SCHEME M.Sc. BOTANY

Course Code	Title of Course	Type of paper	MARKS				CREDITS			
			Theory	Practical	Internal Assessment	Total Marks	T	S	P	Total
SEMESTER – I										
BOT-CC-411	Biology and Diversity of algae and Bryophytes	Core	60	-	40	100	4	0	0	4
BOT-CC-412	Mycology and Plant pathology	Core	60	-	40	100	4	0	0	4
BOT-CC-413	Biology and Diversity of Pteridophytes and Gymnosperms	Core	60	-	40	100	4	0	0	4
BOT-AEC-414	Computer applications and Biostatistics	AEC	60	-	40	100	4	0	0	4
BOT-CP-415	Practical I	Core	-	100	-	100	0	0	4	4
BOT-AECP-416	Practical II	AEC	-	100	-	100	0	0	2	2
BOT-CC-501	Seminar	Core	-	-	50	50	0	2	0	2
Total						**650**				**24**
SEMESTER – II										
BOT-CC-421	Ecology	Core	60	-	40	100	4	0	0	4
BOT-CC-422	Biology And Diversity of Angiosperms	Core	60	-	40	100	4	0	0	4
BOT-CC-423	Genetics	Core	60	-	40	100	4	0	0	4
BOT-CC-424	Cell and molecular Biology	Core	60	-	40	100	4	0	0	4
BOT-OE-425	Plant Diversity	Open elective	30	-	20	50	2	0	0	2
BOT-CP-426	Practical III	Core	-	100	-	100	0	0	4	4
BOT-CP-427	Practical IV	Core	-	100	-	100	0	0	4	4
Total						**650**				**26**
SEMESTER – III										
BOT-CC-431	Plant physiology	Core	60	-	40	100	4	0	0	4
BOT-CC-432	Biochemistry	Core	60	-	40	100	4	0	0	4
RM-CC-022	Research Methodology	Core	60	-	40	100	4	0	0	4
BOT-OE-433	Economic botany	Open elective	30	-	20	50	2	0	0	2
BOT-EC-434	Immunology	Elective (any 1)	60	-	40	100	4	0	0	4
BOT-EC-435	Plant Resource Utilization									
BOT-EC-436	Microbiology									
BOT-CP-437	Practical V	Core	-	100	-	100	0	0	4	4
BOT-EP-438	Practical VI	Practical	-	100	-	100	0	0	2	2
Total						**650**				**24**

SEMESTER – IV										
BOT-CC-441	Plant Biotechnology and tissue culture	Core	60	-	40	100	4	0	0	4
BOT-EC-442	Analytical Botany	Elective (any 1)	60	-	40	100	4	0	0	4
BOT-EC-443	Environment Botany									
BOT-EC-444	Embryology									
BOT-EC-445	Agricultural Ecology	Elective (any 1)	60	-	40	100	4	0	0	4
BOT-EC-446	Molecular interaction of plants with symbionts and pathogens and pests									
BOT-EC-447	Urban Environment									
BOT-CP-448	Practical VII	Core	-	100	-	100	0	0	2	2
BOT-EP-449A	Practical VIII	Elective	-	100	-	100	0	0	4	2
BOT-EP-449B	Practical IX	Elective	-	100	-	100	0	0	4	2
BOT-CC-502	Project	Core	-	-	150	150	0	0	6	6
Total						**750**				**24**
Total Credits									**98**	

INTERNAL ASSESSMENT		
House Tests (Average of Two House Tests)	30 Marks	= 40 MARKS
Tutorial / Assignments	5 MARKS	
Attendance	5 MARKS	
Internal Assessment marks will be distributed equally in all the theory paper.		

Abbreviations: T- Theory S- Seminar P- Practical AEC-Ability Enhancement Course
CC- core course EC- Elective Course OE- Open elective

Contact Hours: For theory 1 Credit = 1hr
For Practical 1 Credit = 2hr
For Seminar 1 Credit = 1hr
For Project 1 Credit = 1hr

Member **External Expert** **HoD**

SEMESTER – I

BOT-CC-411: BIOLOGY AND DIVERSITY OF ALGAE AND BRYOPHYTES

T	S	P	Credit
4	0	0	4

Course Objectives	• Algae in diversified habitat (terrestrial, fresh water, marine) classification and economic importance. • General account of thallus organization, reproduction and life history of Algae. • General characteristics, classification and economic importance of bryophytes in medicine, agriculture and food
Course Outcomes	• Recognize the morphology, anatomy, physiology, reproduction and life cycle pattern. • Their diversification and familiarize with various ecological niche.

MODULE I

- Algae in diversified habitats (terrestrial, freshwater, marine).
- Thallus organization.
- Cell ultrastructure.
- Reproduction (vegetative, asexual, sexual) and patterns of life cycle.
- Criteria for classification of algae**:** (pigments, reserved food, flagella).

MODULE II

- Fine structure of Algal plastids.
- Algal blooms.
- Algal biofertilizers.
- Economic importance of algae.
- General account of Lichens and their economic importance.

MODULE III

- Introduction, Classification and salient features of Bryophytes.
- Comparative account of gametophyte structure. Comparison among Cryptogamous plants.
- A general account of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales.

MODULE IV

- Substratum Ecology: Epiphytes, Epiphylls, Epiliths, Litter species, Fire mosses, Coprophilous species, Calcicoles and Calcifuges, Halophytes, Epizoic Bryophytes.

- Bryophytes as site indicators. Bryogeography and Conservation of bryophytes: Bryophyte endemisms. Threatened bryophytes; strategies to conserve bryodiversity at National and Global levels.
- Role of bryophytes in Ecosystem Dynamics and in carbon budget.

MODULE V

- Morphogenesis in Bryophytes.
- Distribution and ecology of Bryophytes in India with particular reference to Himachal Pradesh.
- Ecological and Economic importance of Bryophytes.

Books Recommended:

1. Fritsch, F.E. (1971). The structure and function of Algae. Vol I and II, London, Cambridge Univ. Press.
2. Kamat, N.D.(1982). Topics in Algae, SaiKirpaPrakashan, Aurangabad
3. Kumar, H.D.(1985). Algal Cell Biology. Affiliated East-west Press Limited, New Delhi
4. Bierhorst D.W. (1971). Morphology of vascular plants. Mac Millan Publishers. New York.
5. Cavers, F. (1911). The interrelationship of Bryophytes. New Phytology. Reprint No. 4: 1203.
6. Chopra, R.S. (1976). The interrelationships of Indian Bryophytes. The ChronicaBotanica. New Delhi.

Member **External Expert** **HoD**

BOT-CC-412:BIOLOGY AND DIVERSITY OF MYCOLOGY AND PLANT PATHOLOGY

T	S	P	Credit
4	0	0	4

Course Objectives	• To understand microbes with regards to their morphological and anatomical features, reproductive structures, their ecological and economic importance. • To identifies the major principles of plant pathology and to recognize their etiological agents of the diseases.To describe aspects of integrated pest management.
Course Outcomes	• To understand about the classification structures, role and infectious cycle of microbes. • Learning host-parasite interaction, recognition concept and infection, symptomatology. • Gain knowledge on disease management strategy.

MODULE I

- Introduction to Mycology: General characteristics of fungi, their significance tohumans, organization of fungal cell, thallus, ultrastructure, reproduction (vegetative, asexual and sexual).
- Recent trends in classification.
- Comparative study of habits, habitats, somatic organization, anamorphs, teleomorphs and evolutionary trends in the life cycles of the members of the following: Ascomycota with emphasis on Yeast, *Penicillium*, *Aspergillus*, and *Neurospora*.

MODULE II

- General account of Powdery mildews and Discomycetes, Basidiomycota (basidiocarps types, development, general account of Hymenomycetes, Ustilaginomycetes andUrediniomycetes).
- General account of Deuteromycetes (sprouting structures), predaceous fungi, Dermatophytes, *Alternaria*, *Cercospora*, *Colletotrichum*, and *Fusarium*.

MODULE III

- Sex hormones in fungi, Heterothallism and parasexual cycle**.**
- Nutrition in fungi(saprophytes, parasites, predators, symbionts)**.**
- Importance of fungi in different microbial and biotechnological processes: Fungi in food and food industry, as agents of biodeterioration and biodegradation, in agriculture, in medical biotechnology.

MODULE IV

- History of plant pathogens, concepts, diagnosis, classification, importance and identification of unknown diseases, symptomatology and disease development.
- Host- pathogen interaction at population level: Transmission and spread of plant pathogens, disease epidemics, modeling and disease forecasting to control crop

losses.Management of plant diseases: Chemical and biological.IPM system development of transgenics, biopesticides, plant diseases clinics, quarantine.

MODULE V

- Specific plant diseases caused by diverse pathogens: Black wart of potato, Club root of Crucifers, Damping of seedlings, Late blight of potato, Downy mildew of grapes and bajra, Stem gall of coriander, Powdery mildew of wheat and apple, Apple scab.

Books Recommended:

1. Barnett, J.H. (1968). Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
2. Bilgrami, K.S. and Dube, H.C. (1980). A text Book of Modern Plant Pathology. Vikas Publication House, New Delhi.
3. Butler, E.J. and Jones, S.G. (1986). Plant Pathology. Periodical Expert Book Agency, New Delhi.
4. Dube, R.C. and Maheshwari, D.K. (1999). A Text Book of microbiology, S.Chandand Co. Ltd. New Delhi.
5. Gupta, R. and Mukerji, K.G. (2001). Microbial Technology. APH Publishing Corp., New Delhi.
6. Kumar, H.D. (1988). Introductory Phycology. Affiliated East-west Press Limited, New Delhi
7. Moore-Landeckar, E.J. (1972). Fundamentals of the Fungi. Prentice Hall, Englewood cliff.

Member **External Expert** **HoD**

BOT-CC-413:BIOLOGY AND DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS

T	S	P	Credit
4	0	0	4

Course Objectives	• To understand the structure, evolution and economic importance of Pteridophytes and Gymnosperms. • To learn about their general characters and classification.
Course Outcomes	• Knowledge of morphological, anatomical, and reproductive diversity within Pteridophytes and Gymnosperms. • Understanding the economic importance of Pteridophytes and Gymnosperms and basic knowledge of fossils.

MODULE I

- General introduction, Classification and Salient features of Pteridophytes; Comparison among Archigoniate.
- Introduction to Palaeobotany: Basic principles and techniques, Geological time scale.
- A general account of the following fossil Pteridophytes: *Rhynia*, *Horneophyton*.
- Salient features of PSILOPSIDA, LYCOPSIDA, SPHENOPSIDA and PTEROPSIDA.

