

DEPARTMENT OF BOTANY

**M. Sc.
(Semester System)**

SYLLABUS

**KUMAUN UNIVERSITY
NAINITAL**

Course structure of M.Sc. Botany

Total Credits:

Total marks: 2400

S.N.	Course Code	Name of Course	Type of course	Credit distribution			Total Credits	Marks (scaled)
				L	T	P		
FIRST SEMESTER: 24 CREDITS								
1	BOT/I/CC/01	Microbiology	CC				4	100
2	BOT/I/CC/02	Phycology	CC				4	100
3	BOT/I/CC/03	Mycology	CC				4	100
4	BOT/I/CC/04	Bryophyta and Pteridophyta	CC				4	100
5	BOT/I/CC/05	Lab based on CC/01 to CC/04	CC				4	200
SECOND SEMESTER: 24 CREDITS								
1	BOT/II/CC/06	Gymnosperms and Paleobotany	CC				4	100
2	BOT/II/CC/07	Diversity and Taxonomy of Angiosperms	CC				4	100
3	BOT/II/CC/08	Plant Development and Reproductive Biology	CC				4	100
4	BOT/II/CC/09	Cytogenetics and Plant Breeding	CC				4	100
5	BOT/II/CC/10	Lab based on CC/05 to CC/08	CC				4	200
6	BOT/II/SSC/01	Plant Cell Structure and Functions	SSC				2	50
7	BOT/II/SSC/02	Applied Microbiology	SSC				2	50
THIRD SEMESTER: 24 CREDITS								
1	BOT/III/CC/11	Plant Ecology	CC				4	100
2	BOT/III/CC/12	Plant Resource Utilization and Conservation	CC				4	100

3	BOT/III/CC/13	Biotechnology	CC				4	100
4	BOT/III/CC/14	Plant Physiology and Biochemistry	CC				4	100
5	BOT/III/CC/15	Lab based on CC/09 to CC/12	CC				4	200
*FOURTH SEMESTER: 24 CREDITS								
2	BOT/IV/EC/16 (i)	Forest Ecology	EC				4	100
3	BOT/IV/EC/16(ii)	Plant Pathology	EC				4	100
4	BOT/IV/EC/16(iii)	Taxonomy of Angiosperms	EC				4	100
5	BOT/IV/EC/16(iv)	Bryology	EC				4	100
6.	BOT/IV/EC/16(v)	Ethnobotany, Traditional knowledge and Intellectual Property Rights	EC				4	100
7.	BOT/IV/EC/16 (vi)	Lichenology	EC				4	100
8.	BOT/IV/EC/16 (vii)	Environmental Biology	EC				4	100
9.	**BOT/IV/EC/17A	Lab based on Final Semester EC 16					4	50
10.	**BOT/IV/EC/17B	Lab based on Final Semester EC 16					4	50
11.	BOT/IV/CC/18	Dissertation					8	300
12.	BOT/IV/SCC/03	Global Climate Change	SSC				2	50
13.	BOT/IV/SSC/04	Medicinal Plants of Central Himalaya	SSC				2	50

*Two elective courses are to be studied in addition to dissertation in fourth semester.

** Lab course (17A&17B) based on the elective course opted by the student.

Department of Botany, Kumaun University, Nainital-263002
New Syllabus Master of Science w.e.f 2017

Semester-I

BOT/I/CC/01: Paper I: Microbiology: Bacteria Virus and Lichens

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

General account of Microorganisms: History of microbiology, Golden Era of Microbiology, characteristic features of bacteria, General account of actinomycetes, classification of microorganism-five kingdom classification, Microbial growth- measurement of microbial growth, Batch, Fed-batch and continuous culture.

Unit 2

Morphology and structure of Bacterial cells: Morphology of bacterial cells based on size, shape and arrangement, fine structure of bacterial cells (of both Gram negative and gram positive bacteria) capsule cell wall, cell appendages (flagella, fimbriae, pilli), structure of plasma membrane, cytoplasmic inclusions-mesosomes, chlorosome. Ribosome- Site of protein synthesis, Microbial genetics- transformation, conjugation and transduction.

Unit 3

Morphology and structure of viruses: History, morphology, fine structure, shape and classification of viruses. Mycophages and Prions, Tobacco mosaic virus(TMV), T4 Bacteriophage and HIV- their fine structure, genome organization and multiplication, bacteriophage therapy.

Unit 4

General account of lichens: Occurrence and distribution, trends in classification, morphological diversity, type forms and ecological groups anatomy (homeomerous and heteromerous), reproduction, Economic importance of lichens, Lichenic acid.

Suggested Readings

- Clifton, A. 1958. Introduction to the Bacteria. McGraw-Hill book Co., New York.
Mandahar, C.L. 1978. Introduction to Plant Viruses. Chand & Co. Ltd., Delhi.
Doelle, H.W. and C.G, Heden 1986. Applied Microbiology, Kulwer Academic Press, London.
Pelczar, M.J., Chan, ECS and Kreig, N.R. 1993. Microbiology, Concept ans Applications. McGraw Hill, New York.
Ross, F.C. 1983. Introductory Microbiology. Charles E. Merril. Publ. Co. Columbus, Ohio.
Alexander, M. 1991. Microbial Ecology. John Wiley and Sons. New York.

- Kaushik, P. 1996. Introductory Microbiology. Emkay Publ, Delhi.
- Miller, B.M. and W. Litsky 1976. Industrial Microbiology. Mc Graw Hill New York.
- Mukherjee, K.G. and Ved Pal Singh, 1997. Frontiers in Applied Microbiology. Rastogi Publ. Meerut.
- Norris, J.R. and D.W. Ribbons 1970. Methods in Microbiology. Academic Press, London.
- Power, C.B. and H.F. Dagainawala 1996. General Microbiology 2 Vols. Himalaya Pub. House, New Delhi.
- Ross, F.C. 1983. Introductory Microbiology. Charles E. Merrill Publ. Co. Columbus. Ohio.

