableexamples.
* Study of hybridization techniques in thefield. Emasculation, selfing and crossing techniques.
* Study of floral modifications that favour inbreeding and outbreeding in the field.
* Pollen viability tests using aceto-carmine, *in-vitro* pollen germination tests.
* Mitotic chromosome analysis using suitable plant material(onion)
* Meiotic chromosome analysis using suitable plantmaterial.
* Induction of polyploidy by colchicinetreatment.
* Karyotype analysis and preparation ofkario-idiogram.
* Analysis of pollen to ovule ratio as an index of the nature of breeding system in somecrops.
* Study of different chromosomal aberrations and their effect onfertility.
* Demonstration on Marker analysis, QTL analysis.
* Analysis of variance (ANOVA); Estimation of heritability and genetic advance

**Suggested Readings**

**DCE: Crop genetics and Molecular breeding**

1. Allard, R.W. 1995. Principles of Plant Breeding. John Wiley and Sons, Inc.
2. Chahal, G.S and Gosal S.S. 2002. Principles and Procedures of Plant Breeding, Narosa Publishing House, New Delhi.
3. Hays H. K., Immer F.R. and Smith D.C. 1955. Methods of Plant Breeding. McGraw Hill Book Company Inc New York.
4. Murray, P. 1994. Recombinant DNA Technology. Portland Press Ltd. USA.
5. Sharma J. R. 1998. Statistical and Biometrical techniques in Plant Breeding New Age International Publishers New Delhi.
6. Sharma J.R 1994 Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers Company Ltd., New Delhi.
7. Sharma, J. R. Principles and practice of plant breeding. Tata McGrow Hill Publ. Co. Ltd., New Delhi.
8. Singh R. K. and Singh B. D. 1997. Biometrical Methods in Quantitative genetic Analysis.
9. Singh, B. D. 2000. Plant breeding- Principles and methods. Kalyani Publishers, Ludhiana.
10. Sinha U. and Sinha S. 1998. Cytogenetics, Plant Breeding and Evolution. Vikas Publishing house Pvt. Ltd. New Delhi.

**Name of the course/Code:BOT-24309 DCE: APPLIED CROP PHYSIOLOGY**

**Learning Objectives:**The objectives of the course are to impart to the students a comprehensive understanding of various physiological processes (such as water relations, mineral nutrition, photosynthesis, and plant growth regulation) and their manipulation in order to increase crop productivity and yield.

**Learning outcomes:** At the end of the course, the students will be able to: a) understand the water relations of crops, transpiration, water use efficiency and the response of plants to nutrient application. b) appraise the effect of environmental factors on photosynthesis and the ways of improving photosynthetic efficiency for greater yield. c) analyze the various growth analytical parameters to understand the relationship between growth and yield and appreciate the role of various plant growth regulators and retardants in agriculture and horticulture

**Unit: I Water relations and mineral nutrition:**

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

**Unit: II Photosynthesis and crop productivity**:

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

**Unit: III Growth analysis and crop yield**:

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

**Unit: IV Chemical control of plant growth:**

Role of plant growth regulators (PGRs) (auxins, gibberellins, cytokinins and ethylene) in agriculture and horticulture; application of plant growth retardants in ornamental horticulture

**Laboratory Exercises:**

* Preparation of calibration curves for the estimation of following tissue constituents in the plant material:
1. reducing sugars b.) total starch content c.) soluble proteins d.) α-amino acids

e.) total phenolics f.) inorganic phosphorus

* Separation and estimation of photosynthetic pigments (chlorophyll-a, chlorophyll-b, total chlorophyll, carotenoids) and anthocyanins.
* Analysis of growth and yield:
1. Dry matter partitioning into roots, leaves and branches.
2. Computation, assessment and comparison of important growth parameters: a.) net assimilation rate (NAR) b.) leaf area ratio (LAR) c.) leaf weight ratio (LWR) d.) relative growth rate (RGR) e.) harvest index (HI) f.) biomass duration (BMD) g.) leaf area duration (LAD)
* Study of the physiological effects of the following growth regulators:
1. Auxins ii.) gibberellins iii.) cytokinins

**Suggested Readings:**

›Epstein, E. and Bloom, A.J. 2004. Mineral Nutrition of Plants: Principles and Perspectives.Sinauer Associates, Inc. Publishers, USA.

