NETAJI SUBHAS UNIVERSITY

JAMSHEDPUR

MASTER OF SCIENCE

BOTANY SYLLABUS

NETAJI SUBHAS UNIVERSITY, JAMSHEDPUR
MASTER OF SCIENCE

BOTANY

The course for Master of Science (M.Sc.) in Botany shall comprise of four semesters of six months duration each. Each semester shall include four theory papers and two practical (laboratory) courses. Each theory course will be of 70 marks each and there shall be a related internal assessment for each theory course involving 30 marks. Practical course will include 100 marks. The practical examinations may be held before or after theory examinations. The students are required to participate in study excursions of short and/or long-term duration organized by the University as and when possible.

The students have to select four papers of specializations (electives); each of two will be taught in third and fourth semesters:

A. Forest Ecology
B. Plant Pathology
C. Ethno botany, Traditional Knowledge and Intellectual Property Rights
D. Bryology
E. Environmental Botany
F. Plant Biotechnology
G. Lichenology

(The Students will opt any one elective course for Dissertation and Project work in IV semester)

SEMESTER-I

Code	**Theory/Practical**	**Credit**	**Examination Scheme**		
			External	**Internal**	**Total**
101	Microbiology (Bacteria, Viruses and Lichens)	4	70	30	100
102	Phycology	4	70	30	100
103	Mycology	4	70	30	100
104	Bryology and Pteridology	4	70	30	100

Practical -1	Practical (Based on Theory Paper 101 &102)	3	75	……	75
Practical -2	Practical (Based on Theory Paper 103 &104	3	75	……	75
Seminar	Seminar-1	1	……	25	25
	Field Report	1	……	25	25
		24			**600**

SEMESTER -II

Code	**Theory/Practical**	**Credit**	**Examination Scheme**		
			External	**Internal**	**Total**
201	Gymnosperms and Palaeobotany	4	70	30	100
202	Taxonomy of Angiosperms	4	70	30	100
203	Plant Morphology, Anatomy and Embryology	4	70	30	100
204	Cell and Molecular Biology	4	70	30	100
Practical -3	Practical (Based on Theory Paper 201 &202)	3	75	……	75
Practical -4	Practical (Based on Theory Paper 203 &204	3	75	……	75
Seminar	Seminar-1	1	……	25	25
	Seminar-2/Field Report	1	……	25	25
		24			**600**

SEMESTER –III

Code	**Theory/Practical**	**Credit**	**Examination Scheme**		
			External	**Internal**	**Total**
301	Plant Ecology	4	70	30	100
302	Cytogenetics and Plant Breeding	4	70	30	100
Elective -1	Plant Biotechnology OR Plant Biotechnology	4	70	30	100
Elective -2	Forest Ecology OR Plant Pathology	4	70	30	100
Practical -5	Practical (Based on Theory Paper 301 &302)	3	75	……	75
Practical -6	Practical (Based on Elective -1 & 2)	3	75	……	75
Seminar	Seminar -3	1	25	……	25
	Field Report	1	25	……	25
		24			**600**

SEMESTER –IV

Code	Theory/Practical	Credit	Examination Scheme		
			External	Internal	Total
401	Plant Physiology and Biochemistry	4	70	30	100
402	Plant Resource, Utilization and Conservation	4	70	30	100
Elective -3	Environmental Botany OR Lichenology	4	70	30	100
Elective -4	Bryology OR Ethnobotany, Traditional Knowledge and Intellectual Property Rights	4	70	30	100
Practical -5	Practical (Based on Theory Paper 401 & 402)	3	75	……	75
Practical -6	Practical (Based on Elective -4 & 5)	3	75	……	75
	Dissertation/ Field Report	2	50	……	50
				……	
		24			**600**

I Semester

Microbiology (Bacteria, Viruses and Lichens)

• General account of Microorganisms: History of microbiology, characteristic features of bacteria and actinomycetes, classification of microorganisms- five kingdom classification, Ainsworth classification.

