DEPARTMENT OF

BOTANY

SRI DEV SUMAN UTTARAKHAND UNIVERSITY, BADSHAHITHAUL

'SYLLABUS'
FOR

Bachelor (Research) of Science (Botany) /Master of Science (Botany)

[AS PER NATIONAL EDUCATION POLICY (NEP)-2020]

FACULTY OF SCIENCE

2023

MEMBERS OF BOARD OF STUDIES (BOS) IN BOTANY
(BOS HELD ON 11.07.2023)

Prof. Gulshan Kumar Dhingra
Dean Science and Professor & HOD Botany
Pt. L. M. S. Campus, Sri Dev Suman Uttarakhand University

Prof. V. D. Pandey
Professor of Botany
Pt. L. M. S. Campus, Sri Dev Suman Uttarakhand University

Prof. N .K. Sharma
Professor of Botany
Pt. L. M. S. Campus, Sri Dev Suman Uttarakhand University

Prof. Indu Tiwari
Professor of Botany
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Dr. Shalini Rawat
Associate Professor of Botany
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Dr. S. K. Kuriyal
Assistant Professor of Botany
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Dr. Preeti Khanduri
Assistant Professor of Botany
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Prof. Mukesh Kumar
(External Subject Expert)
Professor of Botany
Gurukul Kangri University, Haridwar

Prof. Pushpa Negi
Principal,
GPGC, New Tehri

Prof. Pankaj Pant
Principal,
GPGC, Nagnathpokhri

Prof. K.S Negi
Principal,
GPGC, Khanpur

Prof. Anita Rawat
Director, USERC

List of Semester wise Titles of Papers in Botany

Year	Semester	Course Code	Name of Course	Type of course	Total Credits	Marks (scaled)
BACHELOR (RESEARCH) OF SCIENCE						
B.Sc. IV YEAR / M. Sc. I YEAR	**VII / Ist Sem**	BOT/I/CC/01	Microbiology	CC	4	100
		BOT/I/CC/02	Phycology	CC	4	100
		BOT/I/CC/03	Mycology	CC	4	100
		BOT/I/CC/04	Bryophytes and Pteridophytes	CC	4	100
		BOT/I/CC/05	Lab/Practical based on CC/01 to CC/04	LC	4	200
		BOT/I/EC/01	Industrial training/Survey/ Research project	EC	4	100
	VIII / IInd Sem	BOT/II/CC/06	Gymnosperms and Paleobotany	CC	4	100
		BOT/II/CC/07	Plant Diversity and Taxonomy of Angiosperms	CC	4	100
		BOT/II/CC/08	Plant Development and Reproductive Biology	CC	4	100
		BOT/II/CC/09	Cytogenetics and Molecular Biology	CC	4	100
		BOT/II/CC/10	Lab/Practical based on CC/05 to CC/08	LC	4	200
		BOT/II/EC/02	Industrial training/Survey/ Research project	EC	4	100

Year	Semester	Course Code	Name of Course	Type of course	Total Credits	Marks (scaled)
MASTER OF SCIENCE (BOTANY)						
M. Sc. II YEAR	**IX / IIIrd Sem**	BOT/III/CC/11	Plant Ecology and Remote Sensing	CC	4	100
		BOT/III/CC/12	Plant Resource Utilization and Conservation	CC	4	100
		BOT/III/CC/13	Biotechnology	CC	4	100
		BOT/III/CC/14	Plant Physiology & Biochemistry	CC	4	100
		BOT/III/CC/15	Lab/ practical based on CC/09 to CC/12	LC	4	200
		BOT/III/EC/03	Industrial training/Survey/ Research project	EC	4	100
	X / IVth Sem	BOT/IV/CC/16	Plant breeding & Biostatistics	CC	4	100
		BOT/IV/CC/17	Cell Biology	CC	4	100
		BOT/IV/EC/18 (i)*	Forest Ecology	EC	4	100
		BOT/IV/EC/18(ii)*	Plant Pathology	EC	4	100
		BOT/IV/EC/18(iii)*	Taxonomy of Angiosperms	EC	4	100
		BOT/IV/EC/18(iv)*	Ethnobotany, Indigenous knowledge and Intellectual Property Rights	EC	4	100
		BOT/IV/EC/18(v)*	Bryology	EC	4	100
		BOT/IV/EC/18(vi)*	Lichenology	EC	4	100
		BOT/IV/EC/19	Lab based on Final SemesterCC and EC courses	LC	4	200
		BOT/IV/EC/04	Industrial training/Survey/ Research project	EC	4	100

CC= Core course; EC= Elective course; *Two elective courses are to be opted.

Minor Elective Courses in Botany*

Year	Semester	Course Code	Name of Course	Type of course	Total Credits	Marks Scaled
B.Sc IV YEAR/ M.Sc I YEAR	VII /VIII Ist Sem / IInd Sem	BOT/4/ME/01	Plant Cell Structure and Functions	ME	4	100
		BOT/4/ME/02	Applied Microbiology	ME	4	100
		BOT/4/ME/03	Global Climate Change	ME	4	100
		BOT/4/ME/04	Medicinal Plants of Uttarakhand	ME	4	100

- One minor elective course to be opted in semester I or II (VII/VIII)

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Unit	Topic	Total No. of lecturers/ hrs (48)
1	Evolutionary Trends in Bryophytes; Bryology in India; General idea about morphology and Reproduction in Bryophytes; Ecological and Economic Importance of bryophytes, Modern Systems of Classification of Bryophytes.	12
2	Salient features of the following genera: *Sphaerocarpos* *Marchantia, Plagiochasma, Asterella,* *Targionia, Cyathodium Frullania, Porella,* *Pellia, Metzgeria, Riccardia* *Anthoceros, Notothylas* *Sphagnum*, Andreales- *Andreaea* *Takakia*, *Polytrichum*	12
3	A brief account of origin of pteridophytes, Recent trends in classification of Pteridophytes, Heterospory and seed habit, telome theory and stelar system, apogamy, apospory apomixis. Salient features of early land plants- *Rhynia* and *Horneophyton*	12
4	Salient features of the following genera: *Lepidodendron, Lepidocarpon,* *Psilotum* *Lycopodium* *Isoetes* *Selaginella* *Sphenophyllum* *Calamites* *Equisetum* *Ophioglossum* *Osmunda* *Azolla, Marsilea* *Adiantum*	12