Basra, A. 2000. Plant Growth Regulators in Agriculture and Horticulture: Their Role and Commercial Uses. CRC Press.

Davies, P J. 2010. Plant Hormones: Biosynthesis, Signal Transduction, Action (3rd Edition). Springer, Dordrecht, The Netherlands.

Fageria, N.K., Baligar, V.C. and Clark, R. 2006. Physiology of Crop Production (1st edition). Food Products Press, An imprint of the Haworth Press Inc. New York, USA

Hay, R. K. M., and Porter, J.R. 2006. The Physiology of Crop Yield (2nd edition). Wiley-Blackwell Ltd. UK.

Hooykaas, P.J.J., Hall, M.A. and Libbenga, K.R. 1999. Biochemistry and Molecular Biology of Plant Hormones. Elsevier Science, The Netherlands.

Hopkins, W. G. and Huner, N. P. A. 2009. Introduction to Plant Physiology (4th Edition). John Wiley and Sons, Inc. USA.

Hostettmann, K., Chen, S., Marston,A. and Stuppner, H. 2014. Handbook of Chemical and Biological Plant Analytical Methods (3 Volume Set). Wiley

John H, Thornley M & Johnson IR. 2015. Plant and Crop Modeling: A Mathematical Approach to Plant and Crop Physiology. Blackburn Press

Marschner, P. 2012. Marschner's Mineral Nutrition of Higher Plants, (3rd edition). Academic Press, London, UK.

Mengel, K., Kirkby, E. A., Kosegarten, H. and Appel, T. 2001.Principles of Plant Nutrition (5th edition). Kluwer Academic Publisher, Dordrecht, The Netherlands.

Pessarakli, M. 2002. Handbook of Plant and Crop Physiology (2nd Edition). Marcel Dekker Inc. New York, USA.

Rengel, Z. 1999. Mineral Nutrition of Crops: Fundamental Mechanisms and Implications (1st edition). The Haworth Press Inc. New York, USA.

Smith, C.J., Gallan,J., Chiantante, D. And Zochi, G. 1994. Biochemical Mechanisms Involved in Plant Growth Regulation. Oxford University Press, USA.

Srivastava, L. M. 2002. Plant Growth and Development: Hormones and Environment (1st edition). Academic Press, USA.

Taiz, L., LincolnMoller, M., Murphy, A. andZeiger, E. 2022. Plant Physiology and Development (7th Edition).Sinauer Associates, Inc. Publishers, USA.

**Name of the course/Code: BOT-24310 DCE:SOIL SCIENCE AND PLANT NUTRITION**

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

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

**Unit: I**

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

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

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

Soil classification (characteristics of various types of soil orders)

**Unit: II**

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

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

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

**Unit: III**

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

Ion exchange: Cation and anion exchange; mechanism of ion exchange in soils, factors affecting ion exchange. Ion exchange and nutrient availability for plant uptake

**Unit: IV**

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

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

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

Soil degradation: Causes and consequences

**Laboratory Exercises**

* Soil texture and particle size distribution analysis of soils
* Measurement of aggregate stability, bulk density and porosity of soils.
* Measurement of soil-water content by different methods.
* Measurement of soil pH
* Measurement of cation exchange capacity
* Study of various types of organisms in the soil
* Analysis of soil samples for nutrient analysis

**Name of the course/Code: BOT-24311 DCE: Advanced Sustainable Crop and Medicinal Plant Management**

**Learning Objectives:** This course provides an in-depth understanding of sustainable agriculture and its practical application in crop and medicinal plant management. Students will explore agroecological approaches, including agroforestry, polyculture, and organic farming, and learn to integrate these strategies for improved sustainability and productivity, as well as medicinal plant cultivation, conservation, and sustainable harvesting.

**Learning Outcomes:**Upon completing this course, students will be able to design sustainable cropping systems that enhance biodiversity, soil health, and environmental resilience. They will integrate agroecological practices into crop and medicinal plant management and demonstrate proficiency in identifying, cultivating, and conserving medicinal plants, contributing to biodiversity preservation and sustainable resource use.

**Unit: I**

**Principles of sustainable agriculture and Integration of medicinal plants:** Agroecological principles, conservation agriculture, sustainable soil management, agroforestry and polyculture, organic farming practices. Integration of medicinal plants: diversity, cultivation, conservation, harvesting. Threats to medicinal plant biodiversity.