• Culture Study of Microorganisms: Methods of isolation and culture of microorganisms; measurement of microbial growth; microbial genetics.

• 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, fimbrae and pilli), structure of plasma membrane, cytoplasmic inclusions- mesosomes, chlorosome.

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

• Role of microorganism: Root nodules, nif gene organization, role of microorganisms in soil (decomposition and nutrient cycling), water and air; role in industry- production of antibiotics, bio-fertilizers and bio-pesticides.

• General account of lichens: Occurrence, classification, morphology, anatomy, reproduction and their importance.

Suggested readings:

1. Madigan, M.T., J.M. Martink and J. Parker (1997). Brock Biology of Microorganism. Printice hall International, Inc., New, Jersey.

2. Prescott (2000). Microbiology.

3. Cruezer, W. and A. Cruezer (1990). A Textbook of Industrial Microbiology.

4. Alexander, M. (1977). Soil Microbiology. John Wiley and Sons, New York.

5. Dubey, R.C. and D.K. Maheshwari (2010). A Textbook of Microbiology. S. Chand and Co. Pvt. Ltd. New Delhi.

6. Awasthi, D

I Semester

Phycology

• History and Classification of Algae: Criteria of classification, important systems of classification.

• Ecology of Algae: Diversified habitats of algae, eutrophication, water blooms and phytoplanktons.

• Basic concept of Cyanophages.

• Importance of Algae: Useful and harmful aspects of algae.

• A detailed study of following orders with emphasis on given genera:

Cyanophyta: Chroococcales (Chroococcus, Gleocapso, Microcystis); Oscillatoriales (Oscillatoria, Lyngbyo,); Nostocales (Nostoc, Anabaena, Spirulllina), Scytonematales (Scytonema; Tolypothrix; Rivulariales (Rivularia, Gloeotrichia).

Chlorophyta: Chlamydomonadales (Haematococcus); Volvocales (Gonium, Pandorina, Eudorina; Chlorococcales (Chlorella, Hydrodictyon, Pediastrum); Oedogoniales (Oedogonium, Bulbochaete, Scendersmus) Ulvales (Ulva, Enteromorpha); Cladophorales (Cladophora, Pithophora) Chaetophorales (Chaetophora), Fritschiales (Fritschiella), Zygnemetales (Zygnema).

Charophyta: Charales (Nitella, Chara).

Xanthophyta: Heterosiphonales (Botrydium, Vaucheria)

Bacillariophyta: Pennales and Centrales (Pinnate diatoms and Centric diatoms)

Phaeophyta: Ectocarpales (Ectocarpus); Dictyotales (Dictyota), Laminariales (Laminaria); Fucales (Fucus, Sargassum).

Rhodophyta: Nemalionales (Nemalion); Gigartinales (Gracillaria); Gelidiales (Gelidium); Ceramiales (Ceramium).

Suggested readings:

1. Fritsch, F.E. 1979. The structure and Reproduction of Algae Vol. I & II. 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. Fritsch, F.E. 1977. Structure and Reproduction of Algae. Vol. I & II. Vikash Publishing House Pvt. Ltd. New Delhi.

6. Trainer, F.R. 1978. Introductory Phycology. John. Wiley and Son: Inc.

7. Round, F.E. 1984. Ecology of Algae. Academic. Press. London.

8. Tilden, J.F. 1968. The Algae and their Life Relations. Hafner Publishing Co. New York.

9. H.C. Bold and MJ. Wynne. 1978. Introduction to the Algae. Prentice Hall of India. Pvt. Ltd. New Delhi.

I Semester

Mycology

• General characteristics and classification of fungi.

• Reproduction (vegetative, asexual and sexual). Heterothallism; heterokaryosis parasexuality. Recent trends in classification.

• Phylogeny of fungi.

• Importance of Fungi.

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

Myxomycotina: Stemonitis, Physarum.