BOT/I/CC/02: Paper II: Phycology

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

History and Classification of Algae: Criteria of classification, important systems of classification, position of the Algae in the plant kingdom, Classes and Divisions of Algae, Characteristics of Divisions and classes of Algae

Importance of Algae: Useful and harmful aspects of algae

Unit 2

The Pigments of Algae: Pigments and chloroplasts, principal kinds of Algal pigments, properties of chlorophylls, carotenoids, phycobilins, pigments of Cyanophyceae, Chlorophyceae, Charophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae

Ecology of Algae: Diversified habitats of Algae, Eutrophication, water blooms and phytoplanktons

Unit 3

A detailed study of following orders with given genera

Cyanophyta: Chroococcales (*Chroococcus*, *Microcystis*), Oscillatoriales (*Oscillatoria* and *Lyngbya*), Nostocales (*Anabaena*, *Spirulina*), Rivulariales (*Rivularia*)

Chlorophyta: Chlamydomonadales (*Haematococcus*), Volvocales (*Pandorina*, *Eudorina*), Chlorococcales (*Chlorella*, *Hydrodictyon*), Cladophorales (*Cladophora*), Chaetophorales (*Coleochaete*, *Fritschiella*), Zygnemetales (*Zygnema*)

Charophyta: Charales (*Chara*)

Unit 4

A detailed study of following orders with given genera

Xantophyta: Heterosiphonales (*Botrydium*, *Vaucheria*)

Bacillariophyta: Pennales and Centrales (Pinnate diatoms and centric diatoms).

Phaeophyta: Ectocarpales (*Ectocarpus*), Laminariales (*Laminaria*), Fucales (*Sargassum*, *Fucus*)

Rhodophyta: Gigartinales (*Gracillaria*), Gelidiales (*Gelidium*), Ceramiales (*Polysiphonia*), Nemalionales (*Betrachospermum*).

Suggested Readings:

1. Fritsch, F.E. 1979. The structure and Reproduction of Algae Vol.1 &2. Bishan Singh Mahendra Pal Singh. Dehradun.
2. Kumar, H.D. 1988. Introductory Phycology. Affiliated East-West Press Ltd. N. Delhi
3. Morris, I. 1986. An introduction of Algae. Cambridge University Press U.K.
4. Prescott, G.W. 1984. Algae: A review, Bishan Singh Mahendra Pal Singh, Dehradun.
5. Trainer, F.R. 1978. Introductory Phycology. John Wiley and Sons. Inc
6. By Robert Edward Lee (2008) PHYCOLOGY. Colorado State University.
7. Gilbert M. Smith. 1951. Manual of Phycology, Waltham, Mass, U.S.A, Chronica Botanica Company.
8. Desikachary, T.V. 1984. Cyanophyta. ICAR, New Delhi.
9. Round, F.E. 1984. Ecology of Algae. Academic Press, London
10. Tilden, J.F. 1968. The Algae and their Life Relations. Hafner Publishing Co. New York.

BOT/I/CC/03: Paper III: Mycology

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

General characteristics and Classification of Fungi

Reproduction in Fungi (vegetative, asexual and sexual)

Heterothallism and Heterokaryosis

Parasexual cycle.

Unit 2

Recent trends in classification of Fungi

Phylogeny of Fungi

Importance of Fungi

Unit 3

General account of the following classes of fungi with emphasis on the given genera:

Myxomycotina: *Stemonitis*, *Physarum*

Mastigomycotina: *Allomyces*, *Monoblepharis*.

Oomycotina: *Saprolegnia*, *Pythium*, *Phytophthora*, *Sclerospora*.

Zygomycotina: *Mucor*, *Pilobolus*, *Entomophthora*.

Unit 4

Ascomycotina: *Saccharomyces*, *Aspergillus*, *Talaromyces (Penicillium)*, *Taphrina*, *Phyllactinia*, *Peziza*, *Cordiceps*, *Claviceps*.

Basidiomycotina: *Puccinia*, *Ustilago*, *Geastrum*, *Fomes*, *Uromyces*.

Deuteromycotina: *Fusarium*, *Cercospora*, *Pyricularia*, *Colletotrichum*, *Trichoderma*, *Helminthosporium*.

Suggested readings:

1. Mehrotra, R.S. and K.R. Aneja. 1999. An introduction to Mycology. New Age International Publisher.
2. Alexopoulos, C. J. and Mims C. W. 1979. Introductory Mycology. John Wiley and Sons. New York.
3. Webster, I. 1979. Introductory Mycology. Cambridge University Press. New York.
4. Ainsworth, G.C. 1976. Introduction to the history of Mycology. Academic Press. New York.
5. Webster, J. 1985. Introduction to Fungi. Cambridge University Press. New York.
6. Sati, S. C. and Belwal, M. 2012. Microbes Diversity and Biotechnology. Daya Publication.

BOT/I/CC/04: Paper IV: Bryophyta and Pteridophyta

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

Evolutionary Trends in Bryophytes; Bryology in India.

General idea about morphology, cytology and reproduction in Bryophyta.

Ecological and Economic Importance of bryophytes, Role of bryophytes in monitoring mineral deposition and as indicator of air pollution.

Modern Systems of Classification of Bryophytes.