MODULE II

- Structure and Evolution of Stelar system in Pteridophytes.
- TELOME THEORY or the Evolution of Sporophyte in Pteridophytes.
- Alternation of generations; Natural & Induced Implications of Apogamy and Apospory in Pteridophytes.
- Heterospory and Seed habit in Pteridophytes.
- Cytological Evolution and Economic Importance of Pteridophytes.

MODULE Ⅲ

- General Introduction and salient features of Gymnosperms.
- Comparison amongTRACHEOPHYTA.
- Classification of Gymnosperms (latest one).
- A general account of the following Fossil Cycadopsida: *Archaeopteris*, *Lyginopteris*, *Glossopteris, Cycadeoidea*, and *Pentoxylon*.

MODULE Ⅳ

- Salient features of Living CYCADALES, CONIFERALES (Including *Taxus*), andGINKOGOALES (Emphasis not to be placed on Families and Type studies).
- A general account of EPHEDRALES, WELWITSCHIALES, and GENETALES.

MODULE Ⅴ

- Structure, Identification and Evolution of wood and bark in Conifers.
- Evolution and economic importance of Gymnosperms.

Books Recommended:

Gymnosperms:

1. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms, New Age International Pvt. Ltd. New Delhi.
2. Bierhorst D.W. (1971). Morphology of vascular plants. McMillan Publishers. New York.
3. Biswas, C and Johri, B.N. (1997). The Gymnosperms. Narosa Publishing House.New Delhi.
4. Chamberlain, C.J. (1986). Gymnosperms: structure and evolution. CBS publishers. New Delhi.
5. Kubitzki, K. (1990).The families of vascular plants: Pteridophytes and Gymnosperms. SpringerVerlag. NewYork.
6. Sahni, K.C. (1990). Gymnosperms of India. Bishen Singh and Mahendrapal Singh and Co. Dehradun.
7. Sharma, O.P. (2002). Gymnosperms. PragatiPrakashan. Meerut.
8. Siddiqui, K.A. (2002). Elements of Palaeobotany. KitabMahal. Allahabad.
9. Singh, H. (1978). Embryology of Gymnosperms. In Encyclopedia of Plant Anatomy X. Gebryder, Bortragear, Berlin.
10. Sprone, K.R. (1965).The Morphology of Gymnosperms. Hutchinson and Co. London.

Pteridophytes:

11. Sharma, O.P (1990). Textbook of pteridophyta. Mac Millan India Ltd. New Delhi.
12. Smith, G.M. (1971). Cryptogamic Botany. Vol. II: Bryophytes and Pteridophytes. Tata McGraw Hill. New Delhi.
13. Sporne, K.R. (1982). The morphology of Pteridophytes. Hutichinson University Press. London.
14. Trivedi, A.N. 2002. Advances in Pteridology.

Member **External Expert** **HoD**

BOT-AEC-414:BIOSTATS AND COMPUTER APPLICATIONS

T	S	P	Credit
4	0	0	4

Course Objectives	• To equip students with essential skills in bioinformatics (at basic and advanced levels). • To introduce applications of computational biology in diverse areas of biological sciences and provide training in the use of statistics in biological sciences.
Course Outcomes	• Students will learn necessary skills in the use of databases and online tools related to biological data. • Students will be trained in statistical concepts and principles relevant to biological data and their applications.

MODULE I

- Definition and scope of Probability
- Discrete and continuous variables, Presentation of Data.
- Measures of central tendency: Mean, median, mode and Standard deviation.

MODULE II

- Analysis of variance, Correlation, and regression.
- Sampling: techniques, Errors, Framing Hypothesis, Level of Significance
- Hypothesis testing and ANOVA
- Student's t test and Chi Square test

MODULEIII

- Introduction of Digital computers and organization,
- Low and High level languages,
- Binary Number systems
- Operating systems: DOS, WINDOWS.
- Application softwares': MS Word, MS Access, MS Excel, MS Power Point.
- Introduction to Internet and its applications in biology.

MODULEIV

- Definition & scope, Importance of bioinformatics.
- Bioinformatics Software and its Applications, Bioinformatics & drug discovery.

MODULEV

- Type of genomics (Structural, functional and comparative); Introduction to genome sequencing and its significance; Human genome project; Genome sequencing.
- Definition and objectives of proteomics; Relationship between gene and protein; Types of proteomics.

Books Recommended:

1. Goon, A.M. and Dasgupta, B. (1983). Fundamentals of Statistics.Vol. I. World Press. Kolkotta.
2. Hunt, R. and J. Shelly (2002). Computer and Common Sense.4th Ed. Prentice Hall. India.
3. Kanetker, Y. Let us 'C'(2006). B.P.B. Publication.
4. Rajaraman,V.(2004). Computer Programming in FORTRAN. 90 and 95. Prentice Hall. India.
5. Rajaraman, V. and Radhakrishanan, T.(2004). An Introduction to Digital Computers. Prentice Hall. India.
6. Sinha, P.K. (2003). Computer Fundamentals. B.P.B. Publications.

Member **External Expert** **HoD**

BOT-CC-415:PRACTICAL I based onBOT-CC-411, BOT-CC-412, andBOT-CC-413

T	S	P	Credit
0	0	4	4

Course Objectives	• This course aims to have practical knowledge of evolutionary diversification of early land plants and morphological and reproductive innovations in land plants. • Study of morphology, anatomy, reproductive and developmental change.
Course Outcomes	• The students can note visible differences in the morphology and anatomy of various plant forms. • Students will learn about how the organ formation occurs in early land plants that resulted to the diversity of plant species.

ALGAE

Study of Morphological and reproductive parts of followinggenera:

- Cyanophyta: *Anabaena, Microcystis, Oscillatoria*.
- Chlorophyta: *Acetabularia, Chlorella*, *Oedogonium*, *Pithophora*, *Spirogyra*, *Volvox, Nostoc,Ulothrix*.
- Xanthophyta: *Vaucheria*
- Phaeophyta: *Dictyota, Ectocarpus, Fucus*, *Padina* and *Zonaria*.
- Rhodophyta: *Batrachospermum, Gelidium, Gracillaria*and *Polysiphonia*
- Permanent slide preparation: *Oedogonium,Spirogyra* and *Sargassum*.
- Quantification of total soluble carbohydrate in the algal samples.
- Estimation of reserve food material from the given algal samples.
- Study of metal uptake by algae.

Note: The students are required to collect and submit 10 algal specimens.

BRYOPHYTES

Study of morphological, anatomical and reproductive parts of following genera:

- Liverworts: *Marchantia,Porella, Plagiochasma, Targionia.*
- Hornworts: *Anthoceros*.
- Mosses: *Funaria, Polytrichum*.
- Specimen study: *Anthoceros,Sphagnum* and *Marchantia*.
- Collection and identification of bryophytes genera and slide preparation/T.S. of available material near university campus.
- Temporary mount preparation and study of: Gemma cups, gemmae and peristome teeth.

FUNGI AND PLANT PATHOLOGY

- To study morphology of following Myxomycetous fungi: *Trichia, Hemitrichia, Stemonitis.*
- To study comparative morphology of sporangiophores of following Oomycetous fungi: *Peronospora, Bremia*and*Sclerospora*.
- To study comparative morphology of Ascocarps.
- To study symptoms and histopathological details of following: *Albugocandida,Synchytricumendobioticum, Protomycesmicrospors, Physodermamaydis, Erysiphegraminis, Urocystistritici, Pucciniagraministritici, P. recondita, P. striformis, Alternariasolani, Cercosporaarachidicola* and *Colletotrichumcapsici*.
- To study different spore stages in life cycle of *Puccinia* on primary and secondary host.
- Study of crustose, foliose and fruticose lichens.
- Study permanent slide of yeast.
- To study symptoms and spore morphology of *Ustilago, Sphaelotheca* and *Toliposporium*.
- To study range of variation in fructification of following basidiomycetous fungi: *Corticium, Thelephora, Clavaria, Polyporus,Trametes, Ganoderma, Agaricus, Boletus, Russula* and *Lactarius*.

Note: The students are required to collect and submit 10 fungal specimens.

PTERIDOPHYTES

- Morphological study from specimens/class work material of *Psilotumnudum, Tmesipteristannensis, Lycopodiumcernuum, L.clavatum, L. squarrosum, Phylloglossumdriummondii,Azollamicrophylla, Selaginellamonospora, S. bryopteris, S. chrysorrhizas, S. pallidissima, S. adunca, S. subdiaphana,Isoetespanchanan, Equisteumdebile, E. diffusum, E. ramossissimum, E. arvense, Marseilea, Salvinia, Pteris sp. Dryopteris sp., Aspleniumsp,*
- Section cutting:*Equisetium, Sellaginella, Marsilea, Thelypteris, Pterissp, Dicranopterissp*and*Angiopterisevecta.*
- Collection and identification of pteridophyta genera and slide preparation/T.S. of available material near university campus.

GYMNOSPERMS

- Morphological studies from specimens of major genera of all the orders of Gymnosperms.
- To cut and study T.S., T.L.S. & R.L.S. of wood of *Pinus, Cedrus, Taxus, Thuja*
- To study wood elements by maceration of: *Pinus, Cedrus.*

- To study the anatomical details of the leaf/leaflet of *Pinus, Cedrus, Araucaria, Cycas, Thuja.*
- To study male cones of *Pinus, Cedrus, Thuja, Araucaria, Cycas*.
- To Study of female cones of *Pinus, Cedrus, Thuja, Araucaria, Cycas*.
- Study of fossil Gymnosperms specimen: *Taxus, Ginkgo.*
- To Collection and identification of gymnosperm genera and slide preparation/T.S. of available material near university campus.

Note: The students are required to collect and submit 50 (bryophyta, pteridophyta and gymnosperm) specimens.

Member **External Expert** **HoD**

BOT-AECP-416: PRACTICAL based onBOT-CC-414

T	S	P	Credit
0	0	2	2

Course Objectives	• To impart practical knowledge of computer applications and their use in biology. • To provide training in the use of statistical softwares'
Course Outcomes	• Students will learn necessary skills in the use of databases and online tools related to biological data. • Students will be trained in statistical concepts and principles relevant to biological data and their applications.