**Unit: II**

**Plant-Environment Interactions and nutrient management:** Abiotic stress responses, plant-microbe interactions, genetic variability and breeding for stress tolerance; nutrientuptake, and assimilation, precision agriculture application, organic farming practices, nutrient recycling and biofortification techniques.

**Unit: III**

**Climate-Smart Practices:** Climate resilient crop varieties, water management, carbon sequestration. Drought stress-responsive genes, hormonal regulation and epigenetics, mitigating climate change impacts: emissions reduction, land management, renewable energy. Medicinal plant adaptation and breeding for climate resilience.

**Unit: IV**

**Precision FarmingandPest Management:** Biological control and host resistance, cultural practices and precision farming technologies, innovations in irrigation (drip irrigation, soil moisture sensors); genetic engineering for crop improvement, marker assisted selection, genome editing techniques.

**Laboratory exercises**

* Analyze soil properties such as pH, organic matter content, and nutrient levels.
* Conduct a seed germination test to assess the viability and germination rate of crop and medicinal plant seeds.
* Assess the effectiveness of companion planting for pest management by designing and setting up experimental plots with different companion plant combinations.
* Investigate water use efficiency in various plant species by setting up pots or trays with different irrigation regimes and monitoring plant growth and water use.
* Evaluate stress tolerance levels of selected plant species by subjecting seedlings to controlled stress conditions (e.g., drought, salinity) and measuring physiological responses.
* Demonstrate organic farming principles by making compost or compost tea with local materials and applying them to plants quickly.
* Field trip to a local farm or agricultural research station that practices sustainable crop and medicinal plant management.
* Visit a botanical garden specializing in medicinal plants for guided tours, hands-on activities, and discussions on sustainable cultivation practices.

 **Suggested Reading**

1. Altieri, M. A., & Nicholls, C. I. (2020). Principles of Agroecology: Transforming Industrial Agriculture. CRC Press.
2. Gliessman, S. R. (2014). Agroecology: The Ecology of Sustainable Food Systems (3rd ed.). CRC Press.
3. Hiltunen, R., & Holm, Y. (Eds.). (2010). Medicinal Plants: Chemistry, Biology and Omics. CRC Press.
4. Van Dyke, F. (2020). Conservation Biology: Foundations, Concepts, Applications (3rd ed.). Springer.
5. Shabala, S. (2017). Plant Stress Physiology (2nd ed.). CABI.
6. Katewa, S. S., & Joshi, V. D. (Eds.). (2012). Nutrient Management of Medicinal Plants. Agrotech Press.
7. Napier, T. L., & Wood, A. K. (Eds.). (2006). Precision Agriculture: Technology and Economic Perspectives. Elsevier.
8. Modi, P. N. (2019). Irrigation Engineering (10th ed.). Standard Book House.
9. Kumar, V., & Wani, S. H. (Eds.). (2020). Biotechnology for Sustainable Agriculture: Emerging Approaches and Strategies. Springer.

# GENERIC ELECTIVECOURSES

### (Each worth 2 credits)

**Name of the course/Code: BOT-24001GE: PRINCIPLES OF GENETICS**

**Objectives:**This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem solving skills in the field of genetics.

## Learning outcomes: The students will gain knowledge on,

* Fundamental laws of inheritance and gene interaction mechanisms.
* Structural and functional aspects of gene and chromosome.
* Structural and numerical changes in chromosomes and their consequences.

**Unit: I 15h**

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

**Heridityand variation**; chromosomal theory of inheritance; Mendel's laws of inheritance, monohybrid and dihybrid cross (suitable examples).

**Multiple alleles**, gene interactions (complimentary, duplicate, epistatic interactions)

**Linkage:** Types of linkage, coupling and repulsion, crossing over and recombination.**Inheritance** of quantitative traits (multiple factor hypothesis).