Unit 2

Salient features of the following groups with special reference to the genera given:

(A) Marchantiophyta

- (i) Sphaerocarpaceae- *Sphaerocarpos*
- (ii) Marchantiales- *Marchantia*, *Lunularia*, *Plagiochasma*, *Reboulia*, *Asterella*, *Cryptomitrium*, *Targionia*, *Conocephalum*, *Cyathodium*
- (iii) Jungermanniales- *Frullania*, *Porella*, *Radula*
- (iv) Metzgeriales- *Pellia*, *Sewardiella*, *Metzgeria*, *Riccardia*
- (v) Calobryales- *Haplomitrium*

(B) Anthocerotophyta

Anthocerotales- *Anthoceros*, *Foilioceros*, *Megaceros*, *Phaeoceros*, *Notothylas*

(C) Bryophyta

- Sphagnales- *Sphagnum*
- Andreales- *Andreaea*
- Takakiales- *Takakia*
- Eubryales- *Buxbaumia*, *Polytrichum*

Unit 3

A brief account of origin of pteridophytes, classification of pteridophytes, Heterospory and seed habit, evolution of stelar system, telome theory, Evolution of sorus, apogamy, apospory and apomixes.

A brief account of the class:

Psilophytopsida- *Rhynia*, *Horneophyton*

Psilotopsida- *Psilotum*

Unit 4

A brief account of the class

Lycopsidea- *Lycopodium*, *Lepidodendron*, *Lepidocarpon*, *Selaginella*, *Isoetes*

Sphenopsida- *Hymenophyllum*, *Sphenophyllum*, *Calamites*, *Equisetum*

Pteropsida:

Eusporangiate -Ophioglossales

Protileptosporangiate- *Osmunda*,

Leposporangiate: (a) Filicales - *Adiantum*

(b) Marsileales –*Marsilea*

(c) Salviniaceae - *Azolla*

Suggested Readings

Parihar, N.S. 1991. Bryophyta. Central Book Depot, Allahabad.

Puri, P. 1980. Bryophytes. Atma Ram & Sons, Delhi

Ram Udar. Fifty years of Bryology in India. Golden Jubilee Series. IBS, New Delhi

Smith, G.M. 1955. Cryptogamic Botany. Vol. I and II. Tata Mc Graw Hill, New Delhi.

Parihar, N.S. 1996. Biology and Morphology of Pteridophytes. Central Book Depot Allahabad

Sporne, K.R. 1991. The Morphology of Pteridophytes. Hutchinson Library Series London

BOT/I/CC/05: Based on the CC/01 to CC/04 papers

Semester II

BOT/II/CC/06: Paper V: Gymnosperms and Paleobotany

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

Introduction: History, classification, distribution and evolution of gymnosperms

Brief account of the families of Pteridospermales (Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae)

Unit 2

General account of Cycadeoideales

General account of Cordaitales

General account of Pentoxylales

Morphology, anatomy and reproduction in Cycadales

Unit 3

Morphology, anatomy and reproduction in Ginkgoales

Morphology, anatomy and reproduction in Coniferales

General account of Ephedrales

General account of Welwitschiales

General account of Gnetales

Unit 4

Preservation of fossil plants

Types of fossils and modes of formation of different kinds of fossils

Gondwana flora

Suggested Reading

Bhatnagar S.P. and Moitra A 1996. Gymnosperms New Age International, Pvt Ltd (P) New Delhi

Vashishta, P.C., Sinha A.K. and Kumar Anil.2012. Botany for degree students: Gymnosperm. S. Chand, New Delhi

BOT/II/CC/07: Paper VI: Diversity and Taxonomy of Angiosperms

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

Important system of classification Bentham & Hooker, J. Hutchinson and A. Takhtajan and their merits and demerits.

Salient features of International Code of Botanical Nomenclature.

The species concept: Taxonomic Hierarchy, species, genus, family and other categories. Principles used in assessing relationships, delimitation of taxa and attribution of rank.

Unit 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, Type of inflorescence and their origin.

Unit 3

Taxonomic tools, herbarium, flora, histological, cytological, phytochemical, serological, biochemical, and molecular techniques.

Concepts of phytogeography, endemism, plant migration, invasions and introduction.

Unit 4

Distinguishing features only of the following families and their economic importance. Ranunculaceae, Rutaceae, Fabaceae, Asteraceae, Rosaceae, Lamiaceae, Asclepiaceae, Euphorbiaceae, Fagaceae, Violaceae, Convolvaceae, Apiaceae, Acanthaceae, Rubiaceae, Solanaceae, Orchidaceae, Cyperaceae, Poaceae, Liliaceae.

Practical Marks 42.5 (External 32.5+Internal 10) Credit 01 Periods 12.5

Suggested readings

-Bensen L. 1957 Plant Classification. Reprint Oxford & IBH. N. Delhi.

-Davis 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.

-Lawrence G.H.M. 1951. Taxonomy of vascular plants. Mac Millan N.York.

-Sambamurty A.V.S.S. Taxonomy of Angiosperms. I.K. International Pvt. Ltd

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

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 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)

Unit 2

Shoot development: Organization of the shoot apical meristem (SAM): control of cell division and tissue differentiation, especially xylem and phloem: secretory 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.

Unit 3

Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development, pollen germination, pollen tube growth and guidance, pollen allergy,

Female gametophyte: Ovule development, megasporogenesis, development and organization of the embryo sac, structure of the embryo sac cells.

Unit 4

Pollination, pollen-pistil interaction and fertilization: pollination mechanism and vectors, sporophyte and gametophytic self-incompatibility, double fertilization.

Seed development and fruit growth: Endosperm development during early maturation and desiccation stages: embryogenesis, cell lineages during late embryo development, polyembryony, apomixes

Latent life- dormancy: Importance and types of dormancy: seed dormancy, bud dormancy.