CONTENT:

- To use various computer applications: MS Word, MS Access, MS Excel, MSPowerPoint.
- Calculation of mean, mode, median, standard deviation and coefficient of variation.
- Skewness and Kurtosis- coefficients and probability.
- Frequency and probability distributions.
- Studentst-test, F-test, one way and two way ANOVA.
- Correlation and regression analysis.
- Binary numbers

Member **External Expert** **HoD**

SEMESTER – II

BOT-CC-421: ECOLOGY

T	S	P	Credit
4	0	0	4

Course Objectives	• To gain an understanding of ecological diversity, plant succession and ecosystem. • Become familiarize with variety of ways that organism interact with both physical and biological environment.
Course Outcomes	• Knowledge about the ecological groups of plants and their adaptations to diverse habitats. • Gain an insight into the diverse ecosystem and related food webs and ecological pyramids.

MODULE I

- Climate, Soil and Vegetation Patterns and organization: Life zones, major Biomes, vegetation, soil types, concepts of community, ecological succession.
- Ecosystem organization; Structure and functions, Primary production, energy dynamics, litter fall and decomposition.
- Global biogeochemical cycles, mineral cycles in terrestrial and aquatic ecosystems.

MODULEII

- Ecological Management: Concepts, sustainable development, sustainability indicator.
- Population Growth and Dynamics: Models of population growth.
- Reproduction strategies, Mating preference, Spacing systems, r and k selections, Case studies in population Dynamics.

MODULE III

- Competition and Mutualism: Types and theories of competition.
- Commensalism and Mutualism, Plant-pollinator and animal-animal interactions, Niche theory.
- Biological Biodiversity: concepts and levels, role of biodiversity in ecosystem functions and stability, Speciation.

MODULE IV

- Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
- Types; mechanisms; changes involved in succession; concept of climax.

MODULE V

- Major habitat types of the subcontinent, geographic origins and migrations of species.
- Rare, endangered species. Conservation strategies.

- Predation: Predator-prey interaction, Host parasite interaction, Role of predation in nature.
- Degraded ecosystems and their regeneration with special reference to waste lands, forests and aquatic ecosystem.

Books Recommended:

1. Begon, M. and Townsend, C.R. (1995). Ecology: Individuals, Populations and Communities. Blackwell Publishers.
2. Botkin, O. and Keller, E. (1995). Environmental Science. John Wiley Publishers. New York.
3. Chapman, J.L. and Reiss, M.J. (1994). Ecology Principles and Applications. Cambridge Univ.Press.
4. Dash, M.C. (1994). Fundamentals of Ecology. Tata McGraw Hill. New Delhi.
5. Pandey, B.N. and Kulkarni, G.K. (2006). Biodiversity and Environment. APH Publishing Corporation. New Delhi.
6. Ramakrishanan, P.S. (1991). Ecology of Biological Invasion. International Scientific Publications, New Delhi.
7. Odum, E.P. (1971). Fundamentals of Ecology.

Member **External Expert** **HoD**

BOT-CC- 422: BIOLOGY AND DIVERSITY OF ANGIOSPERMS

T	S	P	Credit
4	0	0	4

Course Objectives	• The paper will deal with the various aspects of angiospermic plants such as their diversity, morphology, anatomy, and reproduction. Also, emphasis will be given at their identification and nomenclature.
Course Outcomes	• Acquire knowledge about biology and diversity of angiosperms. • Know about morphological, anatomical features of angiosperms. • Learn about the reproduction biology of angiosperms. • Learn about the identification and nomenclature of the plants.

MODULE I

- Angiosperms: General introduction.
- Origin and evolution of Angiosperms (special reference to Bennettitalean, Gnetalean, Caytonialean, and Herbaceous origin theories).
- Morphology of flowering plants: morphology and modification of Root.

MODULE II

- Morphology and modification of leaf.
- Morphology and modification of stem.
- Morphology and modification of flower/inflorescence and fruit.

MODULE III

- Anatomy of flowering plants: tissue, meristematic tissue, permanent tissue, tissue system
- Anatomy of Dicot and Monocot plants: root, stem, leaf.
- Secondary growth

MODULE IV

- Systems of Angiosperm classification:
    1. Phenetic vs. Phylogenetic system
    2. Relative merits and demerits of major systems of classification
- International code of Botanical Nomenclature: History, Principles & Rules.
- Numerical Taxonomy: Concepts, characters & attributes.
- Taxonomy in relation to anatomy, embryology, palynology, cytology, secondary metabolites in plants.

MODULE V

- Male Gametophyte: Structure of Anthers, Microsporogenesis, Role of Tapetum, Pollen development, Male sterility, Pollen tube growth and guidance.
- Female Gametophyte: Ovule development, Megasporogenesis, Structure and organization of the embryo sac, Nutrition of the embryo sac.

- Pollen-pistil interaction, fertilization; sporophytic and gametophytic self-incompatibility.
- Seed Development: morphology and modification, Endosperm development.

Books Recommended:

1. Benson, L.D. (1962).Plant Taxonomy: Methods and Principles. Ronald Press. New York.
1. Coole, A.J. (1969). Numerical Taxonomy. Academic Press. London.
2. Cronquist, A. (1968). The evolution and classification of flowering plants. Houghton Miffin, Boston.
3. Cronquist, A.(1981). An integrated system of classification of flowering plants. Columbia University Press.
4. Davis, P.H. and Heywood, V. H. (1973). Principles of angiosperms taxonomy. Kreiger Publishing. Co. NewYork.
5. Gupta, R.K. (1981). Systematic Botany. Atma Ram and Sons. New Delhi.
6. Naik, V.N.(1984). Taxonomy of Angiosperms. Tata McGraw Hill. New Delhi.
7. Pandey, S.N. and Misra, S.P.(2008). Taxonomy of Angiosperms. Ane Books. India.
8. Sharma, O.P. (2002). Plant Taxonomy. Tata McGraw Hill Publishing Co. Pvt. Ltd. New Delhi.

Member **External Expert** **HoD**

BOT-CC- 423: GENETICS

T	S	P	Credit
4	0	0	4

Course Objectives	• The paper will deal with Mendelian and non-Mendelian inheritance, quantitative genetics, molecular markers and linkage mapping, prokaryotic and eukaryotic genome-structure, gene function and regulation, epigenetics, cytogenetics and crop evolution.
Course Outcomes	• Acquire knowledge about Inheritance and genetic material. • Know about structure of gene & its regulation. • Learn about the chromosome; their mapping and crop evolution.

MODULE I

- Introduction: Mendelian vs. non-Mendelian inheritance, quantitative and population genetics.
- Microbial genetics: Viral, bacterial and fungal genetics, fine structure of gene. Prokaryotic gene regulation: operons, genetic switches, CRISPR-cas, sigma factors, and small RNAs.

MODULE II

- Eukaryotic genome: Components- repeat elements, transposons, organization and evolution.
- Eukaryotic gene regulation: cis and trans-regulation: promoters, transcription factors, post-transcriptional regulation, role of chromatin and its higher order structure.

MODULE III

- Genetic mapping in eukaryotes: Linkage and crossing over, molecular mechanism of recombination, molecular markers and construction of linkage maps.

MODULE IV

- **Cytogenetics**: Chromosome: structure and nomenclature, centromere and telomere; Sex determination mechanisms, sex chromosome, chromosomal aberrations.
- Molecular cytogenetics: methods and applications.

MODULE V

- **Crop genetics:** Crop domestication in selected taxa, role of chromosomal aberrations in crop evolution, genome analysis in crop plants. Plant genetic resources and their conservation.
- **Epigenetics:** Introduction, methylation, histone modifications, epialleles; their inheritance and role in regulation. Tools to study epigenetics.

Books recommended:

1. Russel, P. J. (2010). iGenetics- A Molecular Approach, Pearson Education Inc.
2. Gardner, E. J., Simmons, M. J., and Snustad, D. P. (1991). Principles of Genetics.John Wiley & Sons.
3. Strickberger, M.W. (2008). Genetics.Pearson (Prentice Hall).
4. Acquaah, G. (2007). Principles of Plant Genetics and Breeding. Blackwell Publishing Ltd. USA.
5. Allard, R. W. (1999). Principles of Plant Breeding.John Wiley and Sons.
6. Singh, R. J. (2002). Plant Cytogenetics.CRC Press.
7. Hartwell, L. H., Hood, L., Goldberg, M. L., Reynolds, A. E., Silver, L. M., and Veres, R. C. (2006). Genetics-From Genes to Genomes. McGraw Hill
8. Lewin, B. (2008). Genes IX. Jones and Barlett Publishers.
9. Hartl, D. L. and Jones, E. W. (2007). Genetics-Analysis of Genes and Genomes.Jones and Barlett publishers.

Member **External Expert** **HoD**

BOT-CC-424:CELL AND MOLECULAR BIOLOGY

T	S	P	Credit
4	0	0	4

Course Objectives	• To introduce about cell and cell organelles. • To understand the various phase of cell division. • To learn about the genetic material of living organisms. • Basic understanding of intercellular communications.
Course Outcomes	• Acquire knowledge about fundamental unit of life *i.e.* cell. • Know about structure of DNA &its working. • Learn about the various factors involved in cell signaling and cellular communications.

MODULE I

- General account of plant cell.
- Cell wall: structure, function and biogenesis.
- Plasma membrane: structure, models, functions, channels and pumps
- Plasmodesmata: structure, role in movement of molecules.

MODULE II

- Chloroplast, endoplasmic reticulum, Golgi body, lysosome, GERL system, ribosome, Mitochondria: Structure, genome organization and function.
- Nucleus: Structure, nuclear pores, nucleosome organization, nucleolus.
- The cytoskeleton: Organization and role of microtubules and microfilaments, motor movements.

MODULE III

- DNA structure: A, B and Z forms; Replication.
- Transcription.
- Translation.

MODULE IV

- Cell cycle and apoptosis: Control mechanisms, cytokinesis and cell plate formation, mechanisms of programmed cell death.
- Regulation of gene expression in Prokaryotes.
- Regulation of gene expression in Eukaryotes.

MODULE V

- Cell Signaling: Hormones and their receptors, cell surface receptors, signaling through G-protein coupled receptors.
- Signal transduction pathways, secondary messengers.
- Regulation of Signaling pathways, light signaling in plants.

Books Recommended:

1. Buchnan, B.B. and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Rockville, Maryland.
2. Grierson, D. and Covey, S.N. (1998). Plant Molecular Biology. Blackie Academic and Professionals. London.
3. Gupta, P.K. (2004). Cell and Molecular Biology. Rastogi Publication. Meerut.
4. Karp, G. (1999). Cell and Molecular Biology. John Wiley & Sons. U.S.A.
5. Kindt, T.A., Goldsby, R.A. and Osborne, B.A (2007). Immunology. W.H. Freeman and Co. NewYork.
6. Lea, P.andLeegood,C. R.C. (1999). Plant Biochemistry and Molecular Biology. John Wiley and Sons, New York.
7. Lehninger, A. (1993).Principles of Biochemistry. Worth Publishers, New York.
8. Lewin, B. (2004). Gene VIII. Pearson Education International. Philadelphia.
9. Lodish, H., Berk,A. and Darnell,J. (2000). Molecular Cell Biology. W.H. Freeman and Co. U.S.A.
10. Robert, D.D. (1978). Cell Biology – A Molecular Approach. Allyn and Bacon, Inc.