Mastigomycotina: Allomyces, Monoblepharis, Plasmodiophora. Oomycotina: Saprolegnia, Pythium, Phytophthora, Peronospora, Sclevospora. Zygornycotina: Mucor, Pilobolus, Entomophthora, Syncephalastum.

Ascomycotina: Saccharomyces, Aspergillus, Talaromyces (Penicillium), Taphrina, Uncinula, Phyllactinia, Peziza, Cordiceps (Yarsa gambu), Mycrophora, Chaetomium, Claviceps.

Basidiomycotina: Puccinia, Ustilago, Amanita, Geastrum, Auricularia, Ganoderma, Fomes, Tiletia, Uromyces, Nidularia.

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

Suggested Readings:

1. Mehrotra, R.S. and K.R. Aneja. 1999. An introduction to Mycology.

2. Alexopoulas and Mims. 1979. Introductory Mycology.

3. Webster, I. 1979. Introductory Mycology.

4. Ainsworth, G.C. 1976. Introduction to the history of Mycology.

5. Webster, J. 1985. Introduction to Fungi.

I Semester

Bryology and Pteridology

• Origin, relationship and evolutionary trends in Bryophytes, fossil, Bryology in India.

• General idea about the morphological, cytological and ecological characteristics of Bryophytes.

• Economic importance of Bryophytes, Bryophytes as monitors of mineral deposition, Air Pollution Indicators.

• Modern systems of classification of Bryophytes and salient features of the following groups with emphasis on the given genera:

Hepaticopsida:

Sphaerocarples: Sphaerocarpus

Marchantiales: Marchantia, Lunularia, Dumortiera, Plagiochasma, Asterella, Cryptomitrium, Targionia, Conocephalum, Reboulia, Cyathodium.

Jungermanniales: Frullania, Porella, Radula. Metzgeriales: Pellia, Sewardiella, Metzgeria, Riccardia. Calobryales: Haplomitrium, Calobryum.

Anthocerotopsida:

Anthocerotales: Anthoceros, Notothylas, Folioceros, Megaceros, Phaeoceros.

Bryopsida:

Sphagnales: Sphagnum.

Eubryales: Funaria, Buxbaumia, Polytrichum.

Andreales: Andreaea.

Takakiales: Takakia

Pteridology

• A brief account of origin of pteridophytes, classification of pteridophytes, heterospory and seed habit, evolution of steler system, telome theory, evolution of sorus, apogamy, apospory and apomixis.

• A brief account of the following classes with emphasis on the given genera:

Psilophytopsida: Rhynia, Horneophyton.

Psilotopsida: Psilotum.

Lycopsida: Lycopodium, Lepidodendron, Lepidocarpon, Selaginella, Isoetes.

Sphenopsida: Hyenia, Sphenophyllum, Calamites, Equisetum.

Pteropsida:

Eusporangiate (Ophioglossales and Marattiales) with special reference to phylogeny of Ophioglossales.

Protoleptosporongiate (Osmunda, Leptopteris)

Leptosporongiate: (a) Filicales (Hymenophyllum, Adiantum, Pteris, Dryopteris)

(b) Marsileales (Marsilea)

(c) Salvineales (Salvinia, Azolla).

Suggested Readings:

1. Kashyap, S.R. 1968. Liverworts of the Western Himalayas and Punjab Plain. The Chronica. Botanic. Delhi.

2. Watson, 1975. Bryophytes. Hutchinson Library, Series, London.

3. Puri, P. 1980. Bryophytes, Alma Ram & Sons, Delhi.

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

5. Smith, G.M. 1971.Cryphogamic Botany Vol I.

6. Beddom, R.H. 1966. The ferns of British India 2 Vol. Oxford and IBH, N. Delhi.

7. Eams, A.J. 1969 Morphology of Lower Vascular Plants.

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

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

10. Baker, J.G. 1995. Handbook of Fern Allies. Reprint. Bishan Singh Mahendra Pal Singh; Dehradun.

II Semester

Gymnosperms and Palaeobotany

• Introduction: History, classification, distribution and evolution of Gymnosperms.