Suggested Readings:

The embryology of Angiosperms (2000 by S.S. Bhojwani and S.P. Bhatnagar. Vikas Publ. House. New Delhi.

Molecular embryology of flowering plants (1997) by V. Raghwan. Cambridge Univ. Press. Camb. Pollen biotechnology for crop production and improvements K.R. Shivanna and V.K. Sawhney. 1997. Cambridge Univ. Press.

Pollen biology by K. R. Shivanna and N.S. Rnagaswamy.

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.
Leins P. Tucker. Sc & Endress P.K. 1988. Aspects of floral development. J. Cramer. Germany.
Lyndon. R.F. 1990. Plant Development. The Cellular Basis. Unwin Hyman. London.
Raghavan V. 1999. Developmental Biology of flowering plants. Springer Verlag. New York.

BOT/II/CC/09: Paper VIII: Cytogenetics and Plant Breeding

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

Mendelian principles: Dominance, Segregation, independent assortment; extension of mendelian principles (codominance, incomplete dominance, gene interactions, pleiotropy); linkage and crossing over, sex linked, sex limited and sex influenced characters

Genetic recombination and gene mapping: Recombination, role of Rec A and Rec B,C,D enzymes, gene mapping methods (linkage maps, tetrad analysis, mapping with molecular markers); population genetics- population, gene pool, gene frequency, Hardy-Wein Berg law

Unit 2

Structural and numerical alteration in chromosome: Origin, meiotic behaviour and consequences of duplication, deficiency, inversion and translocation; effect of aneuploidy on phenotypes in plants; transmission of monosomics and trisomics and their use in chromosome mapping of diploid and polyploidy species, evolution of major crop plants (wheat and rice)

Unit 3

Mutation: spontaneous and induced mutation; physical chemical mutagens; molecular basis of mutation; DNA damage and repair mechanisms; transposable elements, mutations induced by transposons; inherited human diseases; cell cycle and apoptosis, cancer at cellular level.

Unit 4

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

Gene structure and expression: genetic fine structure; cis-trans test; introns and exons; RNA splicing multiple alleles, pseudoallele, regulation of gene expression in prokaryotes and eukaryotes

Suggested Readings:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1989. *Molecular Biology of the Cell* (2nd Edition) Garland Publishing Inc., New York.
2. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. *The Science of Genetics*. Saunders College Publishing, Fort Worth, USA.
3. Burnham, C.R. 1962. *Discussions in Cytogenetics*. Burgess Publishing Co. Minnesota.
4. Busch, C.R. and Rothblum, L. 1982. Volume X. *The Cell Nucleus rDNA Part A*. Academic Press.
5. Barry, J.M. and Barry, B.M. 1973. *Molecular Biology*, Prentice Hall of India. New Delhi.
6. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, Maryland, USA.
7. De, D.N. 2000. *Plant Cell Vacuoles: An Introduction*. CSIRO Publication, Collingwood, Australia.
8. Gupta, P.K. 1998. *Cytogenetics*. Rastogi Publications, Meerut.
9. Hartl, D.L. and Jones, E.W. 1998. *Genetics: Principles and Analysis* (4th Edition). Jones and Bartlett Publishers, Massachusetts, USA.
10. Kleinsmith, L.J. and Kish, V.M. 1995. *Principles of Cell and Molecular Biology* (2nd Edition). Harper Collins College Publishers, New York, USA.
11. Krishnamurthy, K.V. 2000. *Methods of Cell Wall Cytochemistry*. CRC Press, Boca Raton, Florida.
12. Lewin, B. 2000. *Genes VII*. Oxford University Press, New York.
13. Lodish, H., Berk, A., Zipursky, S.L. Maztsudaira, P., Baltimore, D and Darnell, I. 2000. *Molecular Cell Biology* (4th Edition). W.H. Freeman and Co., New York, USA.
14. Malacinski G.M., D. and Freifelder, D. 1998. *Essentials of Molecular Biology* (3rd Edition). Jones and Bartlett Publishers, Inc. London.
15. Stent, G.S. 1986. *Molecular genetics*. Bishen Singh Mahendra Pal Singh. Dehradun.
16. Watson, J.D. 1965. *Molecular Biology of the Genes*, Benjamin.
17. Wolfe, S.L. 1993. *Molecular and Cellular Biology*. Wadsworth Publishing Co. California.

BOT/II/CC/10: Based on the CC/05 to CC/08 papers

BOT/II/*SSC/01: Paper I: Plant Cell Structure and Functions

Principles of microscopy, structural organization of the plant cell and its chemical foundation, Cell wall structure and function, Plasma membrane, Cytoskeleton, organization and role of microtubules and microfilaments.

Structure and functions of endoplasmic reticulum, golgi apparatus, ribosomes and protein synthesis

Structure and genome organization of chloroplast and mitochondria

BOT/II/SSC/02: Paper II: Applied microbiology

Microbiology and its scope: microorganisms in the living World: Group of microorganisms. Occurrence and distribution of microorganisms in Nature. Major fields of applied microbiology. Medical microbiology. Aquatic microbiology: Water purification microbiological examination; biological degradation of waste; ecology. Aero microbiology. Food microbiology. Soil Microbiology. Industrial microbiology. Geochemical microbiology. Mushroom cultivation and Production of single cell protein and yeasts for fox.

III Semester

BOT/III/CC/11: Paper IX: Plant Ecology

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

Climate, soil and vegetation patterns of the world: Major terrestrial biomes; Zonoecotones, Orobiomes and Pedobiomes, Fresh water aquatic ecosystems; 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 interactions, interspecific competition ; Amensalism; herbivory; parasitism; Commensalism, carnivory, pollination, symbiosis (obligate and facultative symbiosis).