Member **External Expert** **HoD**

BOT-OE-425:PLANT DIVERSITY

T	S	P	Credit
4	0	0	4

Course Objectives	• The course aims to have understanding of plant diversity, significance of diversity, need of classification, bases of classification, Plant adaptations, distribution of plants, evolutionary diversification.
Course Outcomes	The students will be learning: • What is the significance of plant diversity? • What are the adaptations in plants in relation to habitat conditions? • Plant diversity at different levels.

MODULE I

- Plant diversity and Classification, Levels of biodiversity, various Phyla of Plants and their characteristics (Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms).

MODULE II

- Ecosystem services, Human Food and Plant diversity, Bacterial diversity, Terrestrial Plant diversity, Marine Plant diversity, Inland water diversity, Rain Forest ecosystem and plant diversity, Landscape diversity

MODULE III

- Biodiversity Hotspots, Keystone species, Threats to Plant diversity, Desertification, Endangered plants, Plant invasions, Loss of Plant diversity, Plant Restoration

MODULE IV

- Indigenous people and plant diversity, Traditional plant conservation practices, Plants in Indian tradition and culture, Plant animal interactions.

MODULE V

- Use and Economic values of plant diversity.
- Tourism and Plant diversity.
- Climate change and plant diversity.

Books recommended:

1. Kumar, U. and Sharma, A.K. (2001). Plant biotechnology and Biodiversity conservation.Agrobios, Jodhpur.
2. Dobson, A. (1996). Conservation and Biodiversity. Palgrave MacMillan
3. Levin, S.A. (2001). Encylopedia of Biodiversity Vol 1 to 5. Academic Press New York
4. Groombridge, B. and Jenkins, M.D. (2002). World Atlas of Biodiversity, Earth living

resources in the 21st Century. University of California Press
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2008). Ecology, Environment and Resource conservation.Anamaya Publications, New Delhi
6. Krishnamurthy, KV. (2003). Text Book of Biodiversity.Science Publishers.

Member **External Expert** **HoD**

BOT-CP-426:PRACTICAL III based on BOT-CC-421 and BOT-CC-422

T	S	P	Credit
0	0	4	4

Course Objectives	• To familiarize the students with the various ecological principles with practical knowledge on ground level. • To impart knowledge of various components of ecosystem though different practical methods. • To provide knowledge of morphological and anatomical structures of various parts of angiospermic plants.
Course Outcomes	• The students will be learning about the concepts, tools and techniques related to the ecology. • The students will learn about the appearance of various cell/tissue type under the microscope and their relevance in the nomenclature.

ANGIOSPERMS

- Study of the locally available plants and recording of the intraspecific variation.
- Description and identification at family, genus and species levels using Floras.
- Identification of key characters in a group of species of a genus and construction of keys.
- Construction of indented keys for the given material
- Simple Nomenclatural problems
- Identification of families studied based on flowers or essential parts of the flowers
- Knowledge of Herbarium techniques
- Record and Herbarium
- To study the anatomy of:
    1. Monocot root.
    2. Dicot root.
    3. Monocot stem.
    4. Dicot stem.
    5. Monocot leaf.
    6. Dicot leaf.

ECOLOGY:

- A trip to the grass land/ forest/ water body to get acquainted with their plant species.
- Distribution pattern of different plant species determined by Quadrate/Transect/ Pointcentred Quarter methods.
- To determine minimum size and number of quadrats required to study grassland.
- Qualitative parameters of distribution of plant species, Frequency, Density, Basal cover,
- Dominance, Abundance and IVI.
- To determine diversity indices (Shannon-Weiner, species richness, B-diversity) from givenData.

- To determine gross and net phytoplankton productivity by light and dark bottle method.
- Analysis of soils of two different areas *i.e*. Cropland and forest/ grassland for certain nutrients, CO_3, NO_3, Base deficiency.
- To study ecological adaptations of the given plants
- Study of diversity of freshwater and marine plants
- To study world formation on the basis of a biome through map provided to you.
- To study world soil map based bioclimatic zones.
- To determine free CO_2 from given water samples.
- To determine dissolved O_2 from given water sample.
- To determine alkalinity of given water sample.
- To test nitrate, ammonium, nitrite nitrogen, calcium, phosphorus and potassium in the crop land, grassland and forest soil samples.
- To estimate organic matter of given soil samples by Walkey-Black method.
- To study of effect of SO_2 (a pollutant) on pollen tube emergence of given pollen samples.
- To study the conventional metrological instruments.

Member **External Expert** **HoD**

BOT-CP-426: PRACTICAL IV Based on BOT-CC-423 and BOT-CC-424

T	S	P	Credit
0	0	4	4

Course Objectives	• To gain the practical understanding the various phase of cell division. • To learn about the genetic material of living organisms under microscope. • Basic understanding of intercellular communications through various biomolecular tests.
Course Outcomes	The students will: • Acquire knowledge about fundamental unit of life *i.e.* cell and its division. • Know about structure of, chromosomes, DNA &their working. • Learn about the various factors involved in cell signaling and cellular communications.

CELL AND MOLECULAR BIOLOGY

- To calculate the index of microscope at low and high power using ocular and stage micrometer.
- To calculate magnification of the microscope (10x, 40x lens) using Camera lucida.
- To measure the size of given pollen grains/spores/fibers with the help of ocular micrometer.
- To draw and measure the size of given pollen grains/spores/stomata using Camera lucida.
- To compare the stomatal index of upper and lower surface of the leaf. (Dicot, Monocot).
- To isolate chloroplasts from green leaves.
- Qualitative identification of carbohydrates: Molisch's test for carbohydrates, Iodine test for starch, Bradford's test for monosaccharides, Seliwanoff'stest for ketoses, Fehling's test for reducing sugars and Bial's test for pentoses.

GENETICS

- Fixation of material in fixative.
- Preparation of various stains for cytogenetic studies.
- Preparation of different fixatives for cytogenetic studies.
- Detailed study of meiosis in *Allium cepa*.
- Detailed study of mitosis in *Allium*.
- Determination of chromosome number through meiosis in available monocots and dicots.
- Analysis of Karyotype from given diagram.
- Study of meiotic abnormalities like laggards, bridges, cytomixis, univalent/multivalent formation from permanent /temporary slides.
- To study the pollen fertility.

Member **External Expert** **HoD**

SEMESTER – III

BOT-CC-431: PLANT PHYSIOLOGY

T	S	P	Credit
4	0	0	4

Course Objectives	• To acquire basic knowledge and fundamental concepts of anatomy and embryology of plants. • To understand various tissue organization, anatomical adaptation, embryo, endosperms and seeds structures.
Course Outcomes	• Gain knowledge of plant cellular organization into the various tissues and their specific functions. • Analyze mechanism and adaptation for fruit and seed dispersal. • Analyze the anatomical adaptations and protective systems in plants.

MODULE I

- Inorganic Nutrition**:** Occurrence, availability and physiological roles of various elements
- Ion uptake and active and passive transport, Role of calmodulin, phloems transport.
- Stomatal physiology: Chemiosmotic mechanism of stomatal movements, hormonal regulation and significance of calcium ions.

MODULE II

- Photochemistry and Photosynthesis: Concepts and historical background, evolution of photosynthetic apparatus.
- Pigments and Light harvesting complexes, photooxidation of water, mechanism of electron and proton transport.
- Carbon assimilation: Calvin cycle, photorespiration, C4 cycle, CAM pathway, Biosynthesis of starch and sucrose, physiological and ecological considerations.

MODULE III

- Respiration: Overview of plant respiration, Glycolysis, TCA Cycle, Electron transport and ATP synthesis, Structure and functions of ATP, Pentose phosphate pathway, glyoxylate cycle, alternative oxidase system.
- Nitrogen Fixation: Nitrogen metabolism: overview, symbiotic and non-symbiotic nitrogen fixation, biological nitrogen fixation, nodule formation, nod factors.
- Mechanism of nitrate uptake and reduction, ammonium assimilation.

MODULE IV

- Sensory Photobiology: History of discovery of phytochromes and cryptochromes, their photochemical and biochemical properties.
- Photobiology of light induced responses, cellular localization.
- Molecular mechanisms of action of photomorphogenetic receptors, signaling and gene expression.

MODULE V

- Plant Growth regulators and elicitors: Physiological effects and mechanisms of action of auxins, gibberllins, cytokinins, ethylene, andabscisic acid.
- The flowering process: Photoperiodism and its significance.
- Endogenous clock and its regulation.
- Role of vernalization.

Books Recommended:

1. Bidwell, R.G.S. (1979). Plant physiology. MacMillan Publishing Co. Inc. NewYork.
2. Buchanan. B.B., Gruissem. W. and Jones, R.L.(2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists. Maryland, USA.
3. Devlin, R.M., and Witham, F.H.(1986). Plant Physiology. C.B.S. Publishers. New Delhi.
4. Number Theory, David M. Burton, McGraw Hill.
5. Lawlor, D.W. (2001). Photosynthesis. Viva Books Pvt. Ltd. New Delhi.
6. Levitt, J. (1980). Responses of Plants to Environmental Stresses. Academic Press. London.
7. Malik, C.P. (2002). Plant Physiology. Kalyani Publishers. India.

Member **External Expert** **HoD**

BOT-CC-432: BIOCHEMISTRY

T	S	P	Credit
4	0	0	4

Course Objectives	• To understand the available techniques for designing a qualitative research. • To gain knowledge on working principles of various techniques.
Course Outcomes	• Learn about basic of biosafety and good lab practices like safe chemical handling, hazardous waste management, safe and proper use of lab equipment. • Learn about the principles of various basic and advanced microscopy.

MODULE I

- Structure of atoms, molecules and chemical bonds.
- Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
- Stablizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.

MODULE II

- Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
- Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
- Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.