Suggested readings

- Alain Vanderpoorten, Bernard Goffinet. (2009).Introduction to Bryophytes. McGraw HillEducation India.
- Pandey, B.P. (1979). College Botany Vol II Including Pteridophyta, Gymnosperms and Paleobotany. . S. Chand and Company Ltd. Ramnagar, New Delhi.
- Parihar, N.S. (1991). Bryophyta. Central Book Depot, Allahabad.
- Parihar, N.S. (1996). Biology and Morphology of Pteridophytes. Central Book Depot Allahabad.
- Puri, P. (1980). Bryophytes. Atma Ram & Sons, Delhi.
- Rashid, A. (1998). An Introduction to Bryophyta: diversity, development and differentiation. Vikas Publishing House.
- Sharma, O.P. (2017). Bryophyta. McGraw Hill Education. India

  Smith, G.M. (1955). Cryptogamic Botany. Vol. I and II. Tata McGraw Hill, New Delhi.
- Sporne, K.R. (1975). The Morphology of Pteridophytes. HarperCollins Publishers Ltd; Revised edition.
- The Pteridophyte Phylogeny Group (PPG Classification) (2016): A community –derived classification for extant lycophytes and ferns. Journal of Systematics and Evolution. 54(6): 563-603.Doi:10.1111/jse.12229
- Udar, R. (1986). Fifty years of Bryology in India. Golden Jubilee Series. IBS, New Delhi.

Practical/ Lab course (BOT/I/CC/05: Based on the CC/01 to CC/04 papers)

SEMESTER VIII/ IInd Sem

BOT/II/CC/06: Paper V: Gymnosperms and Paleobotany
(Credits 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to:

1. Understand the general characters, distribution and significance of Gymnosperms.
2. Understand the morphology, anatomy and reproduction of common Gymnosperms.
3. Remember the evolutionary eras and periods.
4. Understand the techniques and process of fossilization.

Unit	Topic	Total No. of lecturers/hrs (48)
1	Introduction: History, classification, distribution and evolution of Gymnosperms, economic importance of Gymnosperms. Brief account of the families of Pteridospermales (Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae).	12
2	General account of Cycadeoideales, Cordaitales, Pentoxylales Morphology, anatomy and reproduction in Cycadales	12
3	Morphology, anatomy and reproduction in Ginkgoales, Coniferales. General account of Ephedrales, Welwitschiales, Gnetales	16
4	Preservation of fossil plants, Types of fossils and modes of formation of different kinds of fossils; Gondwana flora.	8

Suggested reading

- Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms New Age International, Pvt Ltd (P) New Delhi.
- Biswas, Chhaya, Johri, B. M. (2014). The Gymnosperms. Springer Berlin.
- Chamberlain, C.J. (1980) Gymnosperms Structure and Evolution. CBS Publishers and Distributors.
- Pandey, B.P. (1979). College Botany Vol II Including Pteridophyta, Gymnosperms and Paleobotany. S. Chand and Company Ltd. Ramnagar,New Delhi.
- Pant, D.D. and Osborne, R. and Birbal Sahni. (2002). An introduction to gymnosperms, cycas,and cycadales. Birbal Sahni Institute of Palaeobotany.

- Vashishta, P.C., Sinha, A.K. and Kumar, A. (2012). Botany for degree students. Gymnosperm. S. Chand and Company Ltd. Ramnagar, New Delhi.
- Kaur, Inderdeep and Uniyal, P.L.(2019). Textbook of Gymnosperms. Daya Publication, NewDelhi.
- Singh, S.K. (2002). Gymnosperms and paleobotany. Campus Book International.

BOT/II/CC/07: Paper VI: Plant Diversity and Taxonomy of Angiosperms
(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to

1. Understand about the diversity and classification of plants.
2. Understands description, identification, nomenclature and classification of plants.
3. Study the types of inflorescence and their origin.
4. Understand the concepts of phytogeography, endemism, plant migration, invasions andintroduction.
5. Study the characteristic features and economic importance of some important families.

Unit	Topic	Total No. of lecturers/hrs (48)
1	Important system of classification Bentham & Hooker, J.Hutchinson and A. Takhtajan, Brief account of Angiosperm Phylogeny Group(APG IV) classification and their merits and demerits, Salient Features of International Code of Botanical Nomenclature (ICN) Elementary idea of molecular taxonomy. The species concept: Taxonomic Hierarchy, species, genus, family and other categories. Principles used in assessing relationships, delimitation of taxa and attribution of rank.	12
2	Origin of intrapopulation variation. Population and the environment, ecads, ecotypes, evolution and differentiation of species. Plant exploration in India with special reference to Uttarakhand. Origin and evolution of angiosperms, fossils.	12
3	Taxonomic tools; histological, cytological, phytochemical, serological, biochemical, and molecular techniques. General account of Herbarium and Flora, Concepts of phytogeography, endemism, plant migration, invasions and introduction.	12
4	Distinguishing features of the following families and their economic importance: Ranunculaceae, Violaceae, Rutaceae, Fabaceae, Rosaceae, Apiaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Liliaceae, Poaceae.	12

Suggested readings

BOT/II/CC/08: Paper VII: Plant Development and Reproductive Biology

(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to:

1. Understand the morphological characteristics of flower.
2. Study the fundamental concepts of shoot, leaf and root development.
3. Understand various stages of development of plants.
4. Understand the developmental biology of male and female gametophyte, pollen-pistil interaction.
5. Study the basic idea of embryogenesis and seed development process, apomixesand polyembryony.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	Morphology: Morphology of flower, Stamen and Carpel, Floral characteristics, structure of the pistil, pollen stigma interactions, Plant adaptation–physiological and their Morphological nature (xerophyte, hydrophyte and halophyte).	12
2	Shoot development: Organization of the shoot apical meristem (SAM): control of cell division and tissue differentiation, especially xylem and phloem: secretary ducts and Laticifers. Leaf growth and differentiation, structural development and classification of stomata and trichomes. Root Development: Organization of root apical meristem (RAM), vascular tissues differentiation, lateral root, root hairs, ABC model of flower, Florigen pathway.	12
3	Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development, pollen germination, pollen tube growth and guidance, pollen allergy. Femalegametophyte: Ovule development, megasporogenesis, development and organization of the embryo sac, structure of the embryo sac cells.	12
4	Pollination, pollen-pistil interaction and fertilization: pollination mechanism and vectors, sporophyte and gemetophytic self-incompatibility, double fertilization. Seed development and fruit growth: Endosperm development, embryogenesis, polyembryony and apomixis. Latent life- dormancy: Importance and types of dormancy, seed dormancy, bud dormancy.	12

Suggested readings

- Bhatnagar S.P, Dantu, P.K. Bhojwai S.S. (2018). The embryology of Angiosperms.Vikas Publ. House. New Delhi.
- Fonkot, De. (1994). Plant growth and Development. A molecular approach. Academic Press.San Diego.
- Howell, S.H. (1998). Molecular genetics of plant Development. Cambridge Univ. Press.
- Lalit M. Srivastava. (2002). Plant Growth and Development. Hormones andEnvironment.Academic Press. 1st Edition.
- Leins, P., Tucker, S.C. and Endress, P.K. (1988). Aspects of floral development. J. Cramer.Germany.
- Lyndon. R.F. (1990). Plant Development. The Cellular Basis. Unnin Hyman. London.
- Raghavan V. (1999). Developmental biology of flowering plants. Springer Velag. New York.
- Raghwan, (1997). Molecular embryology of flowering plants. Cambridge Univ. Press.Cambridge.
- Shivanna, K.R. and Sawhney, V.K. (1997). Pollen Biotechnology for Crop Production andImprovements. Cambridge Univ. Press.