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

• General account of Cordaitales.

• General account of Pentoxylales.

• Morphology, anatomy and reproduction in Cycadales, Ginkgoales and Coniferales.

• General account of Ephedrales, Welwitschiales and Gnetales.

Palaeobotany

• Preservation of fossil plants. Types of fossils, modes of formation of different kinds of fossils, Gondwana flora.

Suggested Readings:

1. Bhatnagar, S.P. and A. Mitra. 1996. Gymnosperm, New Age International Pvt. Ltd. N. Delhi.

2. Chamberlian, CJ. 1955. Gymnosperms: Structure and Evolution. Chicago.

3. Andrews, H.N. 1961. Studies in Palaeobotany, N. York.

4. Arnold, C.A. 1947. An introduction to Palaeobotany, N. York.

5. Seward, A.C. 1919.Fossil plants for students of Botany and Geology. 4 vols. Cambridge.

II Semester

Diversity and Taxonomy of Angiosperms

• Important system of classifications of angiosperms (Bentham and Hooker, .I. Hutchinson and A. Takhtajan).

• Salient features of International Code of Botanical Nomenclature.

• Plant Exploration.

• Origin of intra-population variation: Population and the environment, ecads, ecotypes, evolution and differentiation of species.

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

• Origin and evolution of angiosperms: Fossil history, types of inflorescences and their origin.

• Taxonomic Tools: Herbarium, Flora, histological, cytological, phytochemical, serological, biochemical and molecular techniques.

• Concepts of Phytogeography: Endemism, plant migration, invasions and introduction.

• Distinguishing features only of the following families and their economic importance: Ranunculaceae, Rutaceae, Fabaceae, Rosaceae, Apiaceae, Acanthaceae, Rubiaceae, Solanaceae, Orchidaceae, Zingiberaceae, Cyperaceae and Poaceae.

Suggested Readings:

1. Babu, C.R. 2004. Herbaceous Flora of Dehradun. CSIR, N. Delhi.

2. Bensen, L 2003. Plant classification. Reprint. Oxford and IBH. N. Delhi.

3. Core, A.J. 1999. Numerical Taxonomy, Academic Press, London.

4. Cronquist. A. 1981. An integrated System of classification of flowering Plants. Columbia University Press, N. York.

5. Davis, P.H. and Heyhood, V.H. 1993. Principles of Angiosperms taxonomy. Robert E. Kreign Pub. Co., N. York.

6. Gaur, R.D. 1999. Flora of District Garhwal; N.W. Himalaya Transmedia, Srinagar. Garhwal.

II Semester

Plant Morphology, Anatomy and Embryology

• Morphology: Morphology of flower, stamen and carpel. Plant adaptations and their morphological nature.

• Shoot Development: Organization of the shoot apical meristem (SAM); control of cell division and tissue differentiation especially xylem and phloem; secretary ducts and laticifers; wood development in relation to environmental factors and wood anatomy.

• Leaf growth and differentiation (structural development and classification of stomata and trichomes).

• Root development: Organisation of root apical meristem (RAM); vascular tissue differentiation; lateral roots; root hairs.

• Male gametophyte: Structure of anther; microsporogenesis; pollen germination, pollen allergy; pollen embryos.

• Female gametophyte: Ovule development; megasporogenesis; development and organization of the embryo sac.

• Pollination, Pollen-pistil interaction and fertilization: Floral characteristics, pollination mechanism and vectors; commercial consideration; structure of the pistil; pollen stigma interactions, sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects); double fertilization; in vitro fertilization.

• Seed development and fruit growth: Endosperm development during early, maturation and desiccation stages; embryogenesis, cell lineages during late embryo development; polyembryony; apomixis, embryo culture.

• Latent Life-dormancy: Importance and types of dormancy; bud dormancy.