MODULE III

- Primary, secondary, tertiary and quaternary structures of proteins
- DNA: Double helical structure of DNA, DNA replication, recombination and repair.
- RNA :Structure of RNA, role of RNA in gene expression

MODULE IV

- Functional importance of lipid storage & membrane lipids
- Fatty acid metabolism: Synthesis and degradation of fatty acids
- Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins

MODULE V

- Basic concept of metabolism: Coupled and interconnecting reactions of metabolism; cellular energy resources and ATP synthesis.
- Concept of free energy and thermodynamic principles in biology.
- Oxidative phosphorylation & Pentose Phosphate Pathway

Books Recommended:

1. Conn, E.E., P.K Stumpf., G.Bruening and R.H.Doi.(2006). Outlines of Biochemistry. John Wiley. India.
2. Deb, A.C.(2008). Fundamental of Biochemistry. New Central Book Agency Pvt. Ltd. Kolkata.
3. Dey, P.M. and J.B. Harborne. (1997). Plant Biochemistry. Academic Press. London.
4. Hames, D. and Cooper, N. (2008). Biochemistry. Garland Science Publishers, U.S.A.
5. Jain, J.L., N. Jain and S. Jain. (2007). Fundamentals of Biochemistry. S. Chand and Co. Ltd. New Delhi.
6. Malik,C.P. and M.B. Singh.(1980). Plant Enzymology and Histoenzymology. Kalyani Publishers.
7. Mathews, K. and Vanhold, A.(2003). Biochemistry. Pearson Edu. Pvt. Ltd. New Delhi.

Member **External Expert** **HoD**

RM-CC-022: RESEARCH METHODOLOGY

T	S	P	Credit
4	0	0	4

Course Objectives	This course will help to: Develops better insight into topic; Provides systematic structure; Enhance the research quality**;** Derive better solutions; Aids in decision making; Inculcates logical and systematic thinking.
Course Outcomes	At the end of this course, the students should be able to: • understand some basic concepts of research and its methodologies • select and define appropriate research problem and parameters • prepare a project proposal (to undertake a project) • organize and conduct research (advanced project) in a more appropriate manner • write a research report and thesis

MODULE I

- **Foundations of Research:** Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process.
- **Problem Identification & Formulation –** Research Question – Investigation Question –Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

MODULE II

- **Research Design:** Concept and Importance in Research – Features of a good research design Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.
- **Qualitative and Quantitative Research:** Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.

MODULE III

- **Measurement:** Concept of measurement– what is measured? Problems in measurement inresearch – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.
- **Sampling:** Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size,Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample,Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample– Practical considerations in sampling and sample size.

MODULE IV

- **Data Analysis:** Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts,percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis ofassociation.
- **Interpretation of Data and Paper Writing** – Layout of a Research Paper, Journals in Chemical Sciences, Impact factor of Journals, When and where to publish? Ethical issues related to publishing,Plagiarism and Self-Plagiarism.

MODULE-V

- Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer ScienceDiscipline. **Use of tools / techniques for Research:** methods to search required information effectively,Reference Management Software like Zotero/Mendeley, Software for paper formatting likeLaTeX/MS Office, Software for detection of Plagiarism.

Books recommended:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman& Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari
4. Select references from the Internet.

Member **External Expert** **HoD**

BOT-OE-433: ECONOMIC BOTANY

T	S	P	Credit
4	0	0	4

Course Objectives	• Students would be exposed to the economic importance and current research paradigms in various categories of commercially cultivated plants.
Course Outcomes	• Learn about basic of biosafety and good lab practices like safe chemical handling, hazardous waste management, safe and proper use of lab equipment. • Learn about the principles of various basic and advanced microscopy.

MODULE I

- A brief account of the origin, botany, cultivation and uses of food crops.
  - (i) Cereal Crops - Wheat, Rice, Maize,
  - (ii) Sugar Crops - Sugarcane
  - (iii) Tuber Crops - Potato
- A brief account of the origin, botany, cultivation and uses of the following
  - i. Fibre crops: (Cotton, flax, Hemp, sisal) and
  - ii. Fodder crops (Sorghum, Barseem, Guar)

MODULE II

- A brief account of the origin, botany, cultivation and uses of vegetable oil yielding plants.
  (i) Mustard (ii) Coconut (iii) Groundnut (iv) Sunflower.
- A brief account of the origin, history, botany, cultivation, processing chemical composition and uses of the following beverages crops.
  (i) Tea (ii) Coffee

MODULE III

- A brief account of the origin, history, botany, cultivation, processing and uses of Tobacco and Para Rubber.
- Name, family, plant part yielding active principle and uses of the following:
  (i) Medicinal Plants: Aconitum, Cinchona, Belladona, Digitalis, Glycyrrhiza, Artemisia, Rauvolfia, Nux-vomica, Garlic, Neem, Tulsi, Papaver, Vasaka, Aloe, Asafoetida, Genseng.

MODULE IV

- Name, family, plant part yielding active principle and uses of the following
  (i) Aromatic Plants: *Mentha, Rosa, Jasminum, Cymbopogon*, Lavender, Hops, Camphor.
  (ii) Spices and Condiment: Ginger, Turmeric, Cinnamon, Cloves, Cardamom, Chilies, Pepper, Fennel, Coriander, Cumin, Nutmeg, Mace and Saffron.

MODULE V

- Name, family, distribution and uses of important commercial timbers of India (Teak, Sal, Chir, Kail, Deodar, Sisham, Kikar). List of important fuel woods, trees for avenues, pollution control and aesthetics.
- A brief account of the following: (i) Gums (ii) Resin (iii) Tannins (iv) Dyes (v) Rattans (vi) Raw materials for Paper Industry (vii) Bamboos (viii) Wild Fruits.

Books Recommended:

1. Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop Plants in India. NBPGR Science Monograph No. 7.
2. Conway, G. 1999. The Doubly Green Revolution. Food for All in the 21st Century, Penguin Books.
3. Conway, G. and Barbier, E. 1990. After the Green Revolution, Earthscan Press, London.
4. Conway, G. and Barbier, E. 1994. Plant, Genes and Agriculture, Jones and Bartlett Publishers, Boston.
5. Council of Scientific and Industrial Research, (1948-76). The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products, New Delhi. Raw materials I-XII, Revised Vol. I-III (1985-1992) Supplement (2000).
6. Kochhar, S.L. 1998. Economic Botany in the Tropics, 2nd Edition, MacMillan Indian Ltd., New Delhi.

Member **External Expert** **HoD**

BOT-EC-434: IMMUNOLOGY

T	S	P	Credit
4	0	0	4

Course Objectives	• The objective of this module on immunology is • to provide a basic understanding of fundamentals of immunology. • It will also provide conceptual understanding of the current tools and techniques available in the field of immunology.
Course Outcomes	• The students will be learning about • What is immunity and how various factors such as environmental and genetic makeup regulate it, how does immune system evolve? • What are antigen and antibodies and how do they interact with each other? • What happens at cellular level when a foreign antigen enters body?

MODULE I

- Introduction to Immunology: Innate and acquired immunity, characteristics if immune response, humoral and cellular immunity, benefits and damaging effects of immunology

MODULE II

- Cell and tissues of immune system: Cell of immune system, primary and secondary lymphoid organs.
- Antigens: Immunogens, major classes of antigens, physical and chemical properties of antigens.
- Immunoglobulin's: Structure and functions of immunoglobulin's, classes and subclasses of human immunoglobulin's, polymorphism, primary and secondary immune response.

MODULE III

- Complement System: Complement proteins, pathways of complement activation 15 Antigen- antibody reaction, Precipitation, agglutination, Immunofluorescence, radioimmunoassay, ELISA, immunoblotting.
- Monoclonal antibodies: Hybridoma, Isolation and characterization of monoclonal antibodies. Hypersensitivity Anaphylaxis, antibody-mediated cytotoxic and immune complex reactions, delayed –type hypersensitivity.

MODULE IV

- Immunogenetics: Immunoglobulin genes, Ig/TCR gene rearrangement and generation of diversity, introduction to immunogenetics and the MHC, antigen recognition by T cells, TCR, co-receptors, MHC structure, antigen processing and presentation

MODULE V

- Immunity in Health and Disease:Immune response to infectious diseases, immunodeficiency and AIDS, Hypersensitivity, transplant rejections, autoimmunity, Vaccines, Evolution of the immune system.

Books Recommended:

1. Immunology by JarisKuby.
2. Immunology by J. A. Bellanti.
3. Fundamentals of Immunology by W. e. Paul.
4. Essential Immunology by J. M. Roitt.
5. Immunology by E.S. Golub.
6. Immunology by E. Benjamini, R Coice and G. Sunshine.

Member **External Expert** **HoD**

BOT-EC-435: PLANT RESOURCE UTILIZATION

T	S	P	Credit
4	0	0	4

Course Objectives	• Students would be exposed to the economic importance and current research paradigms in various categories of commercially cultivated plants.
Course Outcomes	• Get an overview of the significance of plant diversity, and an insight into global strategies for developing workable models for its exploration and conservation. • Develop an understanding of the importance of national parks, biosphere reserves and sanctuaries. • Understand the role played by government and non-government organizations in conserving biodiversity.

MODULE I

- A brief account of the origin, botany, cultivation and uses of food crops.
  - i. Cereal Crops - Wheat, Rice, Maize,
  - ii. Sugar Crops - Sugarcane
  - iii. Tuber Crops - Potato
- A brief account of the origin, botany, cultivation and uses of the following
  - i. Fiber crops: (Cotton, flax, Hemp, sisal) and
  - ii. Fodder crops: (Sorghum, Barseem, Guar)

MODULE II

- A brief account of the origin, botany, cultivation and uses of vegetable oil yielding plants.
  (i) Mustard (ii) Coconut (iii) Groundnut (iv) Sunflower.
- A brief account of the origin, history, botany, cultivation, processing chemical composition and uses of the following beverages crops.
  (i) Tea (ii) Coffee

MODULE III

- A brief account of the origin, history, botany, cultivation, processing and uses of Tobacco and Para Rubber.
- Name, family, plant part yielding active principle and uses of the following:
  (ii) Medicinal Plants: Aconitum, Cinchona, Belladona, Digitalis, Glycyrrhiza, Artemisia, Rauvolfia, Nux-vomica, Garlic, Neem, Tulsi, Papaver, Vasaka, Aloe, Asafoetida, Genseng.

MODULE IV

- Name, family, plant part yielding active principle and uses of the following
  (iii) Aromatic Plants: Mentha, rosa, Jasminum, cymbopogon, Lavender, Hops, Camphor.

(iv) Spices and Condament: Ginger, Turmeric, Cinnamon, Cloves, Cardamom, Chllies, Pepper, Fennel, Coriander, Cumin, Nutmeg, Mace and Saffron.