BOT/II/CC/09: Paper VIII: Cytogenetics and Molecular Biology

(Credits 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to

1. Apply the concepts of Mendelian genetics to solve problems on linkage, crossing over and genemapping.
2. Apply the principles of population genetics to work out problems on genotype frequency and Hardy-Weinberg equilibrium. Understand the Chromosomal aberrations and their role in genome evolution with special reference tocrop plants.
3. Understand the process of cell cycle its regulation and the mechanism of apoptosis.
4. To understand the basic framework of DNA and RNA, their replication and regulation in prokaryotes and eukaryotes.

Unit	Topic	Total No. of lecturers/ hrs(48)
1	Mendelian principles and its extension (codominance, incomplete dominance, gene interactions); linkage and crossing over, sex linked inheritance. Genetic recombination and gene mapping: Recombination, gene mapping methods (linkage maps, tetrad analysis, mapping with molecular markers). Population genetics - Gene pool, Gene frequency, Hardy-Weinberg law.	12

2	Structural and numerical alteration in chromosome: Duplication, Deficiency, Inversion and Translocation; Effect of aneuploidy on phenotypes in plants; transmission of monosomics and trisomics and their use. Chromosome structure: packing of DNA, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes; euchromatin and heterochromatin; Nuclear DNA content, C- value paradox; cot-curves and their significance.	12
3	Mutation: spontaneous and induced mutation; physical and chemical mutagens; molecular basis of mutation; DNA damage and repair mechanisms; transposable elements, cell cycle and apoptosis.	12
4	Gene structure and expression: genetic fine structure; cis-trans test; introns and exons; Transcription, RNA splicing multiple alleles, pseudoallele, Genetic code, Translation and regulation of gene expression in prokaryotes and eukaryotes.	12

Suggested readings

- Alberts, B., Bray,D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2014). Molecular Biologyof the Cell. Garland Publishing Inc., New York.6th edition.
- Atherly, A.G., Girton, J.R. and McDonald, J.F. (1999). The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
- Barry, J.M. and Barry. B.M. (1973). Molecular Biology, Prentice Hall of India. New Delhi.
- Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000). Biochemistry and Molecular Biologyof Plants. American Society of Plant Physiologists, Maryland, USA.
- Busch, C.R. and Rothblum, L. (1982). Volume X. The Cell Nucleus r DNA Part A. Academic Press.
- De, D.N. (2000). Plant Cell Vacuoles: An Introduction. CSIRO Publication, Collingwood, Australia.
- Gupta, P.K. (1998). Cytogenetics. Rastogi Publications, Meerut. Hartl, D.L. and Jones, E.W. (1998). Genetics: Principles and Analysis (4nd Edition). Jones and Bartlett Publishers, Massachusetts, USA.
- Kleinsmith, L.J. and Kish, V.M. (1995). Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York, USA.
- Lewin, B. (2000). Genes VII. Oxford University Press, New York.
- Lodish, H., Berk, A., Zipursky, S.L. Maztsudaira, P., Baltimore, Dand Darnell, l. (2016). Molecular Cell Biology (8th Edition). W.H. Freeman and Co., New York, USA.
- Malacinskim G.M.D. and Freifelder, D. (1998). Essentials of Molecular Biology (3rdEdition).Jones and Bartlett Publishers, Inc. London.
- Stent, G.S.(1986).Molecular genetics. Bishen Singh Mahendra Pal Singh, Dehradun.
- Watson, J.D. (2013).Molecular Biology of the Genes, Banjamin.7th Edition.
- Wolfe, S.L. (1993).Molecular and Cellular Biology. Wadsworth Publishing Co.California.

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Practical/ Lab course BOT/II/CC/10: Based on the CC/06 to CC/09

papersMinor Elective Courses in Botany

BOT/4/ME4 /01: Paper I: Plant Cell Structure and Functions
(Credits 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to:

1. Understand the plant cell structure and its function.
2. Understand the various cell components and the general principles in cell communication and interaction.
3. Study the structure and genome organization of chloroplast and mitochondria.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	Principles of microscopy, structural organization of the plant cell and its chemical foundation, Cell wall structure and function	12
2	Plasma membrane, Cytoskeleton, organization and role of microtubules and microfilaments	12
3	Structure and functions of endoplasmic reticulum, golgi apparatus, ribosomes and protein synthesis	12
4	Structure and genome organization of chloroplast and mitochondria.	12

BOT/4/ME/02: Paper II: Applied microbiology

(Credits 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to:

1. Understand the major fields, scope and importance of applied microbiology.
2. Study the medical, aquatic, food, soil, industrial and geochemical microbiology.
3. Understand the mushroom cultivation and single cell production.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	Microbiology and its scope: microorganisms in the living World: Group of microorganisms. Occurrence and distribution of microorganisms in Nature. Major fields of applied microbiology.	12
2	Medical microbiology. Aquatic microbiology: Water purification microbiological examination; biological degradation of waste; ecology. Aero microbiology.	12
3	Food microbiology. Soil Microbiology	12
4	Industrial microbiology. Geochemical microbiology. Mushroom cultivation and Production of single cell protein.	12

Suggested readings

- Saxena, S. (2015). Applied Microbiology, Springer.
- Gadd, G. and Sariaslani S. (2020). Advances in Applied Microbiology, Elsevier.
- Pelczar, M.J., Chan, ECS and Kreig, N.R. (1993). Microbiology. McGraw Hill, New York. Fifth Edition.
- Tortora,G.J.,Funke, B.R. and Case C.L.(2021).Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 13th edition.
- Willey, Joanne, Sherwood, Linda., Woolverton, Christopher J. (2017). Prescott's Microbiology. McGraw Hill New York, 11th edition.