• Tissue - General account

Stem anatomy - Dicot and Monocot

Root anatomy - Dicot and Monocot

Anamolous Secondary Growth - Boerhaavia, Draceena, Nyctanthes, Mirabilis, Salvadora, Laptadenia

Periderm formation.

Suggested Readings:

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

2. Aghwan, V. 1999. Molecular embryology of flowering plants. Cambridge Univ. Press, Camp.

3. Shivanna, K. R. and Sawhney, V. K. 1999. Pollen biotechnology for crop production and improvement Cambridge Univ. Press.

4. Shivanna, K. R. and Sawhney, V. K. Pollen biology.

5. Fonkot De. 1994. Plant growth and Development, A molecular approach, Academic Press, San Diego.

6. Howell, S. H. 1998. Molecular genetics of plant Development. Cambridge Univ. Press.

II Semester

Cell and Molecular Biology

• Cell wall: Structure and functions, biogenesis.

• Plasma Membrane: Structure, models and functions, plasmodesmeta and their role in movement of molecules and macromolecules.

• 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.

• Cell shape and motility: The cytoskeleton, organization and role of microtubules and microfilaments.

• Cell cycle and Apoptosis: Role of cyclins and cyclin-dependent kinases, cytokinesis and cell plate formation.

• Other cellular organelles: Structure and functions of microbodies, Golgi apparatus, lysosomes, endoplasmic reticulum.

• Techniques in cell biology: Immunotechniques, FISH, GISH, confocal microscopy.

Suggesting Readings:

1. Wolfe, S. L. 1993. Molecular and Cellular Biology.

2. Buchanan, B. B. Greuissem, W. and Jones, R. L. 2000. Biochemistry and Molecular Biology of plants.

3. Kleinsmith, L. S. and Kish, V. M. 1998. Principles of cell and Molecular Biology.

4. Krishnamurthy, K. V. Methods in cell wall cytochemistry.

5. Lewin, B. 2000. Genes-VII. Oxford Univ. Press. New York, U. S. A.

6. Lodesh, H. et. al. 2000. Molecular cell biology IV edition. Freeman and Co. New York, U.S.A.

III Semester

Plant Ecology

• Climate, soil and vegetation patterns of the world: Major biomes and vegetation types and environmental factors.

• Population dynamics: Characters, r and k strategies.

• Vegetation organization: Concepts of community and continuum; community character, concept of ecological niche, ordination.

• Ecological succession: Causes, mechanism and types, concepts of climax.

• Ecosystem: Structure and functions; primary production (methods of measurement, global pattern, controlling factors); energy dynamics (Trophic 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, hydrological cycle.

• Biological diversity: Concept and levels; species richness, diversity indices, concept of α and β diversity, role and application of biodiversity in ecosystem function; speciation and extinction; IUCN categories of threat; distribution and global patterns of biodiversity, hot spots; inventory.

• Environmental pollution: Kinds; sources, quality parameters; effects on plants and ecosystems and remedies.

• Climate change: Greenhouse gases sources, trends and role; ozone layer and ozone hole; consequences of climate change (CO; sequestration, global warming, sea level rise, UV radiation).

Suggested Readings:

1. Odum, H.T. 1983. Basic Ecology.

2. Odum, E. P. 1999. Fundamentals of Ecology.

3. Heywood, V. H. and Watson, R. T. 1995. Global Biodiversity Assessment.

4. Barbour, M. G.; Burk, J. H. and Pitts, W. D. 1998. Terrestrial Plant Ecology.

5. Smith, R. L. 2006. Ecology and Field Biology.

6. Ricklets E. and Miller, Gary L. Ecology-Robert.

7. Asthana, D. K. and Asthana, M. Environment-Problems and solutions.

8. Katyal, T. and Satak, M. Environmental Pollution

III Semester

Cytogenetics and Plant Breeding

• Chromosome structure: Chromatin organization: and packaging of DNA; molecular organization of centromere and telomere; nucleolus and ribosomal RNA genes; euchromatin and heterochromatin; karyotype analysis; banding patterns; specialized types of chromosomes; ploytene, lampbrush, B-chromosomes and sex chromosomes.