Unit 2

Population Ecology: Characteristics of population; population growth curves; population regulation life history strategies (r and k selection); population genetics and natural selection.

Habitat and niche: Concept of habitat and niche; niche width and overlap, fundamental and realized niche.

Unit 3

Ecological succession: Causes, mechanism and types, changes involved in succession; Transient and cyclic changes; Examples of succession; Methods of standing succession; concept of climax.

Ecosystem: Structure and functions; primary production (methods of measurement, Global pattern, Controlling factors); energy dynamics (Tropical organization, energy flow pathways, ecological efficiencies); litter fall and decomposition (mechanism, substrate quality and climatic factors); Global biogeochemical cycles of C, N, P and S (pathways, processes in terrestrial and aquatic ecosystems); nutrient use efficiency; Global hydrological cycle.

Unit 4

Applied Ecology: 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.

Environmental pollution: kinds; sources; quality parameters; effects on plants and ecosystems and remedies.

Climate change and conservation: Biology; Greenhouse gases; sources, trends and role; ozone layer and ozone hole; Consequences of climate change; principles of conservation; Major approach to management with special reference to Indian Biosphere reserves.

Suggested readings

Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987 Terrestrial Plant Ecology.

Benjamin/Cummings Publication Company, California

Odum, E.P. 1983 Basic Ecology Saunders, Philadelphia

Smith, R.L. 1996 Ecology and Field Biology Harper Collins, New York

Baskin and Baskin 2001. Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination Elsevier

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

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

Sustainable development: Basic concepts.

World centres of primary diversity of domesticated plants: The Indo-Burmese centre plant introduction and secondary centres.

An idea of (i) Food, forage and fodder crops. (ii) Fibre crops. (iii) Medicinal and Aromatic Plants and (iv) Vegetable oil- yielding crops and their uses.

Unit 2

Important fire-wood and timber-yielding and non-timber forest products (NTFPs) Such as bamboos, rattans, raw materials for paper-making, gums, tannins, dyes, resins and fruits.

Green revolution: Benefits and adverse consequences.

Plants used as avenue trees: for shade, pollution control and aesthetics.

Principles of conservation: extinctions: environmental status of plants based on International Union for Conservation of Nature (IUCN).

Unit 3

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 for conservation on wild biodiversity.

Unit 4

Strategies for conservation- ex-situ conservation: Principles and practices; botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks, general account of the activities of botanical Survey of India (BSI), National Bureau of Plant Genetic resources (NBPGR), Indian Council of Agriculture Research (ICAR), Council of Scientific and Industrial Research (CSIR) and Department of Biotechnology (DBT) for conservation, non-formal conservation efforts.

Suggested Readings:

Global Biodiversity Assessment (1995) by V.H. Heywood and R.I. Watson.

Plant genetic resources Conservation and Management (1991) by R.S. Paroda and R.K. Arora.

The Conservation by Plant Diversity (1995) O.H. Frankel, A.D.H. Brown and J.J. Burdon.

Technical guidelines for the site movement of Germplasm (1989) by FAO IBPGR.

BOT/III/CC/13: Paper XI: Biotechnology

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 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.

Unit 2

Callus culture, organ culture, cell suspension culture, cryopreservation, protoplast culture, organogenesis, somatic embryogenesis, artificial seed, somatic hybridization, hybrids and cybrids, and somaclonal variation.

Unit 3

Recombinant DNA technology: Tools of genetic engineering, enzymes, cloning vectors, plasmids, cosmids, lambda phage, shuttle vectors, BACs, and YACs.

Cloning strategies, Screening and selection of transformants.

Unit 4

Gene libraries (a general account): Genomic DNA libraries, cDNA libraries

Hybridization- colony hybridization, Southern hybridization, Northern hybridization, Western hybridization,

DNA sequencing techniques: Concept of nucleic acid sequencing, Maxam and Gilbert sequencing, Sanger sequencing

Genetic Engineering of plants: Aims, tools, strategies for development of transgenic plant with suitable examples

Suggested Readings:

1. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.
2. Brown, T.A. 1999. Genomes. John Wiley and Sons (Asia) Pvt. Ltd. Singapore.
3. Callow, J.A., Ford-Lloyd, B.V. and Newbury, H.J. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use. Cab International, Oxon, UK.
4. Chrispeels, M.J. and Sadava, D.E. 1994. Plants, Genes and Agriculture. Jones and Bartlett Publishers, Boston, USA.
5. Collins, H.A. and Edwards, S. 1998. Plant Cell Culture. Bioscientific Publishers, Oxford, UK.
6. Glazer, A.N. and Nikaido, H. 1995. Microbial Biotechnology, W.H. Freeman and Company, New York, USA.
7. Gustafson, J.P. 2000. Genomes. Kluwer Academic Plenum Publishers, New York, USA.
8. Henry, R.J. 1997. Practical Application of Plant Molecular Biology. Chapman & Hall, London, UK.
9. Jain, S.M., Sopory, S.K. and Veilleux, R.E. 1996. In Vitro Haploid Production in Higher Plants, Vols, 1-5., Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.
10. Jolles, O. and Jornvall, H. 2000. Proteomics in Function Genomics. Birkhauser Verlag, Basel, Switzerland.
11. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton. Florida, USA.
12. Old, R.W. and Primose, S.B. 1989. Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford, UK.
13. Primose, S.B. 1995. Principles of Genome Analysis. Blackwell Science Ltd, Oxford, UK.
14. Raghavan, V. 1997. Molecular Biology in Flowering Plants. Cambridge University Press, New York, USA.
15. Shantharam, S. and Montgomery, J.F. 1999. Biotechnology, Biosafety and Biodiversity. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
16. 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

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 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.