BOT/4/ME/03: Global Climate Change

(Credits 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to:

1. Understand the global climate changes and global warming.
2. Learn about the measures being taken for the mitigation of climate changes.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	General concept of Global climate change; Greenhouse effect; Greenhouse gasses; Carbon foot print, Carbon sequestration.	12
2	Impact of global warming and climate change, weather extremes, ecosystem disruption, human health, sea level rise and impact on forests	12
3	International initiative for mitigating global changes; Inter governmental panel on climate change (IPCC); United Nation Frame work convention on Climate change	12
4	Kyoto protocol; Montreal protocol; Paris Pact; India's initiatives for mitigating climate change.	12

Suggested readings

- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Compony Pvt. Ltd., New Delhi.
- Singh, S., Singh, P., Rangabhashiyam, S. and Srivastava, K. K. (2021). Global Climate Change, Elsevier.
- Mathez, E. A. and Smerdon, J. (2009). Climate Change- The Science of Global Warming and Our Energy Future, Columbia University Press.

BOT/4/ME/04: Medicinal Plants of Uttarakhand
(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to:

1. Understand the diversity and distribution of medicinal plants in Uttarakhand
2. Study the techniques/methods for the sustainable utilization of the medicinal plants.
3. Understand the economic importance of medicinal plants.

Unit	Topic	Total No. of lecturers / hrs (48)
1	Retrospect and prospects of medicinal plants	12
2	Brief history, properties, action and uses of some important medicinal plants Diversity, distribution and indigenous uses of threatened medicinal plants	12
3	Policies for threatened med conservation and management of marketing of medicinal plants	12
4	Economics and exploitation of resources and people conflict	12

Suggested readings

- Arber, A. (1999). Herbal plants and Drugs. Mangal Deep Publications.
- Chopra, R.N., Nayar S.L. and Chopra, I.C. (1956). Glossary of Indian Medicinal Plants, C.S.I.R,New Delhi.
- Kala, C. P. (2010). Medicinal Plants of Uttarakhand: Diversity, Livelihood and Conservation, Biotech Books.
- Sah, R. (2004). Nature's Medicinal plants of Uttarakhand: Tree, shrubs and Climbers. Vol. I. Gyandodaya Prakashan, Nainital.
- Sah, R. (2004). Nature's Medicinal plants of Uttarakhand: Herbs, Grasses and Ferns. Vol. II. Gyandodaya Prakashan, Nainital.

SEMESTER IX/ IIIrd Sem

BOT/III/CC/11: Paper IX: Plant Ecology and Remote Sensing

(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to:

- Understand the scope and concepts of ecology and discuss the biosphere, biomesand biogeography.
- Analyze the process of ecological succession.
- To distinguish between species, populations, communities, ecosystem and biomes.
- To understand the concept of remote sensing and its applications.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	Concept of ecology, its scope and historical development, Climate, soil and vegetation patterns of the world: Major terrestrial biomes; Aquatic ecosystems; Fresh and Marine ecosystems; Vegetation Types and environmental factors. Vegetation organization: Concepts of community and continuum; Community structure and attributes; Edges and ecotones; Keystone species and control of community structure. Species interactions, Types of biotic interactions	12
2	Population Ecology: Characteristics of population; population growth curves; population regulation, life history strategies (r and k selection); population genetics. Concept of habitat and niche.	12
3	Ecological succession: Causes, mechanism and types, changes involved in succession; Examples of succession; concept of climax. Ecosystem: Structure and functions; primary production (methods of measurement), energy dynamics (Tropical organization, energy flow pathways, ecological efficiencies); Global biogeochemical cycles of C, N, P and S ; Global hydrological cycle, Restoration ecology.	12
4	Environmental pollution: kinds; sources; quality parameters; effects on plants and ecosystems and their remedies. Climate change and conservation: Greenhouse gases; ozone layer and ozone hole; Consequences of climate change. Remote Sensing: Concept and stages in the acquisition of remote sensing data, spectral signature, Plant sensors and space platforms, basic principles of photogrammetry and photo interpretation, Application of remote sensing.	12

Suggested readings

- Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plant Ecology. Benjamin/Cummings Publication Company, California
- Baskin and Baskin, (2001). Seeds: Ecology, Biogeography and Evolution ofDormancy and Germination Elsevier
- Kormondy, E.J.(2017). Concept of Ecology. Pearson India.
- Odum, E.P. (1983). Basic Ecology Saunders, Philadelphia
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Compony Pvt. Ltd., New Delhi.
- Smith, R.L. (1996). Ecology and Field Biology Harper Collins, New York

BOT/III/CC/12: Paper X: PLANT RESOURCE UTILIZATION AND CONSERVATION

(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessments)

Course outcomes: After the completion of the course the students will be able to:

1. Describe economically important plants with binomial names, family and uses.
2. Understand the various uses of plants; biodiversity status, loss and management strategies
3. Understand the biogeography and initiatives for biodiversity conservation.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	World centers of primary diversity of domesticated plants: TheIndo-Burmese center plant introduction and secondary centers. An idea of (i) Food, forage and fodder crops. (ii) Fiber crops. (iii) Medicinal and Aromatic Plants and (iv) Vegetable oil-yielding crops (v) fruits and their uses.	12
2	Important fire-wood and timber-yielding and non-timber forest products (NTFPs) Wild edible plants of Uttarakhand: Green revolution: Benefits and adverse consequences, Sustainable development: Basic concepts. Plants used as avenue trees: for shade, pollution control and aesthetics. Principles of conservation: International Union for Conservation of Nature (IUCN).	12
3	Biodiversity concept; Levels of Biodiversity: genetic, species, community and ecosystem diversity; Uses of biodiversity; Biodiversity, Ecosystem services and functions. Distribution of biodiversity; Gradients of biodiversity; Hotspots; Threats to biodiversity. Extinction of species: Biodiversity assessment and inventory; Conservation of biodiversity; Indices; biodiversity and its conservation; International efforts for conserving biodiversity	12

4	Strategies for conservation: In-situ conservation: International efforts and Indian initiatives; protected areas in India sanctuaries, National Parks, biosphere reserves, wetlands, mangroves and coral reefs. Ex-situ conservation: Principles and practices; Botanical gardens, gene banks, seedbanks, in vitro repositories, Cryobanks, general account of the activities of BSI, NBPGR, ICAR, CSIR and DBT for conservation efforts.	12

Suggested readings

- Frankel O.H, Brown A.D.H. and Burdon J.J. (1995). The Conservation by Plant Diversity Technical guidelines for the site movement of Germplasm (1989) by FAO IBPGR.
- Kochhar S.L. (2016). Economic Botany. Cambridge University Press, London.
- Pandey, B.P. (1999). Economic Botany. S. Chand, New Delhi.
- Paroda R.S. and Arora R.K. (1991). Plant genetic resources Conservation and Management. International Board for Plant Genetic Resources, (IBPGR), Rome.
- Pullin A.S. (2002). Conservation Biology. Cambridge University, Press, London.
- Watson, R.T., Heywood, V.H., Baste, T., Dias, B., Gámez, R., Janetos, T., Reid, W. Ruark, G. (1995). Global biodiversity assessment: summary for policy-makers. Cambridge (England).