• Structural and numerical alterations in chromosomes: Origin, meiotic behaviour and consequences of duplication, deficiency, inversion and translocation, heterozygotes; characteristics and types of aneuploids, role of polyploidy in crop evolution, evolution of major crop plants (wheat and rice).

• Genetics of prokaryotes and eukaryotic organisms: Phage phenotypes; genetic recombination in bacteria; genetic transformation, conjugation and transduction in bacteria; cytoplasmic male sterility, genetic basis of inbreeding depression and heterosis; exploitation of hybrid vigour.

• Gene structure and expression: Genetic fine structure; cistrons test; fine structure analysis of eukaryotes; introns and exons RNA splicing; regulation of gene expression in prokaryotes and eukaryotes; split genes, overlapping genes and pseudogenes.

• Genetic recombination and gene mapping: Recombination, independent assortment and crossing over; molecular mechanism of recombination; chromosome mapping; genetic and physical maps, linkage groups.

• Mutation: Spontaneous and induced mutations; physical and chemical mutagens; molecular basis of mutation; transposable elements in prokaryotes and eukaryotes; mutations induced by transposons (DNA damage and repair mechanisms; inherited human diseases; cancer at cellular level; proto-oncogenes and oncogenes.)

• Cytogenetics of aneuploids and structural heterozygotes: Effect of aneuploidy on phenotypes in plants; transmission of monosomics and trisomics and their use in chromosome mapping of diploid and polyploidy species; Robertsonian translocation.

• Molecular Cytogenetics: Nuclear DNA content; C-value paradox; cot-curves and their significance; restriction mapping-concept and techniques; multigene families, in situ hybridization.

Suggested Reading:

1. Albert, B. Lewis, D. Raff, J. Roberts, K. and Watson, J. D. 2004. Molecular Biology of the cell, 2nd Ed. by Garland Pub, Inc. New York.

2. Atherly, A.G.; Girton, J. R. and McDonald, J. F. 1999. The Science of Genetics. Saunders College Pub. Fort worth, USA.

3. Khush, G. S. 2003. Cytogenetics of Aneuploids. Academic Press, New York. London.

4. Krap. G. 1999. Cells and Molecular Biology; Concepts and Experiments. Wileys & sons Inc. USA.

5. Lewin, B. 2000, Gene. Vol. Vii. Oxford Univ. Press, New York, USA.

6. Watson, J. D. Molecular Biology of the Gene.

7. Khanna, V. K. 2003. Lab manual of plant cytogenetics. Kalyani Publication.

IV Semester

Plant Physiology and Biochemistry

• 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 signalling, phytochromes and cryptochromes.

• Photosynthesis: General concepts and historical back ground, 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.

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

• 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.

• Carbohydrates: Monosaccharide's, oligosaccharides, polysaccharides.

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

• Alkaloids: Structure and classification of alkaloids.

Suggested Readings:

1. Devi, P. 2000. Principles and methods of Plant Molecular Biology, Biochemistry and Genetics.

2. Dennis, D. T.; D. H. Turpin; D. D. Lefebvre and D. B. Layzell. Plant Metabolism.

3. Scott, R. P. W. 1995. Techniques and Practice of Chromatography.

4. Hopkins, W. G. 1995. Introduction to plant physiology.

6. Salisbury & Ross 2003. Plant Physiology.

7. Lehninzer. Principles of Biotechnology.

IV Semester

Plant Resource Utilization and Conservation

• Sustainable development: Basic concepts.

• World centres of primary and secondary diversity of domesticated plants.

• Uses of important plants (i) Food, forage, fodder and fibre crops. (ii) Medicinal and aromatic plants and (iii) Vegetable oil yielding plants.

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

• Green revolution: Benefits and adverse circumstances.

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

• Conservation of plant biodiversity: Principles of conservation, extinction, environmental status of plants based on international Union for conservation of Nature (IUCN).