MODULE V

- Name, family, distribution and uses of important commercial timbers of India (Teak, Sal, Chir, Kail, Deodar, Sisham, Kikar). List of important fuel woods, trees for avenues, pollution control and aesthetics.
- A brief account of the following: (i) Gums (ii) Resin (iii) Tannins (iv) Dyes (v) Rattans (vi) Raw materials for Paper Industry (vii) Bamboos (viii) Wild Fruits.

Books Recommended:

1. Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop Plants in India. NBPGR Science Monograph No. 7.
2. Conway, G. 1999. The Doubly Green Revolution. Food for All in the 21st Century, Penguin Books.
3. Conway, G. and Barbier, E. 1990. After the Green Revolution, Earthscan Press, London.
4. Conway, G. and Barbier, E. 1994. Plant, Genes and Agriculture, Jones and Bartlett Publishers, Boston.
5. Council of Scientific and Industrial Research, (1948-76). The Wealth of India.

Member **External Expert** **HoD**

BOT-EC-436: PLANT RESOURCE UTILIZATION

T	S	P	Credit
4	0	0	4

Course Objectives	• To communicate the basic knowledge in general microbiology with detailed subdivision of microbiology. • Further bacteriology, virology, mycology give individual sections of microbiology with detailed information on economic importance of microbiology • Finally this course explains the advanced sections of microbiology like Microbial genetics, Food microbiology, Soil Microbiology, Environmental microbiology and Industrial microbiology.
Course Outcomes	• Students will learn various aspects of basic microbiology such as Bacteriology, Virology, Biochemistry, Microbial Physiology, Cell Biology and Molecular Biology in addition to becoming aware of the applied aspects of microbiology such as Soil microbiology, Industrial Microbiology, Food and Dairy Microbiology and Environmental Microbiology.

MODULE I

- General microbiology: Introduction, Morphology and ultrastructure of bacteria. Nutritional types (autotrophs and heterotrophs), growth and growth control of bacteria. Microbial respiration.
- Brief account of photosynthetic and accessory pigments, Principle of microscopy. Culturing of microorganisms, staining techniques.
- Brief account of discovery of viruses. General properties, structure, cultivation, purification, replication and transmission of viruses. Brief account of bacteriophages and plant viruses, Economic Importance.
- Emergence of Archaebacteria, Metabolism and energetics of Archaea, Genome of Archaea.

MODULE II

- General characters of Actinomycetes, Mycoplasmas and Cyanobacteria. Economic importance.
- Status of fungi – Kingdom Mycota. General characters, nutrition, reproduction. Heterothallism and parasexuality.
- Edible and poisonous mushrooms. Mushroom cultivation. Importance of fungi in agriculture and industry. Classification of fungi (Einsworth System).
- General account of Myxomycota, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina

MODULE III

- DNA replication in prokaryotes, Genetic recombination in bacteria and mutations.

MODULE IV

- Food microbiology: Introduction, Food spoilage, Food preservation, Food intoxication or food poisoning, Fermented food items, Microorganisms as food.
- Soil Microbiology: Classification of soils – physical and chemical characteristics, microflora of soil, a brief account of microbial interactions symbiosis – mutualism – commensalisms – competition – ammensalism – synergism – parasitism – predation; Biogeochemical cycles (C, N, P & S).
- Overview of industrial microbiology: Introduction, Microorganisms of industrial importance, Common industrial products

MODULE V

- Microorganisms in relation to plant growth, Biofertilizers, Biological control, biopesticides.
- Water and Air microbiology, Waste treatment.

Books Recommended:

1. Prescott, L. M., Harley, J. P. and Klein, D.A. Microbiology. McGraw Hill, New York
2. Lehninger, A., Cox, M. and Nelson, D. L. Principles of Biochemistry, W. H. Freeman & Company.
3. Gardner, E. J., Simmons, M. J. and Snustad, D. P. Principles of Genetics, John Wiley & Sons.
4. Sambrook, J., Fritsch, E. F. and Maniatis, T. Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press, USA.
5. Stanbury, P. F., Whitaker, A. and Hall, S.J. Principles of Fermentation Technology, Butterworth-Heinemann Publishers.
6. Cohen, A. Medical Virology, John Wiley & Sons, Incorporated.

Member **External Expert** **HoD**

BOT-CP-437: PRACTICAL V based on BOT-CC-431 and BOT-CC-432

T	S	P	Credit
0	0	4	4

Course Objectives	• To impart students the practical knowledge regarding the mechanisms underlined absorption of water and minerals, solute transport, photosynthesis, respiration and nitrogen metabolism. • To acquaint the students about the interactions of various molecules and their functioning including the analytical techniques for qualitative and quantitative estimations.
Course Outcomes	The students will: • Gain knowledge of plant cellular processes and their mechanisms helpful for the growth and development and their survival. • Learn about the various biomolecules present in the plant systems and their estimation procedures.

PLANT PHYSIOLOGY

- To demonstrate the phenomena of adsorption.
- To determine the water holding capacity of different types of soils.
- To demonstrate the operation of the solubility theory of permeability.
- To determine the osmotic pressure of the cell sap of the given plant material by Plasmolytic method.
- To determine the effect of temperature and alcohol on permeability and find out thermal death point.
- To determine the surface tension of alcohol by drop counting method.
- To study the effect of light on the relative loss of water vapour from leaves.
- To measure and compare the rate of transpiration under different environmental conditions with simple potometer.
- To compare the rate of transpiration from two sides of a leaf.
- To demonstrate suction due to transpiration (or transpiration pull).
- To demonstrate transpiration by using Ganong'spotometer.
- To demonstrate the effect of CO_2, light intensity and temperature with time on the rate of photosynthesis in twigs of *Hydrilla*.
- To demonstrate that light, chlorophyll and CO_2 is necessary for photosynthesis.
- To separate leaf pigments by (i) Column Chromatography (ii) Paper Chromatography.
- To separate chloroplast pigments from leaf by chemical method and to calculate their Rf value.
- Quantitative determination of photosynthetic pigments from given plant material.
- To show that oxygen is released during photosynthesis.
- To demonstrate the phenomenon of anaerobic respiration.

- To demonstrate that O_2 is taken in and CO_2 is given out during respiration.
- To determine the respiratory quotient of given plant material by Ganong'srespirometer.

BIOCHEMISTRY

- Measurement of pH of biological liquids using pH strips.
  a) Blood
  b) Urine
  c) Saliva
  d) Tear
  e) Soil
  f) Milk
- Measurement of pH of biological liquids using pH meter
  - Blood
  - Urine
  - Saliva
  - Tear
  - Soil
  - Milk
- To prepare the buffer solutions.
- Titration of a mixture of a strong acid and a weak acid.
- Titration of a mixture of a strong acid with weak and strong acid.
- Identification of sugars in fruit juices using chromatographic techniques.
- Benedict’s test for reducing sugar.
- Iodine test for polysaccharides.
- Estimation of carbohydrates.

Member **External Expert** **HoD**

BOT-EP-438: PRACTICAL VIbased on BOT-CC-434, BOT-CC-435 and BOT-CC-436

T	S	P	Credit
0	0	2	2

Course Objectives	• To Increase the understanding about the diversity of microorganisms their classification structure and growth. • To acquaint students about the different uses of plant based materials for human use.
Course Outcomes	• To develop theoretical and technical skills of basic microbiology. • The students will be learning about the local plants used for various human uses.

MICROBIOLOGY

- Basic microbiological techniques: preparation of media, sterilization, slant and stab preparation. Pouring of plates and pure culture by streak and pour plate method.
- Qualitative and quantitative analysis of soil or water microbiota, characterization of selected pure culture isolates by gram staining, simple and negative staining, endospore staining and physio-biochemical features (extracellular enzymes, antibiotic sensitivity/production).
- Determination of bacterial growth and growth kinetics under batch cultivation (turbidimetric and cell count method)
- Bacterial transformation: Competent cell preparation, transformation, screening of transformed isolates.
- Plasmid isolation and gel electrophoresis.
- Bacteriophage titration, purification and quantification.
- Isolation of antibiotic producing organism from soil and their sensitivity assay against standard laboratory strains of bacteria

PLANT RESOURCE UTILIZATION

- To study the different type of starch grains: wheat, rice, maize, *Phaseolus*, Potato.
- To study the morphological and anatomical features of the following plants:

(i) Spices and Condiments.
(ii) Medical plants.
(iii) Fibers.
(iv) Oil seeds.

- To study of calcium carbonate crystals in *Ficus*.
- To study different types of woods for texture and density.
- Collection of various medicinal plants, fibers, spices/condiments and oil seed plants.

Member **External Expert** **HoD**

SEMESTER – IV

BOT-CC-441: PLANT BIOTECHNOLOGY AND TISSUE CULTURE

T	S	P	Credit
4	0	0	4

Course Objectives	• Understand basic knowledge of tissue culture tools, medium sterilization and techniques of tissue culture. • To learn about basic concepts of recombinant DNA technology. • Course aims at the concept, scope, instrumentation, basic requirements and applied aspects of plant tissue culture.
Course Outcomes	• The students will be learning about scope and application of the biotechnology and biotechnological utilization of regeneration potential. • Learn the specific and non-specific methods of gene transfer.

MODULE I

- **Basic Techniques:** Nutrition Medium, Sterilization Techniques, Principles (Cyto-differentiations, Organogenic differentiation).
- **Types of culture:** Embryo culture, Callus culture and Organ culture.
- **Micropropagation:** Axillary bud Proliferation approach, Meristem & shoot tip culture, Bud culture, Organogenesis & Embryogenesis & their applications.

MODULE II

- **Cell suspension culture**: Types of suspension cultures, Production of secondary metabolites and their applications.
- **Somaclonal Variation:** Selection of somaclonal variants, mechanism & their applications, Cryopreservation.
- **Haploid Production:** Androgenic Methods, Gynogenic Haploids, Chromosome elimination techniques, Distant hybridization, Embryo rescue.

MODULE III

- Protoplast isolation, fusion. Section of hybrid cells, regeneration of hybrid plants, Applications & limitation, Cybrids, Hybrids, somatic hybrids, cytoplast &Plastocyte.

MODULE IV

- **Recombinant DNA technology**: Isolation, cloning vectors and amplification of genes & their applications.
- **Molecular markers & Marker assisted selection**: Morphological, Biochemical & Molecular markers. Non-PCR based approaches & PCR based techniques & their advantages & disadvantages Gene transfer in Plants: Vector &Vectorless.

MODULE-V

- **Transgenics in Crop improvement:** Resistance to biotic & abiotic stress, Transgenics for quality & as bioreactors.
- Application of microbial biotechnology for human welfare.