BOT/III/CC/13: Paper XI: Biotechnology
(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to

1. Understand the process and techniques of bio- technology and plant tissue culture.
2. Analyze the tools and techniques used in genetic engineering
3. Evaluate the methods and applications of recombinant DNA technology.
4. Understand the blotting techniques, DNA sequencing, and genetic engineering of plants.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	Biotechnology: Principle and scope, bio-safety guidelines. Plant cell and tissue culture: Concept of cellular totipotency, principle of root and shoot generation in vitro, clonal Propagation, applications of cell and tissue culture.	12
2	Gene libraries (a general account): Genomic DNA libraries, cDNA libraries. Recombinant DNA technology: Tools of genetic engineering, enzymes, cloning vectors, plasmids, cosmids, lamda phage, shuttle vectors, BACs, and YACs. Cloning strategies, Screening and selection of transformants.	12
3	Genetic Engineering of plants: Aims, tools, strategies for development of transgenic plant with suitable examples. Callus culture, organ culture, cell suspension culture, cryopreservation, protoplast culture, organogenesis, somatic embryogenesis, artificial seed, somatic hybridization, hybrids and cybrids, and somaclonal variation.	12
4	Hybridization- colony hybridization, Southern hybridization, Northern hybridization, Western hybridization, Genomics, DNA sequencing techniques: Concept of nucleic acid sequencing, Maxam and Gilbert sequencing, Sanger sequencing, Proteomics, Bio-ethics and IPR.	12

Suggested readings

- Bhojwani, S.S. (1990). Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.
- Brown,T.A.(2018).Genomes 4. John Wiley and Sons (Asia) Pvt. Ltd. Singapore.
- Callow, J.A., ford-Lioyd, B.V. and Newbury, H.J. (1997). Biotechnology and Plant Genetic Resources: Conservation and Use. Cab International, Oxon, UK.
- Chrispeels, M.J. and Gepts, P. (2017). Plants, Genes and Agriculture. Oxford University Press.
- Collins, H.A. and Edwards, S. (1998). Plant Cell Culture. Bioscientific Publishers, Oxford, UK.
- Glazer, A.N. and Nikaido, H. (1995). Microbial Biotechnology, W.H. Freeman and

Company, New York, USA.

- Gustafson, J.P. (2000). Genomes. Kluwer Academic Plenum Publishers, New York, USA.
- Henry, R.J. (1997). Practical Application of Plant Molecular Biology. Chapman & Hall, London, UK.
- Jain, S.M., Sopory, S.K. and Veilleus, R.E. (1996). In Vitro Haploid Production in Higher Plants, Vols, 1-5., Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherland.
- Jolles, O. and Jornvall, H. (2000). Proteomics in Function Genomics. Birkhauser. Verlag, Basel, Switzerland.
- Kartha, K.K. (1985). Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton. Florida, USA.
- Primose, S.B. (1995). Principles of Genome Analysis. Blackwell Science Ltd, Oxford,UK.
- Raghavan, V. (1997). Molecular Biology in Flowering Plants. Cambridge University Press, New York, USA.
- Shantharam, S. and Montogmery, J.F. (1999). Biotechnology, Biosafety and Biodiversity. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Vasil, I.K. and Thorpe, T.A. (1994). Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.

BOT/III/CC/14: Paper XII: Plant Physiology and Biochemistry

(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to:

1. To understand the mechanism of transport and translocation of water and analyze the mechanismsof acclimation and adaptation of plants to stress conditions.
2. To understand the process of transpiration, photosynthesis and respiration and analyze thesetechniques in various groups of plants.
3. To know the nitrogen cycle and the role of microbes and plants in the nitrogen cycle.
4. To understand the role of plant growth regulators and photoreceptors in plant growthand development.
5. To understand the structure, classification and function of carbohydrate, lipids and proteins.
6. To know about catalytic mechanism of enzymes, its inhibitors and regulation.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	Membrane transport and translocation of water and solutes: Plant –water relations, mechanism of water transport through xylem, phloem loading and unloading, passive and active solute transport, membrane transport of proteins. Transpiration and Guttation.	12
2	Photosynthesis: General concepts and historical background, steps of photosynthesis, Emerson's effect, two pigment systems, Calvin cycle, photorespiration and its significance. C4 cycle, CAM pathway Respiration: Glycolysis. TCA cycle, electron transport chain and ATP synthesis, pentose- phosphate pathway, glyoxylate cycle. Nitrogen fixation and metabolism: Biological nitrogen fixation, mechanism of nitrate uptake and reduction.	12
3	Plant growth regulators: Physiological effects of auxins, gibberellins, cytokinins, ethylene and abscisic acid. A brief Account of Photoperiodism and vernalization. Signal transduction and sensory photobiology: Receptors, phospholipids signaling, phytochromes andcryptochromes. Plant responses to biotic and abiotic stress.	12
4	Structure, classification & function of carbohydrates, lipids and proteins Enzymology - General aspects, allosteric mechanism, regulatory and active sites, isozymes, kinetics of enzymatic analysis, Michaelis - Menten equation and its significance, Allosteric enzymes, Enzyme inhibition (competitive and non - competitive).	12

Suggested readings

- Buchanan, B.B, Gruissem W. and Jones, R.L. (1996). Biochemistry and Molecular Biology of plants by Enzymes: A practical introduction to structure, mechanism and data analysis. R. A. Copeland.
- Devi, P. (2000). Principles and methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios.
- Huner, N.P.A, and Hopkins, W. G. (2008). Introduction to Plant Physiology. Wiley 4th Edition.
- Scott, R.P.W. (1995). Techniques and Practice of Chromatography. Taylor and Francis, Routlledge.
- Taiz, L; Zeiger, E; Moller, I. M. and Murphy A. (2014). Plant Physiology and Development.Publisher:Sinauer Associates IsanIm print of Oxford University Press. 6th Edition.