• Strategies for in-situ conservation: International efforts and Indian initiatives; protected areas in India- sanctuaries, national parks, biosphere reserves, wetlands, mangroove and coral reefs for conservation of wild biodiversity.

• Strategies for ex-situ conservation: Principles and practices; botanical gardens, field gene 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 Agricultural Research (ICAR), Council of Scientific and industrial Research (CSIR), and the department of Biotechnology (DBT) for conservation, non-formal conversation efforts.

Suggested Readings:

1. Heywood, V. H. and Watson, R. T. 1995. Global Biodiversity Assessment. Paroda, R. S. and Arora, R. K. 1991. Plant genetic resources Conservation and Management.

2. Frankel, O. H.; Brown, A. D. H. and Burdon, J. J. 1995. The conservation of Plant Diversity.

3. Technical guidelines for the safe movement of Germplasm by FAO/IBPGR.

Elective Course: Plant Biotechnology

• Biotechnology: Principle and scope, bio-safety guidelines.

• Plant cell and tissue culture: Concept of cellular differentiation and totipotency, principle of root and shoot generation in vitro, applications of cell and tissue culture.

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

• Recombinant DNA technology: Tools of genetic engineering; enzyme, vectors; plasmids, cosmids, lamda phage vectors, shuttle vectors. BACs and YACs. Cloning strategies, genomic libraries, CDNA libraries, single gene cloning.

• Detection and characterization of transformants: Screening and selection for transformants: Hybridizations - colony, Southern, Northern, Western. DNA sequencing techniques, expression vectors in bacteria and eukaryotes; expression of industrially important products.

• Genetic engineering of plants: Aims, tools, strategies for development of transgenic plant with suitable example, alien gene transfer and applications.

• Elementary Knowledge of next generation sequencing, intellectual property rights, genomics and proteomics.

• Biological databases (gene and protein). DNA restriction map analysis, DNA and protein sequence alignment. BLAST, and FASTA.

Suggested Readings:

1. Bhojwani, S.S. (1990). Plant Tissue Culture: Applications and Limitations. Elsevier Science Publisher, New York (U.S.A).

2. Glazer, A.N. and Nikido, H. (1995). Microbial Biotechnology. W.H. Freeman and Company, New York (USA).

3. Shantharam, S. and Montgo Mery, J.F. (1999). Biotechnology, Biosafety and biodiversity. Oxford and IBH Publishing Company. Pvt. Ltd. New Delhi.

4. S.B. Primrose and R. M. Twyman. Principles of Gene Manipulation and Genomics.

5. Arthur Lesk. Introduction to Bioinformatics.

Elective Course :Forest Ecology

• General aspects of forests: Forest ecology and forest ecosystem, importance of forests in environmental conservation, wildlife, and biodiversity.

• Forest biomass, productivity and energy flow: Methods of estimating biomass and productivity across the forests of world, allocation of biomass and productivity to different tree components, production efficiency of leaves particularly in relation to leaf-span and other related leaf characters (e.g., leaf area and specific lea" mass) both at individual leaf and stand levels.

• Forest litter: Types of litter and coarse woody debris, litter fall, forest floor litter mass, litter decomposition and factors affecting such as microbes, fauna, abiotic factors and litter characters.

• Water cycle in a forested area: Impact of forest on precipitation apportionment, water discharge from watersheds, water's role in nutrient cycling.

• Nutrient cycling: Concept of inter and intra system cycling and tree-internal cycling; distribution of nutrients in different forest components, nutrients uptake and nutrient return from vegetation to soil subsystem, nutrients retention by vegetation, nutrient release through litter decomposition, nutrient immobilization, role of microbes, especially of nitrogen-fixers and mycorrhiza in forest nutrient cycling.

• Succession: An idea of forest succession with particular reference to Himalaya, attributes of species of different successional stages, recovery measures of disturbed sites, species selection for disturbed sites in Himalaya.