**Unit: II 15h**

**Morphology** of eukaryotic chromosome; karyotype concept.

**DNA packaging**: Nucleosome structure; euchromatin and heterochromatin, c-value paradox and its significance.

**Gene concept**: Split genes, overlapping genes, pseudo-genes.

**Structural changes**: Inversion and translocation heterozygotes.

**Numerical changes**: Euploidy and aneuploidy – origin & classification.

**Suggested Readings**

1. Gupta, P.K. Genetics and Cytogenetics. Rastogi Publications, Meerut.
2. Gardner E.J., Simmons M.J., Snustad D.P. (1991). Principles of Genetics. John Wiley & Sons.
3. Singh B.D.2004. Genetics. Kalyani Publication, Ludhiana.
4. Singh R.J. (2002). Plant Cytogenetics. CRC Press.
5. Sinha U. and Sinha S. 1998. Cytogenetics, Plant Breeding and Evolution. Vikas Publishing house Pvt. Ltd. New Delhi.
6. Strickberger2005. Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
7. Swanson C. P., T. Merz, and W.J. Young – 1982 : Cytogenetics ; Prentice – Hall of India Pvt. Ltd., New Delhi.
8. Sybenga, J. 1975. Meiotic configurations. Springer Verlag, Berlin, Germany.

Name of the course/Code: BOT-24002GE: **Title: Global Environmental Change**

**Learning Objectives:**

* To understand the scientific basis of global environmental changes.
* To explore the social, economic, and political dimensions of these changes.
* To analyze the impacts of global environmental changes on ecosystems and human societies.
* To evaluate strategies for mitigating and adapting to environmental changes.

**Learning Outcomes:**

* By the end of this course, students should be well-equipped to understand the complexities of global environmental change, critically assess the challenges and opportunities it presents, and contribute thoughtfully to discussions and actions aimed at creating a sustainable future.

**Unit I**

1. **Introduction to Global Environmental Change**
	* Definition and scope of global environmental change.
	* Historical perspective: Natural vs. anthropogenic changes.
	* Overview of the Earth’s systems: atmosphere, hydrosphere, biosphere, and lithosphere.
2. **Climate Change**
	* The greenhouse effect and global warming.
	* Causes of climate change: Natural cycles and human activities.
	* Impacts of climate change: Sea-level rise, extreme weather events, changing ecosystems.
	* Mitigation and adaptation strategies.
3. **Biodiversity Loss**
	* The importance of biodiversity for ecosystem services.
	* Causes of biodiversity loss: Habitat destruction, pollution, overexploitation, invasive species.
	* Conservation strategies: Protected areas, biodiversity hotspots, sustainable use.

**Unit II**

1. **Population Growth and Urbanization**
	* Global population trends and projections.
	* Impacts of urbanization on the environment.
	* Sustainable cities: Green infrastructure, smart growth, and urban planning.
2. **Energy Use and Environmental Impact**
	* Fossil fuels and renewable energy sources.
	* The environmental impact of energy production and consumption.
	* The transition to a sustainable energy future.
3. **Global Environmental Governance**
	* International environmental agreements and organizations.
	* The role of governments, NGOs, and the private sector in environmental governance.
	* The concept of sustainability and sustainable development goals (SDGs).
	* The relationship between economic development and environmental protection.

**Recommended Reading:**

* "The Sixth Extinction: An Unnatural History" by Elizabeth Kolbert
* "The Uninhabitable Earth: Life After Warming" by David Wallace-Wells
* "The Age of Sustainable Development" by Jeffrey D. Sachs
* "Our Common Future" by the World Commission on Environment and Development

**Name of the course/Code: BOT-24003 GE: BASICS IN PLANT BIOLOGY**

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

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

**UNIT I**

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

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

### UNIT II

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

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

**Name of the course/Code: BOT-24004 GE: COMMERCIAL PLANT PROPAGATION**

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

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

### Unit: I

**Vegetative propagation**

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

### Micropropagation (Tissue Culture)

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

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

### Unit:II Propagation through seeds and other propagules

**Seed production and storage**: breeder seed, foundation seed, registered seed, certified

seed; seed storage and viability tests: Cut test, Float test, X-ray photographs

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

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

**1.**     Razdan, M.K. 2005. An introduction to plant tissue culture. Science Publishers.

**2.**     Trigiano, R. N. and Gray, D. J. 1999. Plant Tissue Culture Concepts and Laboratory      Exercises. Second Edition. CRC Press.

**3.**     Bhojwani, S.S. & Razdan, M.K. 1996. Plant Tissue Culture -Theory and practice.   Elsevier Publishers.

**5.**     Reinert, J. and Bajaj, Y.P.S. 1996. Applied and Fundamental aspects of Plant Cell        Tissue and Organ Culture. Narosa Publications.