Enzymology: General aspects, allosteric mechanism, regulatory and active sites, isozymes, kinetics of enzymatic analysis, Michaelis - Menten equation and its significance.

Signal transduction and sensory photobiology: Receptors, phospholipids signaling, phytochromes and cryptochromes.

Unit 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, ammonium assimilation.

Unit 3

Plant growth regulators: Physiological effects and mechanism of auxins, gibberellins, cytokinins, ethylene, abscisic acid, polyamines, jasmonic acid, hormone receptors and vitamins and hormones, phytochrome and cryptochrome.

Photoperiodism and vernalization: Photoperiodism and its significance, floral induction and development, significance of vernalization.

Stress physiology: Plant responses to biotic and abiotic stress, mechanism of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, freezing and heat stress, oxidative stress.

Unit 4

Carbohydrates: structure and function of Monosaccharides, oligosaccharides, polysaccharides.

Lipids: Fat metabolism (Simple lipids, compound lipids, derived lipids).

Proteins : Amino acids, Structure of primary, secondary and tertiary proteins, protein sequencing.

Suggested Readings:

- Buchanan, B B; W. Gruissem and R. L. Jones.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.
- Dennins, D. T; D.H. Turpin; D.D. Lefebvre and D.B. Layzell. Plant Metabolism.
- Scott, R.P.W. 1995. Techniques and Practice of Chromatography.
- Hopkins, W. G. 1995. Introduction to plant physiology.
- Cooper, T.G. 1977. Tools in Biochemistry.
- Salisbury & Ross 2003. Plant Physiology.
- Lehninger. Principles of Biotechnology
- Srivastava, H.S. 1983. Elements of Biochemistry. Rastogi Publications, Merrut
- Meister ,A . 1965. Biochemistry of the Amino acids. 2 vols. Academic Press, New York.
- Bosch, C. 1972. Mechanism of Protein Synthesis and its Regulation. ElsevierPub. Comp. N. York.
- Summer, J. B. and G. F. Somers-1953. Chemistry and Methods of Enzymes. Academic Press, New York.
- Ribonsen, T. 1968. The biochemistry of Alkaloides Springer Verlog, Berlin

BOT/III/CC/15: Based on the CC/09 to CC/12 papers

Semester IV

BOT/IV/EC/16(i): Elective Course/Special Paper XIV(i): Forest Ecology

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 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 of biomass; 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.

Unit 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.

Unit 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). 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 reabsorption; Nutrient return from vegetation to soil; Decomposition and nutrient release, nutrient use efficiency, nutrient conserving adaptation in oligotrophic soil; Effects of N and P enrichment on biodiversity.

Forest Hydrology: Impact of forest on precipitation apportionment, Water discharge from watersheds, Role of water in nutrients cycling.

Unit 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 acut vs Chronic human disturbance; Shifting cultivation.

SUGGESTED READING:

1. Bir, S.S. and Chatha, G.S. 1988. Forest Vegetation Characteristics of Indian Hills. Today and Tomorrow's Printers & Publ., New Delhi.
2. Misra, R.1968. Ecology Work Book. Oxford & IBH Publishing Co. New Delhi.
3. Puri, G.S., V.M. Meher-Homji, R.K. Gupta and R.K. Puri (1960). Forest Ecology. Oxford and IBH Pub.Co. Pvt. New Delhi.
4. Singh, J.S. Singh S.P. and Gupta, S.R. 2014. Ecology, Environmental science and Conservation. S. Chand and Compony Pvt. Ltd., New Delhi.
5. Waring, R.H. and Schlesinger, W.H. 1985. Forest Ecosystems: Concepts and Management. Academic Press, New York.
6. Troup, R.S. 1921. Silviculture of Indian Trees vol.2. University Press Oxford, U.K.
7. Singh, J.S., S.P. Singh, and S.R. Gupta 2014. Forest of Himalaya: structure, Function and Impact of Man. Gyanodaya Prakashan, Nainital, India.

BOT/IV/EC/16 (ii): Elective course/special paper (ii): Plant Pathology

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

A brief history of plant pathology in India and losses caused by pathogens and pests; types of pathogens, symptoms of different diseases.

Inoculum: Inoculum types, theory of inoculums, survival and longevity of inoculums, inoculums production, potential and density.

Plant microbes interaction: molecular basis of host recognition, pathogenesis: prepenetration, 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).

Unit 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.

Physiology of diseased hosts: Change in physiology processes, e.g., respiration, photosynthesis and disturbance in other metabolic pathways.

Unit 3

Disease resistance: (i) Protection (structural, chemical, absence of nutrients and common antigens) (ii) Defence (histology defence, chemical- polyphenols, prohibitins, inhabitins, phytoalexins, lectins), (iii) 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, systematic and non-systematic chemical), biological control: Introduction, biological control of insects and pests, use of resistance varieties quarantine.

Unit 4

Brief account, structure, importance, disease cycle and control of the following:

- (i) 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.
- (ii) General characteristics, importance, disease cycle and control of the following: (i) Bacterial disease, (ii) Viral disease, (iii) Mycoplasma disease.

Suggested readings:

1. Mehrotra, R. S. 1980. Plant pathology. Tata Mc Grow Hill Publishing Co Ltd. New Delhi.
2. Agrios, G. N. 1969. Plant Pathology. Academic Press. New York.
3. Mehrotra, R. S. and Agrawal, A. 2003. Plant Pathology. Tata Mc Grow Hill Publishing Co Ltd. New Delhi.
4. Bouarab, N. K., N. Bissow and F. Daayt. Molecular Plant Microbe Interactions.