Books recommended:

1. Bajaj, Y.P.S. (2000). Biotechnology in Agriculture and Forestry-46-Transgenic Trees, springer Pub., New York, USA
2. Bhojwani, S.S., and Razdan, M.K. (1996).Plant Tissue Culture:Theory and Practice (A revised Edition), Elsevier Science Pub., New York, U.S.A.
3. Brown, T.A. (1999). Genomes. John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
4. Chawla, H.S. (2005).Introduction to Plant Biotechnology, Oxford & IBH Pub., New Delhi, India.
5. Gupta, P.K. (1996). Elements of Biotechnology, Rastogi& Co., Pub., Meerut, India.
6. Hammond, J., McGarvey, P. and Yusibov, V. (Eds.) (1999). Plant Biotechnology – New Products and Applications, Springer Pub., New York, USA.

Member **External Expert** **HoD**

BOT-EC-442: ANALYTICAL BOTANY

T	S	P	Credit
4	0	0	4

Course Objectives	• To understand the available techniques for designing a qualitative research. • To gain knowledge on working principles of various techniques.
Course Outcomes	• Learn about basic of biosafety and good lab practices like safe chemical handling, hazardous waste management, safe and proper use of lab equipment. • Learn about the principles of various basic and advanced microscopy.

MODULE I

- Basic Principles of research techniques and safety measures: Aims of Lab investigation, Experimental designs, SI units, safety against Chemical, Physical and Biological hazards. Waste disposals.
- Cell culture techniques: Cell culture Laboratory, equipment's, aseptic techniques and good culture practices, type of cultures, potential uses of cell culture.

MODULE II

- Anatomical and histochemical techniques: Functioning and application of microtomy, stains and staining techniques; Maceration; Principle of fixation, types of fixatives and their applications.
- Principle and methods of histochemical localization of carbohydrates lipids, proteins, nucleic acids and enzymes.

MODULE III

- Centrifugation: Principle, functioning and applications of low speed, high speed and ultracentrifugation.
- Spectroscopy: Principle, functioning and applications of UV-visible spectrophotometry, spectrofluorometry.

MODULE IV

- Electrophoresis: Principle, functioning and applications of simple and 2D gel electrophoresis.
- Chromatographic techniques: Principle and applications of paper chromatography column chromatography, thin layer chromatography, Ion Exchange, Gel filtration chromatography and Gas chromatography.

MODULE V

- Definition; Type of genomics (Structural, functional and comparative); Introduction to genome sequencing and its significance; Human genome project; sequencing.

- Definition and objectives of proteomics; Relationship between gene and protein; Types of proteomics.

Books Recommended:

1. Wilson, K. and Walker, J.(2009). Principles and techniques of Biochemistry and molecular Biology. Cambridge Univ. Press, India.
2. Plummer, David T. (1996). An introduction to practical Biochemistry 3rd Ed. Tata McGraw Hill. Pub. Corp. Ltd., New Delhi.
3. Rao, B. S. and Deshpande, V. (2000). Experimental Biochemistry. A student companion. I. K. International Pvt. Ltd., New York.

Member **External Expert** **HoD**

BOT-EC-443: ENVIRONMENT BOTANY

T	S	P	Credit
4	0	0	4

Course Objectives	• After going through the content of this course, the students are expected tounderstand and appreciate the current ecological and environmental problems confronted by manat local, regional, national and global level. For the present and the future scenario, especiallypollutions of different types, conservation for posterity apart from issues of climate change and biodiversity will be main agenda for study.
Course Outcomes	The students will be learning: • Why conservation biology is necessary to understand for protecting biological resources in changing environment? Where is the role of each and every species in nature and Environment? • How a degraded ecosystem could be converted into its original state and then possible for further use? • What are main drivers of conservation biology actually work so far to cope up with changing environment?

MODULE I

- Conservation Biology: Definition, scope, objectives and principles of conservation biology, protected areas, National and International organizations involved in conservation practices, Conservation of plant genetic diversity.
- Restoration Ecology: Definitions, Scope, Mechanisms, Pattern process and action of restoration ecology, case study from India; concept and mechanisms of ecological restoration, land use change and habitat degradation, soil restoration and soil degradation.
- Importance of Restoration Ecology for Ecosystem, Biodiversity and natural resourceconservation practices in India.

MODULE II

- Management and Conservation of Natural Resources: Types of resources, Sustainabledevelopment and ecological economics. Sustainable utilization of natural resources (economic, sociological, ecological and socio-cultural dimension).
- Management and Conservation of Biological Resources: Biodiversity Concept, definition(s), Scope and limitations of Biodiversity Science, Scales and composition of Biodiversity: Genetic, Species, Ecological/Ecosystem Diversity, cultural, rituals role in biodiversity saving. Biodiversity threats and measurements. Values and applications with humankind; Indian case studies especially - Project Tiger and Elephant.
- Biosphere Reserves and Biodiversity hotspots: The concept, major functions and current status in India and world; Risk categories of plants: Major risk categories, IUCN Red List of threatened species, RLI.

MODULE III

- Global Environmental Changes: Global warming, climate change, Reasons, possible effects and measures to combat the problem.
- Ozone Depletion: Phenomenon, reasons, possible ecological effects and measures to checkthe depletion of ozone.

MODULE IV

- Invasion Ecology: Definition, factors (both Intrinsic and extrinsic) affecting invasion,Status and impact of plant invasion on native flora; use and ecological role of weeds in Indian Agro-ecosystems, Major-weeds of the world; Ecological approach to weed management.
- Field Experiments and Methods: Vegetational analyses, Ecosystem analyses, Biodiversity quantification, analyses of synthetic and analytical characters of local plant community.

MODULE V

- Protection of Environment: International concern and efforts for environmental protection, global plan, Stockholm Summit, priority issues; Earth Summits.

Books Recommended:

1. Singh, J.S., Singh S.P. and Gupta, S.R. Ecology, Environment Science and Conservation, S. Chand & Company, Private Ltd., New Delhi, 2014.
2. Martha, J.G. Principles of Conservation Biology, Sinauer Associates, Inc., Publishers, USA, 2006.
3. Andel, J.V. and Arnoson, J. 2012. Restoration ecology –the new frontier, 2nd edition, John Willey & sons, LtD., The Atrium, Southern Gate, Chichester, West Sussex, PO198SQ, UK.
4. Sodhi, N.S. and Ehrlich, P.R. Conservation Biology for All, Oxford University Press, New York, USA, 2010.
5. Botkin, D. and Keller, E., Environmental Science, John Wiley, New York, U.S.A., 1995.
6. Newman, E. I. Applied Ecology, Blackwell Scientific Publishers, UK, 1994.
7. Odum, E. P. Fundamentals of Ecology, Saunders Toppan, U.S.A, 1971.
8. Rice, E.L., Allelopathy, Academic Press Inc., U.S.A., 1987.
9. Cain, M. Bowman, W.D. and Hacker, S.D., Ecology, Third Edition, Sinauer Associates, Inc., Publishers, U.S.A., 2013.
10. Andel, J.V. and Arnoson, J. 2006. Restoration ecology –the new frontier, published by Blackwell Science Ltd.UK.

Member **External Expert** **HoD**

BOT-EC-444: EMBRYOLOGY

T	S	P	Credit
4	0	0	4

Course Objectives	• To understand the various aspects of plant floral parts, development and reproduction. • To understand the various aspects of embryology and apomixis.
Course Outcomes	The students will be able to: • Discuss the structural elements of plants floral parts and reproduction. • Discuss the Pollination, embryology and apomixis.

MODULE I

- Historical account of plant Reproduction; Microsporangium: Anther Wall, Endothecium Middle layers, Tapetum, Nuclear behavior in tapetal cells, Sporogenous tissue.
- Male Gametophyte: Formation of vegetative and generative cells, Formation of Sperms, Pollen wall, Abnormal features. Megasporangium: Types of ovule, Integuments, Nucellus, Megasporogenesis, Special features.
- Female Gametophyte: Types of female gametophytes, ultra structure of mature Embryo sac, Haustorialbehavior of embryo sac, Nutrition of Embryo sac.

MODULE II

- Pollination: Anther dehiscence, pollen transfer, self-pollination, cross-pollination, artificial pollination.
- Fertilization: Pollen germination and pollen-tube growth. Path of pollen-tube, pollentube discharge, Double fertilization, Syngamy.

MODULE III

- Endosperm: Types of endosperm, ruminate endosperm, cytology of endosperm. Functions of endosperm.
- Embryo: Embryogeny in dicotyledons, Embryogeny in monocotyledons. suspensor, under developed and reduced embryos, Nutrition of embryo. Polyembryony: Causes of polyembryony, experimental induction of polyembryony, classification of polyembryony practical value of polyembryony.

MODULEIV

- Apomixis: Vegetative reproduction, apospory, causes of apomixis, significance of apomixis.
- Seed: Seed development, importance of seeds, Seed dispersal, Seed Dormancy.

MODULE-V

- Embryology in relation to Taxonomy: importance of Embryological characters in taxonomic considerations, families with special embryological features.

- Role of Palynology in taxonomy; Experimental Embryology: Embryo rescue and its culture, Parthenocarpy, parasexual hybridization.

Books Recommended:

1. Maheswari, P. A. (1950).Introduction to Embryology of Angiosperms.
2. Shivanna, K.R. and John, B.M. (1989).The Angiosperm Pollen structure and Function, Wiley Eastern Ltd. Publications.
3. Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. Comparative Embryology of Angiosperms, Vol. I & II, Springer Verlag.
4. Bhojwani, S.S. and Bhatnagar, S.P. (1971). The Embryology of Angiosperms.

Member **External Expert** **HoD**

BOT-EC-445: AGRICULTURAL ECOLOGY

T	S	P	Credit
4	0	0	4

Course Objectives	• This course aims to introduce the students to the application of concepts and principles of ecology to human managed ecosystems*i.e.*agroecology.
Course Outcomes	• The students will be learning: 1. The meaning of terms agriculture, domestication and selection. 2. What are the ecological principles that are applicable in managed ecosystems such as agriculture systems? 3. The relationship of domesticated biodiversity with its wild biodiversity? 4. How ecological problems influence the agriculture and human food security?

MODULE I

- Agroecology – definitions of terms, scope of the discipline, approaches and viewpoints, domestication, selection and protection of crop plants and farm animals, wild relatives of the crops.
- Ecological experimentation in agriculture.

MODULE II

- Ecosystem functioning of farming systems – energy and material flows, trophic relations, spatial scales and ecological footprints, organic farming.
- Genetically modified organisms and their implications.