**6.**     Gamborg, O.L. and Philips, G.C. 1995. Plant cell, tissue and organ culture-  Fundamental methods. Springer-Verlag.

**4.**     Smith, R.H. 1995. Plant tissue culture: Techniques and experiments. Academic  Press.

**7.**     Bhojwani, S.S. and Razdan, M.K. 1983. Plant tissue culture: theory and practice.   Elsevier Science Publishers.

**5.**     De, K.K. 1992. An Introduction to plant tissue culture. New Central Book

         Agency, Calcutta.

**7.**                  Hudson T., Hartman, Anton M Kofranek, Vincent E. Rubatzky, William J. Flocker.1988. Plant science: Growth, Development and Utilisation of cultivated plants. (Second Edition). Printice-Hall, Inc, New Jersey U.S.A.

**8.**                  Davidson and Mecklenburg R.1981.Nursery Management: Administration and Culture. Engle wood cliffs, NJ: Printice-Hall, Inc, New Jersey U.S.A.

**9.**         Davis, TD, Sankhla,N and Haissig.1988.(Eds.) Adventitious root formation on   cuttings.Portland,Oregon:Dioscorides Press.

**10.**   Genders, R.1973.Bulbs,a complete handbook. Indiana-Bobbs-Merrill.

**11.**   Kahn, A A.1982.(Ed).The Physiology and Biochemistry of seed development,   dormancy and germination.Geneva New York state Agr.EXP.sta

**12.**   Bhojwani, S.S.  and Razdan, M.K. 1996. Plant Tissue Culture, Theory & Practice, a revised edition Elsevier Science B.V. Amsterdam. Pp.1- 767.

**13.**   Herman, E. B. 1999. Regeneration and Micropropagation Techniques. Media and Application. Aaritech Publications. Pp 1-150

**14.**   Razdan, M. K. 2003. Introduction to plant tissue culture. Science Publishers  Pp 1-       375

**15.**   Smith, R. H. 2000. Plant Tissue Culture techniques and experiments.  Gulf Professional Publishing Science. Pp 1-231

### Name of the course/Code: BOT-24005 GE: WEED MANAGEMENT

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

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

**Unit: I**

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

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

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

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

### Unit: II

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

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

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

**Name of the course/Code: BOT-24006GE: AQUATIC ECOSYSTEM MANAGEMENT**

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

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

### Unit: I

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

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

### Unit: II

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

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

### Name of the course/Code: BOT-24007GE: BIOTECHNIQUES IN LIFE SCIENCE

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

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

**UNIT I**

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

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

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

**UNIT II**

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

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

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

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

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

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

### UNIT: I

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

###  UNIT: II

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

1

* 1. Pandey, AK and Kasana, S. (2021) *Plant Systematics*(1st edition). Jaya Publishing House, New Delhi.
	2. Singh, G. (2021)  *Plant Systematics: An Integrated Approach* (4th edition)*.* CRC Press, India
	3. Pandey, AK and Kasana, S. (2021) *Plant Systematics*(1st edition). Jaya Publishing House, New Delhi.

4.       Simpson, MG (2010). *Plant Systematics* (2nd edition). Elsevier, California, USA.

5.       Judd, WS et al (2016). *Plant Systematics: A Phylogenetic Approach* (4th edition). Sinauer Associates, Inc. Sunderland, USA.

6.       Stuessy, TF (2009) *Plant Taxonomy* (2nd edition). Coulmbia University Press.  New York

7.       Soltis D. et al. (2018). *Phylogeny and Evolution of the Angiosperms* (2nd Edition). The University of Chicago Press.

8.       Stace, C.V., (1989) *Plant Taxonomy & Biosystematics*. Cambridge University Press.

9.       Hickey, M. and King, C. (2000). *The Cambridge illustrated Glossary of Botanical Terms*. Cambridge University Press.

10.       Beentje, H. (2016) *The Kew Plant Glossary* (2nd edition). Kew Publishing, London

**Name of the course/Code: BOT-24009GE: BIO-FERTILIZERS AND ORGANIC FARMING IN SUSTAINABLE AGRICULTURE**

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

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

**Unit: I**

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

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

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

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

**Unit: II**

**Organic farming**: Basic concepts, principles, perspective and components of organic farming,

organic farming verses conventional farming and need for organic farming.