5. Narayansamy, P. Pathogens detection and disease diagnosis.
6. Butler, E. J. 1918. Fungi and Diseases in plants. Thacker and Spink and Cooperation. Calcutta.
7. Singh, R. S. 1988. "Plant diseases". Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
8. Lucas, J. A. 1988. Plant Pathology and Plant Pathogens. Third edition. Blackwell.

BOT/IV/EC/16 (iii): Elective Course/Special paper (iii):Taxonomy of Angiosperms

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

History of different systems of classification (introduction only). Important systems- Benthom and Hooker, Hutchinson, A. Takhtajan, A. Cronquist, Robert Thorne.

A brief account of major contribuion made by the following taxonomists: C. Linnaeus, J.D.Hooker, Willium Roxburgh and Duthie.

Unit 2

Taxonomic evidences- wood anatomy, embryology, palynology, cytotaxonomy, biosystematics, chemotaxonomy and numerical taxonomy.

Cladistics in taxonomy, relevance of taxonomy to conservation.

Unit 3

Some important families: Magnoliaceaea, Myrtaceae, Scrophulariaceae, Verbinaceae, Cannabinaceae, Lauranthaceae, Primulaceae, Fagaceae, Orchidaceae, Poaceae.

Local plant diversity and general account of Kumaun flora

Unit 4

Scrophulariaceae, Verbinaceae, Cannabinaceae, Cucurbitaceae, Fagaceae, Orchidaceae, Poaceae. Wild and cultivated fruits of Kumaun.

Suggested readings

- Heywood V.H. 1970Plant taxonomy London.
- Heywood V.H. and D.M. Moore. 1984 Current concept in plant taxonomy. Systematic special voume 25. London.
- Bhattacharya B. and B.M. Joshi 1998. Flowering plants . Taxonomy and phylogeny Norsa publishing house New Delhi.

- Lawrence G.H.M. 1951. Taxonomy of vascular plants. Mac Millan N.York.
- Davis P.H. and Heywood V.H. 1973. Principles of angiosperms taxonomy. Robert E. Kreign Pub. Co. New York.
- Bensen L. 1957. Plant Classification reprint.Oxford & IBH N.Delhi.
- Gaur R.D. 1999. Flora of District Garhwal, N.W. Himalaya Transmedia, Srinagar Garhwal.
- Sambamurty A.V.S.S. Taxonomy of Angiosperms. I.K. International Pvt. Ltd

BOT/IV/EC/16 (iv): Elective Course/Special Paper (iv): BRYOLOGY

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

Distribution of bryophytes in India, the bryogeographical units: Vanishing bryophytes in Kumaun Himalaya, the red List monotypic, endemic liverwort taxa. Rare and endangered liverworts of Kumaun Himalaya.

Taxonomic methodology in the identification of some common West Himalaya mosses, distinguishing features of the following orders, families and genera.

1. Polytricales

Polytrichaceae- *Pogonatum, Atricum*

2. Fissidentales

Fissidentaceae- *Fissidens*.

3. Dicranales

Dicranaceae- *Dieranum*

4. Pottiales

Pottiaceae- *Hyophila, Hydrogonium*.

5. Grimmiales

Grimmiaceae- *Grimmia, Rhacomitrium*.

6. Bryales- (a) Bryaceae- *Bryum, Rhodobryum*

(b) Mniaceae- *Mnium*

(c)- Bartramiaceae- *Philonotis*

7. Isobryales- (a) Orthotricaceae- *Macromitrium*

(b) Leucodontaceae- *Leucodan*

(c) Meteoriaceae- *Meteorium*

(d) Neckeraceae- *Neeckera, Cryptoleptodon*

8. Hypnobryales- (a) Thuidiaceae- *Thuidium, Anomodon, Herpetin*

(b) Brachytheciaceae- *Brachythecium*

(c) Entodontaceae- *Entodaon*

(d) Hypnaceae- *Hypnum*

Unit 2

Bryophyte ecology: Habitats, growth forms, the role of bryophytes in succession, bryophytes as bio-indicators, and uptake of mineral elements, response to air pollution.

Unit 3

Physiology of bryophytes: General idea of conduction and water reactions in bryophytes, external and internal conduction cells involved in conduction, ecto, exo and mesohydric groups, desiccation and hydration, desiccation tolerance.

Unit 4

Culture of bryophytes: A general idea of culture techniques for bryophytes.

Chemistry of bryophytes: A brief account of distribution of various organic compounds in bryophytes and their uses in medicines.

Suggested Readings:

Mosses of Eastern India and Adjacent regions Vol. I. Vol. II and Vol III by S.C. Ganguly.
Biology of Bryophytes by R.N. Chopra and P.K. Kumra.

BOT/IV/EC/16 (v): Elective Course/Special Paper V: Ethnobotany, Traditional Knowledge And Intellectual Property Rights

(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Unit 1

Ethnobotany: Its Concept, Scope and Relevance.
Interdisciplinary approaches in Ethnobotany.
Ethnobotany in India: Retrospect and prospects.
Methods of research in Ethnobotany.

Unit 2

Indigenous systems of medicines in India.
Traditional Agriculture Practices in Ancient India.
Some aspects of Biodiversity and Indian Traditions.

Unit 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.

Unit 4

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.

Unit 5

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 to Traditional knowledge and Biowealth.

***Practicals:**

1. Field trips for exploring traditional knowledge.
2. Knowing what plants used by tribes.
3. Process of preparation of drinks, food etc. including storing process.
4. Identification of ethnobotanical plants or subjects used by locals.