Practical/ Lab Course (BOT/III/CC/15: Based on the CC/11 to CC/14 papers)

SEMESTER X/ IVth Sem

BOT/IV/CC/16: Core Course Paper XIII: Plant breeding & Biostatistics (Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to

1. To provide information on methods and role of plant breeding in crop improvement.
2. To understand the concept of hybrid vigour.
3. To impart knowledge of biostatistics in biological science.
4. Application of biostatistics.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	The role of plant breeding – historical aspects and genetic basis: mode of reproduction in relation to breeding methods, breeding techniques; method of plant breeding in relation to self pollinated and cross pollinated plants. Hybridization Interspecific and inter generic: pure line; back cross hybridization; self incompatibility system. Heterosis: its genetic and physiological basis.	12
2	Breeding for resistance to diseases. Role of mutation in crop improvement and evolution. Plant breeding work done in India with special reference to paddy, wheat, mustard and sugarcane. Maintenance of collection, registration of varieties, seed production, testing, certification and distribution, Quarantine.	12
3	Biostatistics and its application in life sciences. Methods of representation of statistical data and measurements of central tendencies: Mean, Median, Mode, Variance, Standard deviation.	12
4	Correlation, regression. Probability and use of binomial trials. Test of significance Chi square test, t test and F test.	12

Suggested readings

- Harihar, Ram, 1997. Vegetable Brccding: Principles and Practices Jagminder Book Agency New Delhi
- Hill. J. 1997. Quantitative and Ecological Aspccts of Plat Brecding. Jagmínder Book Agency, New Delhi.
- Kapoor, RL. 1997. Plant Breeding and Crop Improvement. 2 Vols
- Mc Donald, M.B. 1997. Secd Production: Principles and Practices.
- Pochfan. J.M and D. Borthakur., 1969,. Asian Ficld Crops. Oxford and IBH Publ. New Delhi.
- Poclhman, J.M and Sleeper, D.R. 1995. Brocding Fild Crops. Panima Publ. IHouse, New Delhi.
- Sharnia, J.R 1994. Principles and Practice of Plant Brecding. Tata MeGraw Hill Publ. Co. Ltd.,

New Delhi.

- Singh. B.D. 2002. Plant Rreeding Principes and Methods. Kalyani Publ. New Delhi.
- Bliss, CL 1967. Statistics in Biology. 2 Vols, Mc Graw Hill, New York.
- 10 Downey, NM and Heuth, RW. 1960, Basic Statistical Methods, Harper Intermational.
- Rayner, AA. 1969. A fist Course in Biometry for Agiculture Students. Peitermaritzburg University of Natal Press.
- Singh, R.K. 1994. Biometrical Techniques in Breeding and Genetics.

BOT/IV/CC/17: Core Course Paper XIV: Cell Biology
(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)Course outcomes: After the completion of the course the students will be able to

1. Understand the various aspects of cell biology.
2. Study the structure and function of various cell organelles.
3. Understand the cell cycle, its regulation and apoptosis.
4. Study various techniques used in cell biology.

Unit	Topic	Total No. of lecturers/hrs (48)
1	**Cell Wall:** Structure and Function **Plasma Membrane:** Structure, models and functions, Plasmodesmeta and their role in movement of molecules and macromolecules	12
2	**Chloroplast:** Structure and genome organization and transcription **Mitochondria:** Structure, genome organization, biogenesis, RNA editing **Plant vacuoles:** Tonoplast membrane, ATPase, storage organelles **Nucleus:** Structure, DNA structure, A, B and Z forms, nuclear pores, nucleosome organization **Ribosomes:** Structure, protein synthesis, mechanism of translocation, Initiation and termination.	16
3	**Cell shape and mortality:** The cytoskeleton , organization and role of microtubules and microfilaments **Cell cycle and Apoptosis:** Role of cyclins and cyclin-dependent kinase, cytokinensis and cell plate formation.	10
4	**Other cellular organelles:** structure and functions of microbodies, Golgi apparatus, lysosomes, endoplasmic reticulam **Techniques in Cell Biology:** Immunotechnique, FISH, GISH, Confocal microscopy **Immunology :** Basic techniques	10

Suggested readings

- Hopkin, A. Morgan, J. Roberts, R and Walters (2019). Essesntials of Cell Biology (5thEdition). International Student Edition.
- Rastogi, V. B. Cell Biology. Medtech Science Press: A Division of Scientific International.
- Verma, P.S. and Agrawal, V. K.. Cell Biology. (2016) S. Chand and Company, New Delhi.

BOT/IV/EC/18(i): Elective Course/Special Paper XV (i): Forest Ecology

(Credits: 4, Max Marks: 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to:

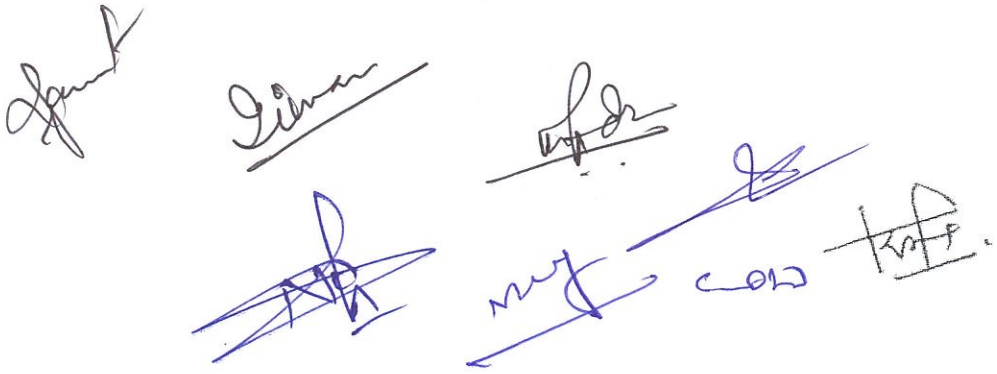
1. Understand the structure and function of forest ecosystem.
2. Understand methods for studying vegetation, community pattern and processes, ecosystemfunction, biodiversity, carbon stock and carbon sequestration.
3. Help the students to understand the linkage between men and forests.