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

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

**Name of the course/Code:BOT-24010GE"R for Everyone: A Beginner's Guide to Data Analysis"**

**Course Objectives:**

* To introduce the basics of R programming and its applications in data analysis.
* To develop the ability to manipulate, visualize, and analyze data using R.
* To build foundational skills for further studies in data science, statistics, and related fields.

**Learning outcomes:**

**Knowledge and Understanding:**

* **Understand** the basic concepts and syntax of R programming.
* **Recognize** the importance of R in data analysis and its application in various fields.

**Practical Skills:**

* **Write** basic R scripts to perform data manipulation, analysis, and visualization.
* **Import, export, and clean** data from different sources.
* **Create** clear and informative visualizations using ggplot2.
* **Perform** basic statistical analyses and interpret the results.

**Critical Thinking and Problem Solving:**

* **Develop** strategies to clean and prepare data for analysis.
* **Apply** appropriate R functions to analyze data effectively.
* **Troubleshoot** and debug common issues in R code.

**Unit I**

1. **Introduction to R and RStudio**
	* Overview of R and its uses in data analysis.
	* Setting up the R environment: Installing R and RStudio.
	* Introduction to the RStudio interface.
2. **Basic R Syntax**
	* R as a calculator: Basic arithmetic operations.
	* Variables and data types (numeric, character, logical, etc.).
	* Vectors, matrices, lists, and data frames.
3. **Data Import and Export**
	* Importing data from CSV, Excel, and other formats.
	* Exporting data to various formats.
	* Working with built-in datasets in R.
4. **Data Cleaning and Preparation**
	* Handling missing data.
	* Data transformation and normalization.
	* Reshaping data with tidyr: gather, spread, unite, and separate.

**Unit II**

1. **Data Manipulation with dplyr**
	* Introduction to the dplyr package.
	* Filtering, selecting, and arranging data.
	* Creating new variables with mutate and summarizing data with summarize.
	* Grouping data with group\_by.
2. **Data Visualization with ggplot2**
	* Introduction to the ggplot2 package.
	* Understanding the grammar of graphics.
	* Creating basic plots: Scatter plots, bar charts, histograms, and boxplots.
	* Customizing plots: Themes, labels, and colors.
3. **Basic Statistics in R**
	* Descriptive statistics: Mean, median, mode, variance, and standard deviation.
	* Introduction to probability distributions (normal, binomial, etc.).
	* Basic inferential statistics: t-tests, chi-square tests, and correlation.
	* Generating summary statistics for datasets.

**Recommended Resources:**

* **Books:** "R for Data Science" by Hadley Wickham & Garrett Grolemund, "The Art of R Programming" by Norman Matloff.
* **Online Courses:** Coursera’s R programming courses, DataCamp’s R tracks.
* **Cheat Sheets:** RStudio’s collection of R cheat sheets for quick reference.

**OPEN ELECTIVE COURSES**

### (Each worth 2 credits)

**Name of the course/Code: BOT-24001OE: BASICS OF BIODIVERSITY**

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

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

**Unit: I**

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

### Unit: II

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

## Name of the course/Code: BOT-24002OE: COMMERCIAL FLORICULTURE­

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

**Learning Outcomes:** On the completion of the course, the students will be able to:

* Appreciate the role of ornamentals in improving environment and quality of life.
* Evaluate the economic importance of flowers and the role of advanced technology in in the cultivation and marketing of quality flowers
* Learn various nursery management practices and pre- and post-harvest technology of cut flowers

**Unit I: Floriculture industry**:

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

**Unit II: Propagation of ornamental plants and Hi-tech floriculture**:

Hi-tech floriculture: concept and components, Propagation of ornamental plants – asexual (division, cutting, budding, grafting and layering) and sexual (seed dormancy and germination) methods, ornamental plant nursery, production of bulbous plants, production and postharvest handling (pretreatments, storage, packaging, transport and vase treatments) of cut flowers.

**Suggested Readings:**

Bhatacharjee,S.K. & De, L.C. 2010. Advanced Commercial Floriculture. Vols. I-II. Pointer Publishers

Bhattacharjee SK. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ.

Bhattacharjee, S. K. 2005. Post-Harvest Technology of Flowers & Ornamental Plants. Pointer Publishers.