Suggested Readings:

- Paroda. R.S. & R.K. Arora (1991). Plant Genetics Resoueces Conservation and Management concepts and approaches. New Delhi.
- Jain. S.K. (1989 Ed.) Method of Approaches in Ethnobotany. Lucknow.
- Jain. S.K. (1989 Ed.) A Mannual of Ethnobotany. Jodhpur.
- Jain. S.K. & V. Mudgal (1999) A handbook of Ethnobotany. Dehradun.
- Martin. G.J. (1994) Ethnobotany: A Method Mannual. London.
- Pande. P.C. D.S. Pokharia & J.C. Bhatt (1999 Ed.) Ethnobotany of Kumaun Himalaya. Jodhpur.
- Wariko. K. (1995) Society and culture in the Himalaya. New Delhi.
- Krattigar. F. Anatole. et al. (1994 Ed.) Widening Perspectives on Biodiversity. Dehradun.
- Yamin. F. (1995) The Biodiversity Conservation and Intellectual Property Rights. Switzerland.
- Raychaudhari. S.P. (1996) Agricultural Practices in Ancient India. Indian Jour. Hist. Science. 1(2): 148-156.
- Schultes. R.E. (1962) The role of ethnobotanists in the search for new medicinal plants. Lloydia. 25: 257-266.

BOT/IV/EC/16 (vi): Elective Course/Special Paper (vi): Lichenology
(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

History of Lichenology, Biogeographical distribution, habitat and growth form of lichens.
Classification

Symbiosis in lichens- types of symbiotic association

Identification, morphological, anatomical and chemical methods (spot test, thin layer chromatography, microcrystallography and UV fluorescence analysis).

Reproduction- asexual and sexual means, lichenized and non lichenized diaspores, isidia, soredia, conidia, parthecia 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.

Role of lichens in environmental monitoring- pollution succession, lichenometry, pedogenesis and biodegradation.

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

Families and their representative genera

Parmeliaceae, Lecanoraceae, Teloschistaceae, Ramalinaceae, Physciaceae, Collemataceae, Candelariaceae, Pertusariaceae, Peltigeraceae

Lichen flora of Kumaun Himalaya general account

Suggested Readings:

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) microchemical methods of identification of lichen, British lichen society, London

Smith A.L (1921) lichen Cambridge University press. London

BOT/IV/EC/16 (vii): Elective Course/Special Paper (vii): Environmental Biology
(48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Environment: Definition, major components of physical environment, Geosphere, lithosphere, hydrosphere, atmosphere and outer space. Impact of man and physical environment and vice-versa.

Resource and Energy Conservations: Concepts of resources, renewable and non-renewable resources, resource conservation, soil, water and forest resources, wild life resources, wild life management laws and principle, wild life sanctuaries, national parks and biosphere reserves. Introduction to various energy resources such as solar, wind, biomass, thermal, nuclear and biogas. energy conservation pattern and strategies.

Environmental monitoring: Meaning and scope, Environmental monitoring as a tool to environmental management concept of bio monitoring and biological indicator, biodiversity indices, environmental monitoring system.

Ecotoxicology: Branches and its significance, types of toxicants, toxic elements, organometallic and organometalloids, toxic inorganic and organic compounds, toxic natural products national and international laws of toxicology, radiation, ecology and recycling.

Environmental Pollutions: Definition, types and cause of pollution, air pollution, carbon, sulphur and nitrogen pollution, acid rains, ozone fluorocarbon hydrocarbons, metal photochemical products, water pollution sources of pollution and the pollutants, solid waste pollution, degradation and cycling of water, noise pollution, radioactive pollution and the pollutants, global warming and climate change, legal aspects of environmental pollution. Indian laws and policies for control of environmental pollution.

Environmental Impact Assessment: Scope, importance and applications of EIA process. Its role in protection and conservation of environment and economic resources, environmental and socio-economic aspects environmental priorities in India.

Environmental Management: Definition and basic concept, sustainable development environmental issues challenges and strategies in management, eco-planning, national and international organization and policies on environmental management, environmental management with special reference to land, water and forest resources, environmental education and awareness. Environmental laws.

References:

1. Energy, Environment and Natural resources- J.S. Singh, S.P. Singh and S.R. Gupta
2. Environmental Sciences- G.T. Miller
3. Environmental Science- R.T. Wright
4. Environmental Science- Piyush Malviya and Pratibha Singh
5. Environmental Science and Impact Assessment- S.C. Santra

6. Fundamental of Ecology- E.P. Odum
7. Ecology and Environment- P.D. Sharama
8. Environmental Concepts and Strategies- T.N. Khoshoo

** BOT/IV/EC/17A – Lab based on Final Semester EC 16

**BOT/IV/EC/17B – Lab based on Final Semester EC 16

BOT/IV/CC/18 - Dissertation

BOT/IV/SCC/03: Global Climate Change

General concept of Global climate change; Greenhouse effect; Greenhouse gasses; Carbon foot print; Impact of global warming and climate change especially on elevated temperature, weather extremes, ecosystem disruption, human health, sea level rise and impact on forests; International initiative for mitigating global changes; Inter governmental panel on climate change (IPCC); United Nation Framework convention on Climate change; Kyoto protocol; Montreal protocol; Paris Pact; India's initiatives for mitigating climate change.

BOT/IV/SSC/04: Medicinal Plants of Central Himalaya (48 h, 4 credits, Max Marks 100; 75 External Exam+ 25 internal assessment)

Retrospect and prospects of medicinal plants

Brief history, properties, action and uses of some important medicinal plants

Diversity, distribution and indigenous uses of threatened medicinal plants

Government policies for conservation and management of threatened medicinal plants

Economics and exploitation of resources and people conflict.