Unit	Topic	Total No. of lecturers/hrs (48)
1	General Aspects of Forests: Forest ecology and forest ecosystem, Importance of forests in environmental conservation, Wildlife biodiversity and climate change. Primary Productivity and Detritus Pool: Solar radiation and energy units; Concept of primary productivity. Formulations of Primary Productivity: Photosynthetic pathways and their significance; photosynthetic capacity; distribution ofbiomass; Allocation of net primary production and accumulation of biomass; Measurement of biomass and primary productivity in forest ecosystems of the world; Plant biomass and turnover; efficiency of energy Capture. Human Use of Productivity; Environmental factors and productivity.	12
2	Litter fall in Forest Ecosystems; determining litter fall, factors affecting it; Forest litter: type of litter; Coarse Woody debris; forest floor litter mass. Detritus Pathway of Energy Flow and Decomposition Processes: Decomposer organisms and their trophic interactions; decomposition processes; Measurements of Litter Decomposition; Decomposition rate.	12
3	Nutrient Cycling in Forest Ecosystems: The nutrient cycle models in forest ecosystem; Ecosystem Inputs of Nutrients: Atmosphere, Weathering of rock minerals, Hydrologic inputs, Biological inputs, biotic accumulation and storage of nutrients in plants; Nutrient outputs (Ecosystem losses), nutrient re- translocation. Stream water losses, losses to the atmosphere; Nutrient losses due to fire, nutrient losses in forest harvest; Intra-System Cycle: Availability of nutrients in soil solution; Nutrient supply and uptake , Role of mycorrhizae in nutrient cycling; Nutrient concentration and storage in vegetation; Nutrient re-absorption; Nutrient return from vegetation to soil; Decomposition and nutrient release, nutrient use efficiency, nutrient conserving adaptation in oligotrophic soil; Effects of Land P enrichment on biodiversity. Forest Hydrology: Impact of forest on precipitation apportionment, Water discharge from watersheds, Role of water in nutrients cycling.	12

4	Succession: An idea of forest succession with focus on Himalayan forest ecosystem. Attributes of species of different successional stages; recovery measures of disturbed Sites and species selection for disturbed sites in Himalaya. Major forest types of forest India: Forest classification of India; Forest of Himalaya with particular reference to Sal, Pine and Oak forests. Global climate changes and forests. Man and forest: Commercial exploitation of forest, shifting Agriculture; settled agriculture; structure and functioning of Central Himalayan Agroecosystem. Regeneration status of major forest trees acute vs. chronic human disturbance; Shifting cultivation.	12

Suggested reading

- Bir, S.S. and Chatha, G.S. (1988). Forest Vegetation Characteristics of Indian Hills. Today and Tomorrow's Printers & Publ., New Delhi.
- Misra, R. (1968). Ecology Work Book. Oxford & IBH Publishing Co. New Delhi.
- Puri, G.S., Meher-Homji V.M., Gupta R.K. and Puri R.K. (1960). Forest Ecology. Oxford and IBH Pub.Co. Pvt. New Delhi.
- Singh, J.S. and. Singh, S.P. (2014). Forest of Himalaya: structure, Function and Impact of Man. Gyanodaya Prakashan, Nainital, India.
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Compony Pvt. Ltd., New Delhi.
- Waring, R.H. and Schlesinger, W.H. (1985). Forest Ecosystems: Concepts and Management. Academic Press, New York.



BOT/IV/EC/18 (ii): Elective course/special paper (ii): Plant Pathology

(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to

1. General characteristics of plant pathogenic organisms including fungi, bacteria, viruses and mycoplasma.
2. Study of interaction between plant and pathogen in relation to the environment and mechanism of disease development by pathogens.
3. Understand the genetics of host parasite interaction.
4. Understand the various enzymes and toxins involved in disease development.
5. Study of various important plant diseases, disease cycle and control measures.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	A brief history of plant pathology in India and losses caused by pathogens and pests; Types of pathogens, symptoms of different plant diseases. Inoculum: Inoculum types, theory of inoculums, survival and longevity of inoculums, inoculums production, potential and density. Plant microbe interaction: molecular basis of host recognition, pathogenesis: pre-penetration, penetration and post penetration events, factors affecting disease development (host factors, environmental factors, virulence susceptibility). Dissemination of pathogens: Means of dissemination (active and passive dissemination).	12
2	Genetics and host parasite interaction: Concept of compatibility and specificity, gene for gene relationship, genetics of resistance, source of resistance, inheritance of resistance in the host. Enzymes and toxins: Enzymes involved in disease development, toxins and their role in plant health.	12
3	Disease resistance: (i) Protection (structural, chemical, absence of nutrients and common antigens). Defense (histology defense, chemical- polyphenols, prohibitions, inhabiting, phytoalexins, lectins). Genetic resistance: resistant genes, biotechnological approaches for transfer of R- genes into susceptible plant. Seed pathology: Seed borne pathogens, mechanism of seed infections in field and during storage, transmission of pathogens through seeds, seed health testing methods, market disease of fruits and vegetables. Disease control: Cultural practices, chemical methods (insecticides, systemic and non-systemic chemical), biological control: Introduction, biological control of insects and pests, use of resistance varieties quarantine.	12

4	Brief account, structure, importance, disease cycle and control of the following: Damping off, (ii) Wilt, (iii) Root rot, stem rot and fruit rot (iv)Mildews (powdery and downy), (v) Rusts, smuts, (vi) Leaf spots and leaf blights. General characteristics, importance, disease cycle and control of the following: (i) Bacterial disease, (ii) Viral disease, (iii) Mycoplasma disease.	12

Suggested readings

- Agrios, G.N. (2011). Plant Pathology. Elsevier.
- Bouarab, N. K., N. Bissow and F. Daayf. (2009). Molecular Plant Microbe Interactions.
- Butler, E. J. (1918). Fungi and Diseases in plants. Thacker and Spink and Cooperation. Calcutta.
- Lucas, J.A. (1988). Plant Pathology and Plant Pathogens. Third edition. Blackwell.
- Mehrotra, R. S. (2013). Plant Pathology. Tata Mc Grow Hill Publishing Co Ltd. New Delhi.
- Mehrotra, R. S. and Agrawal, A. (2003). Plant Pathology. Tata Mc Grow Hill Publishing Co Ltd. New Delhi.
- Singh, R. S. (1988). "Plant diseases". Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

BOT/IV/EC/18 (iii): Elective course/Special paper (iii): Taxonomy of Angiosperms
(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to

1. Understand the naming of the plant through plant nomenclature.
2. Learn the phylogeny and classification of angiosperms of system their use and utility.
3. Identify the various angiosperms families with specific key characters.
4. Learn various advanced tools to study plant taxonomy.