Lauria A &Ries VH. 2001. Floriculture – Fundamentals and Practices. Agrobios.

Paliyath, G., D.P. Murr, A.K. Handa, and S. Lurie. 2008. Postharvest Biology and Technology of Fruits, Vegetables, and Flowers . Wiley-Blackwell Publishing, Ames, Iowa, USA

Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios.

Randhawa,G.S. and Mukhopadhyay A.2012. Floriculture In India. Allied Publishers Pvt Ltd. New Delhi, India.

Reddy S, Janakiram B, Balaji T, Kulkarni S &Misra RL. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.

Salunkhe, Dattajirao K., Bhat, Narayana R., Desai, Babasaheb B. 1990. Postharvest Biotechnology of Flowers and Ornamental Plants. 1st ed. Springer-Verlag Berlin Heidelberg.

Verma, Anil. 2012. Postharvest Technologies for Commercial Floriculture. New India Publishing Agency (NIPA).

Wills, R.B.H., W.B. McGlasson, D. Graham, and D.C. Joyce. 2007. Postharvest- An introduction to the physiology and handling of fruit, vegetables and ornamentals. Fifth edition. CAB International, Wallingford, UK .

### Name of the course/Code: BOT-24003OE: BIOENERGY

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

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

**Unit: I**

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

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

**Biofuels**: Introduction, history, classification of biofuels

### Unit: II

**Bio-renewable liquid fuels:** Bioalcohols; Bioethanol and biodiesel

**Gaseous biofuels**: Introduction, Biogas production; landfill gas;

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

## Name of the course/Code: BOT-24004OE:BASICS OF LIFE SCIENCE

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

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

## UNIT:I

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

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

**From Inanimate to Animate**: origin of life.

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

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

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

### UNIT: II

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

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

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

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

**The Plant Kingdom:** life cycle of a flowering plant, importance of plants for sustenance oflife on earth, plants andmedicine.

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

## Name of the course/Code: BOT-24005OE: BIOPESTICIDES AND INTEGRATED PEST MANAGEMENT

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

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

**Unit: I**

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

**Biopesticides**: definition, types, advantages and limitations

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

**Bio-insecticides**: bacterial insecticides, fungal and viral insecticides

**Bioherbicide**s: 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

**Name of the course/Code: BOT-24006OE:HERBAL COSMETIC TECHNOLOGY**

**Learning Objective**  : 1. To provide the students a basic understanding and recognition of various raw materials and their properties in cosmetic formulations. 2. To learn formulation of herbal cosmetics. 3. Analysis and testing methods in cosmetics. 4. Motivate students to take up cosmetics as a field of research for further education.

**Learning Outcomes**: 1. Knowledge and understanding of a variety of plants in cosmetics. 2. Job opportunities in cosmetic industry 3. Entrepreneurship in the field of herbal cosmetic.

**Unit :1**

**Introduction to Herbal Cosmetics**: Advantages of using herbal cosmetics, Herbal extracts used in cosmetics, Types of herbal cosmetics, Global scenario of herbal cosmetics and Scope of herbal cosmetics in the Indian market. Quality assurance in herbal cosmetics.

**Herbal Skin care products** : Use of herbs in Skin and hand creams (aloe vera, daucus carota, Curcuma longa, Crocus sativus) facial skin care Products like cleansing creams, emollients, moisturizers, bleaches, body lotions and bath time herbs, Skin protectants and sunscreen products, skin tonics anti acne and anti ageing creams.

**Unit:2**

**Hair Cosmetics** : Herbs used in haircare (Rosmarinus officinalis, Allium cepa, Rosa sinensis), Types of herbal shampoos, formulations of herbal shampoos and conditioners, Herbal hair colourants, Hair fixers, sprays and gels.

**Perfumes and Fragrances:** Herbs used in perfumery (Rosmarinus officinalis, Lavendula angustifolia) deodorants , soaps and shampoos, Selection and formulation of fragrances, fragrances and allergenicity, Aromatherapy, essential oils, health benefits of aromatherapy.

**Suggested Readings**

1. *Textbook of Herbal Cosmetics* by Vimaladevi M.
2. *Herbal Cosmetics Handbook* by H. Panda.
3. *International Cosmetic Ingredient Dictionary and Handbook* by The Personal Care Products Council.