MODULE III

- Climate change – agriculture and adaptation mechanisms.
- Ecological problems of crop cultivation and solutions – pollution, leakage and erosion, land development, diseases, weeds and pests.
- Chemical, biological and ecological control.

MODULE IV

- Interactions between farming systems and biodiversity – biodiversity in farming systems, landscape fragmentation, relationships and interdependencies of biodiversity within farming systems with outside farming systems.

MODULE V

- Case studies of farming systems of India.

Books Recommended:

1. Gliessman, S.R. (2015). Agroecology: The Ecology of Sustainable Food Systems. CRC Press.
2. Altieri, M.A. (2018). Agroecology: The Science of Sustainable Agriculture. Second

Edition.CRC press.
3. Gliessman, S.R. (2014). Field and Laboratory Investigations in Agroecology.Third Edition.CRC Press.
4. Wojtkowski, P.A. (2006). Introduction to Agroecology: Principles and Practices. Food Products Press.
5. Alagh, Y.K. (2013). The Future of Indian Agriculture.
6. Mazoyer, M. and Roudart, L. (Translated by Membrez, J.H.). (2014). A History of World Agriculture: From the Neolithic Age to the Current Crisis. Monthly Review Press, New York.

Member **External Expert** **HoD**

BOT-EC-446: MOLECULAR INTERACTIONS OF PLANTS WITH SYMBIONTS, PATHOGENS AND PESTS

T	S	P	Credit
4	0	0	4

Course Objectives	• This paper aims to introduce various aspects of biochemical and molecular interactions of plants with symbionts, pathogens and pests at an advanced level.
Course Outcomes	• The students will: 1. Understand plant responses to biotic components of their environments. 2. Learn concepts, techniques and applications related to the plant interactions with microbes, pathogens and herbivores.

MODULE I

- Introduction to the biotic interactions of plants.

MODULE II

- Recent advances in plant-pathogen and plant-insect interactions: Stages of pathogenesis, Structural and biochemical host defense mechanisms against pathogens and pests, Basal resistance, Non-host resistance, PTI and ETI. Distinction between necrotrophic and biotrophic pathogens.
- Plant defense against necrotrophs and biotrophs. Systemic acquired resistance, Induced systemic resistance. Induced resistance, signaling pathways, cross-talk between SA and JA-dependent defense responses.

MODULE III

- Genetics, genomics and applications: Genetics, genomics and applications: Gene-for-gene concept, Models for perception of effector proteins by plants, Cloning of resistance genes (R genes) and avirulence genes (Avr genes) from plants and pathogens, Induced responses to herbivory.

MODULE IV

- Recent advances in symbiotic interactions with plant with special references to mycorrhizae and root nodule symbiosis.

MODULE V

- Genetic engineering for the production of resistance plants to pathogens and pests.

Books Recommended:

1. Karban, R. and Baldwin, I.T. (1997). Induced responses to herbivory, Chapter 3, 47-100.Chicago University Press.
2. Hull, R. (2001). Mathew's Plant Virology. Academic Press, NY.
3. Strange, R.N. (2003). Introduction to Plant Pathology. John Wiley & Sons, USA.33
4. Dickinson, M. (2003). Molecular Plant Pathology, Bios Scientific Publishers, London.

5. Burchett, S. and Burchett, S. (2018). Plant Pathology. Garland Science, USA.
6. Mehrotra, R.S. (2017). Plant Pathology, 3rd Edition, McGraw-Hill Education, New Delhi.
7. Recent and important review articles from scientific journals.

Member **External Expert** **HoD**

BOT-EC-447: URBAN ENVIRONMENT

T	S	P	Credit
4	0	0	4

Course Objectives	This course will help the students to understand: • The impacts of diverse and complex themes of urbanization • How urbanization affects patterns of biodiversity • How urbanization is changing climate. • Urban pollution and management strategies.
Course Outcomes	• This course explores the ecology and biophysical environment of urban ecosystems. • The students will interpret and synthesize literature on climate and water patterns, nutrient cycling, monitoring, and management strategies of conservation of biodiversity in urban ecosystem. • Thestudents will effectively communicate scientific knowledge of how urban ecosystem are structured and function and the problems of emerging pollutants. They will be acquainted about societal issues related to urban areas.

MODULEI

- Introduction to urban environment:–Why should we study it?Urbanization patterns; Thedynamics of urban environment; What makes urban ecosystem different; Classification of urban life; Urban habitats.

MODULEII

- Urban Ecology:–Urban climate; Urban nutrient dynamics; Urban water cycle; Homogenization of urban ecosystem; Species interactions in urban environment; Concept of green roofs.

MODULE III

- Pollution in urban areas:– Sources of urban air pollution, implications and health issues; Grey water pollution, implications and health issues;Soil contamination in urban areas in India; Light and Noise pollution;Waste water collection, treatment and disposal; Most polluted urban cities in India.

MODULEIV

- Environmental problems and solutions of urban areas:–Urbanization and climate change;Urban heat islands and human health.

MODULEV

- Problems of slums and shanty towns; Invasive species; Solid waste management; Traffic congestion.

Books Recommended:

1. Gaston, K.J. 2010.Urban Ecology. Cambridge University Press, New York.
2. Hall, M.H.P. and Balogh, S.B. 2019. Understanding Urban Ecology.An InterdisciplinarySystems Approach.Springer, New York.
3. Leinbach, K. 2017. Urban Ecology: A Natural Way to Transform Kids, Parks, Cities, and the World. Morgan James Publishing, USA.
4. Parris, K.M. 2016.Ecology of Urban Environments. Wiley-Blackwell, USA.

Member **External Expert** **HoD**

BOT-CP-448: Practical VII based on BOT-CC-441

T	S	P	Credit
0	0	2	2

Course Objectives	This course will help the students to understand: • About the basic requirements for plant tissue culture in laboratory and how to prepare culture media and aseptic room. • About the working of various instruments required for the tissue culture and recombinant DNA technology. • About the handling of Genetic material.
Course Outcomes	The students will be able to: • To prepare the suitable media for various explants. • Handle different instruments • Isolate and process DNA.

CONTENT

- Preparation of complex nutrient medium (Murashige&Skoog's medium).
- To selection, Prune, sterilize and prepare an explant for culture.
- To demonstrate various steps of Micropropagation.
- To understand principle, working and handling of
  - (i) Laminar Air Flow
  - (ii) pH meter
  - (iii)Autoclave
  - (iv)BOD Incubator
  - (v) Centrifuge
  - (vi)Micropipettes
  - (vii) Incubator Shaker
  - (viii)Water double-distillation unit
- Isolation of DNA from Plants.
- Separation of proteins by electrophoresis.
- Removal of chromium/ nitrate/ ammonia by immobilized cyanobacterial cells.
- Demonstration of DNA amplification by PCR.

Member **External Expert** **HoD**

BOT-EP-449A: Practical VIII Based on BOT-EC-442 to BOT-EC-444

T	S	P	Credit
0	0	2	2

Course Objectives	This course will help the students to understand: • The working of some lab instruments. • The pollen structure under microscopy and to prepare their permanent slides. • The various components of the environment.
Course Outcomes	The students will be able to: • Handle lab instruments without any help. • Prepare permanent slides of pollen grains without destroying them. • Understand what cause pollution and how can they identify its direct or indirect effect on nature.

ANALYTICAL BOTANY

- Use of spectrophotometer in biochemical estimations- chloroplast pigments, proteins,carbohydrates etc.
- Demonstration of instruments: Gel Electrophoresis, Microtome, pH meter, oven,incubator, autoclave and centrifuge.

EMBRYOLOGY

- Prepare of smear for the study of gametophyte.
- Micro- dissection techniques for embryo and embryo sac.
- Elementary techniques for pollen germination.
- Study for various stages in reproduction from permanent slides, pre and post fertilization in embryo sac.

ENVIRONMENT BOTANY

- Physico-chemical analysis of polluted water- color, acidity, alkalinity, taste, turbidity, total solids, total dissolved solids, conductivity, hardness, pH, Biological oxygen demand, Dissolved oxygen, Chemical oxygen demand.
- Biological examinations of polluted water- microscopic and culturing method (Densitycount).
- Physico-chemical analysis of polluted soil, pH, Electric conductivity, soluble cations and anions, heavy metals (base deficiency).
- To analyze distribution pattern of selected species in an ecosystem.
- To measure the photosynthetic rate (A) and the specific leaf area of five tree species and observe relation between them.
- Preparation of ethnobotanical herbarium.

Member **External Expert** **HoD**

BOT-EP-449B:PRACTICAL IX based on BOT-EC-445 to BOT-EC-447

T	S	P	Credit
0	0	2	2

Course Objectives	This course will help the students to understand: 1. How plants interact with the different symbionts and pests in nature? 2. About the various components of made-made ecosystem *i.e.*agroecosystem and how it can affect the surroundings. 3. How urbanization affects patterns of biodiversity. 4. Urban pollution and management strategies.
Course Outcomes	The students will be able to: • Differentiate between positive and negative interactions. • Evaluate the composition of the soil and for which crop it is most suitable. • The students will effectively communicate scientific knowledge of how urban ecosystem are structured and function and the problems of emerging pollutants. They will be acquainted about societal issues related to urban areas.

MOLECULAR INTERACTION OF PLANTS WITH SYMBIONTS AND PATHOGENS AND PESTS

- To study the nature and extent of damage to vegetable crops.
- Isolation of rhizosphere and soil microorganisms.
- Isolation of phyllosphere microorganisms.
- Antagonism study among the fungal organisms.
- Identification of few plant pathogenic microorganisms.

AGRIECOLGY

- To estimate soil moisture content at different agricultural systems.
- To estimate soil pH at different agricultural systems.
- To estimate soil organic matter content at different agricultural systems.
- To study soil nutrient contents (N, P, K) at different agricultural systems.
- To study plant species diversity/crop diversity in different agricultural systems.
- Seed viability test.
- To study faunal species diversity at different agricultural systems.
- To study management practices at different agricultural systems and prepare group and/or individual reports.
- Weed seed bank.
- Case studies/field reports (pollinators).

URBAN ENVIRONMENT

- Physico-chemical analysis of polluted water- color, acidity, alkalinity, taste, turbidity, total solids, total dissolved solids, conductivity, hardness, pH, Biological oxygen demand, Dissolved oxygen, Chemical oxygen demand.
- Biological examinations of polluted water- microscopic and culturing method (Densitycount).
- Physico-chemical analysis of polluted soil, pH, Electric conductivity, soluble cations and anions, heavy metals (base deficiency).
- To analyze distribution pattern of selected species in an urban ecosystem.

Member **External Expert** **HoD**