Unit	Topic	Total No. of lecturers/ hrs(48)
1	History of different systems of classification (introduction only). Important systems- Benthom and Hooker, Hutchinson, A. Takhtajan, A. Cronquist, Robert Thorne, Angiosperm Phylogeny Group (APG IV) classification. A brief account of major contributuion made by the following taxonomists: C. Linnaeus, J.D. Hooker, Willium Roxburgh and Duthie.	12
2	Taxonomic evidences- wood anatomy, embryology, palynology, cytotaxonomy, biosystematics, chemotaxonomy and numerical taxonomy. Relevance of taxonomy to conservation, Cladistics.	12
3	Some important families: Magnoliaceae, Myrtaceae, Scrophulariaceae, Verbenaceae, Loranthaceae, Cannabaceae, Moraceae, Fagaceae, Orchidaceae, Zingiberaceae, Cyperaceae, Poaceae.	12
4	Local plant diversity and general account of Garhwal flora. Wild and cultivated fruits of Garhwal region.	12

Suggested readings

- Angiosperm Phylogeny Group (APG-2016). An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnaean Society 181: 1-20.
- Bensen L. (1957). Plant Classification reprint. Oxford & IBH N. Delhi.
- Bhattacharya B. and B.M. Joshi. (1998). Flowering plants. Taxonomy and phylogeny Norsa publishing house New Delhi.
- Davis P.H. and Heywood V.H. (1973). Principles of angiosperms taxonomy. Robert E. Kreign Pub. Co. New York.
- Gaur R.D. (1999). Flora of District Garhwal, N.W. Himalaya Transmedia, Srinagar Garhwal.
- Heywood V.H. (1970). Plant taxonomy London.
- Heywood V.H. and D.M. Moore. (1984). Current concept in plant taxonomy. Systematic special volume 25. London.
  Lawrence G.H.M. (1951). Taxonomy of vascular plants. Mac Millan N.York.
- Sambamurty A.V.S.S. (2010). Taxonomy of Angiosperms. I.K. International Pvt. Ltd

- Saxena, N.B. and Saxena, S. (2012). Plant Taxonomy. Pragati Prakashan.
- Sharma,O.P. (2009). Plant Taxonomy. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Singh, G. (2010). Plant Systematics. CBS PUB & DIST PVT Limited INDIA.

BOT/IV/EC/18 (iv): Elective Course/Special Paper (iv): Ethnobotany, Traditional Knowledge And Intellectual Property Rights

(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to

1. Understand the concept, scope and importance of ethnobotany.
2. Study the ethnobotany of major tribal communities of Uttarakhand.
3. Understand the concepts and implications of Intellectual property rights.

Unit	Topic	Total No. of lecturers/ hrs (48)
1	Ethnobotany: Its Concept, Scope and Relevance. Interdisciplinary approaches in Ethnobotany. Ethnobotany in India: Retrospect and prospects. Methods of research in Ethnobotany.	12
2	Indigenous systems of medicines in India. Tradition al Agriculture Practices in Ancient India. Some aspects of Biodiversity and Indian Traditions. Traditional knowledge of Uttarakhand: With species reference to food and medicine. Ethnobotany of major tribal communities (Raji, Bhotia, Tharu and Boxa) of Uttarakhand. Changing values in traditional societies and ecological implications.	12
3	Role of ethnobotany in primary health care programmes and development of new drugs. Ethnobotany on development and conservation on bioresources. Plant exploration Crop and Germplasm collection of land races: Methods and strategies.	12
4	Basic concepts of Intellectual Property Rights (IPRs). The implications of the Intellectual Property Rights on the Convention on Biological Diversity (CBD). Intellectual Property Rights with particular reference toTraditional knowledge and Biowealth.	12

Suggested readings

- Chopra, R.N. and Kumar, P.K. (2019). Biology of Bryophytes. New Age International Pub.
- Ganguly, S.C. (1969-1980). Mosses of Eastern India and Adjacent regions Vol. I. Vol. II and Vol III.
- Vashishta, P. C. Sinha, A. K. and Kumar A. (2010). Bryophyta. S. Chamd Delhi, India.

BOT/IV/EC/18(vi): Elective Course/Special Paper (vi): Lichenology

(Credits: 4, Max Marks 100; 75 External Exam+ 25 internal assessment)

Course outcomes: After the completion of the course the students will be able to

1. Understand the general characters, structure, types, reproduction and various habitats of lichens.
2. Understand the physiology and biochemistry of plants.
3. Study the ecological and economic importance of lichens.
4. Study the major lichen families and their representative genera.

	Topic	Total No. of lecturers/ hrs (48)
1	History of Lichenology, Biogeographical distribution, habitat and growth form of lichens; Classification; Symbiosis in lichens-types of symbiotic association, Identification, morphological, anatomical and chemicalmethods (spot test, thin layer chromatography, microcrystallography and UV fluorescence analysis), biotechnological aspects of lichens.	12
2	Reproduction- asexual and sexual means lichenized and non lichenized diasporas, isidia, soredia, conidia, perithecia and apothecia. Chemistry- chemical composition of lichens primary and secondary metabolites, major pathway of secondary metabolite formation. Physiology- nutrients, elemental accumulation and mineral cycling, nitrogen metabolism and lichen sensitivity to air pollution.	12
3	Role of lichens in environmental monitoring- pollution succession, lichenometry, pedogenesis and biodetoriation. Importance of lichens- as food, medicine, dyes, perfumery etc An elementary idea of lichen tissue culture. Tools and techniques used in identification of some common Central Himalayan lichen.	12
4	Families and their representative genera: Parmeliaceae, Lecanoraceae, Teloschistaceae, Ramalinaceae, PhysciaceaeCollemataceace, Candelariaceae, Pertusariaceae, Peltigeraceae. Lichen flora of Garhwal Himalaya general account.	12

Suggested readings

- Arya, V., Kumar, B. and Arya, P. (2019). Lichen Wealth of Uttarakhand Himalaya. Lap Lambert Academic Publishing.
- Awasthi, D.D. (2000). Hand book of lichens, Bishen Singh Mahendrapal Singh: Dehradun India.
- Awasthi, D.D. (2007). A compendium of the macrolichens of India, Nepal and Srilanka. Dehradun Bishen Singh Mahendrapal Singh: Dehradun India.
- Divakar, P.K and Upreti, D.K. (2005). Parmelioid lichens in India (A revisionary study), Bishen Singh Mahendrapal Singh: Dehradun India.
- Nash, T.H. (2008). Lichen biology, UK.
- Orange, A., James, P.W and White, FJ. (2001). Crochemical methods of identification of lichen, British lichen society, London.
- Smith, A.L. (1921). Lichen Cambridge University Press, London

Practical/Lab Course/BOT/IV; Lab Course based on CC16,17 and Two Elective Courses from 18 (i) to (vi)

Prof. Gulshan Kumar Dhingra

Prof. V. D. Panday

Prof. N .K. Sharma

11/07/23

Prof. Indu Tiwari

Dr. Shalini Rawat

Dr. S. K. Kuriyal

11/07/23.

Dr. Preeti Khanduri

Prof. Mukesh Kumar

11.7.2023

Prof. Pankaj Pant
Principal,
GPGC, Nagnathpokhri

11.7.2023

Prof. K.S Negi
Principal,
GPGC, Khanpur

Prof. Pushpa Negi
Principal,
GPGC, New Tehri

11.07.23

Prof. Anita Rawat
Director, USERC