• Structure and functioning of major forests types of world: Tropical rain forests, monsoon forest, temperate coniferous, temperate deciduous forest, boreal forest, tundra’s and timber line areas in India.

• Major forest types of India: Forest classification of India, forest of Himalaya with particular reference to Oak, Pine and Sal forest.

• Relationship between man and forest in the Himalaya.

• Linkages between subsistence hill and agriculture and living and forests and other non-cultivated land, shifting cultivation, acute vs. chronic human disturbance, regeneration status of major forest trees and related problems.

• Global climate changes and forests.

Suggested Readings:

1. Perry, D. A. 1999. Forest Ecosystems.

2. Waring, R. H. and Schlesinger, W. H. 1985. Forest Ecosystem: Concepts and Management.

3. Singh, J. S. and Singh, S. P. 2003. Forests of Himalaya.

4. Puri, G.S., V.M. Mehar-Homji, R.K. Gupta and R.K. Purl (1960). Forest Ecology. Oxford and IBH Pub. Co. New Delhi.

Elective Course: Plant Pathology

• History of plant pathology in India: Losses caused by pathogens and pests; types of pathogens; symptoms of different diseases.

• Inoculum: Inoculum types, theory of inoculum, survival and longevity of inoculum, inoculum production, liberation, potential and density.

• Plant-microbe interaction: Molecular basis of host recognition, pathogenesis: prepenetration, penetration and post penetration events, and factors affecting disease development (host factors, environmental factors, virulence and susceptibility).

• Genetics of host parasite interactions: Concepts of compatibility and specificity, gene- for-gene relationship, genetics of resistance, sources of resistance, inheritance of resistance in the host.

• Dissemination of pathogens: Means of dissemination (active and passive dissemination).

• Enzymes and toxins: Enzymes involved in disease development; toxins and their role in plant health.

• Physiology of diseased hosts: Changes in physiological processes, e.g., respiration, photosynthesis and disturbance in other metabolic pathways.

• Disease resistance: (i) Protection (structural, chemical, absence of nutrients and common antigens) (ii) Defence (histological defence, chemical-polyphenols, prohibitins, inhabitins, phytoalexins and lectins), (m) Genetic resistance: resistant genes.

• Seed pathology: Seed borne pathogens, mechanism of seed infection in field and during storage, transmission of pathogens through seeds, seed health testing methods, storage disease of seeds and their control, market diseases 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 resistant varieties, integrated management for disease control, quarantine.

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

(i) Damping off, (ii) Wilt, (m) Root rot, stem rot and fruit rot, (iv) Mildews (powdery and downy), (v) Rusts, (vi) Smuts, (vii) Leaf spots and leaf blights.

• General characteristics, importance, disease cycle and control of the following:

(i) bacterial disease, (ii) viral disease, (m) mycoplasma disease.

Suggested Readings:

1. Mehrotra R.S. Plant Pathology. Tata Mc Grow Hill Publishing Co. Ltd. New Delhi.
2. Agrios, G.N. Plant Pathology.
3. Mehrotra and Agrawal. Plant Pathology.
4. Bouarab, N.K., N. Bissow and F. Daayf. Molecular Plant Microb Interactions.
5. Narayansamy, P. Plant Pathogen detection and disease diagnosis.
6. Butler, EJ. Fungi and Diseases in Plants.

Elective Course: Bryology

• Distribution of bryophytes in India, the bryogeographical units, vanishing bryophytes in Netaji Subhas Himalaya, the Red List monotypic endemic liverwort taxa, Rare and Endangered liverworts of Netaji Subhas Himalaya.

• Taxonomic methodology in the identification of some common West Himalayan mosses, distinguishing features of the following orders families and genera:

Polytrichales:

Polytrichaceae- Pogonatum, Atrichum.

Fissidentales:

Fissidentaceae- Fissidens

Dicranales:

Dicranaceae- Dicranum

Pottiales:

Pottiaceae- Hyophila, Hydrogonium

Grimmiales:

Grimmiaceae- Grimmia, Rhacomitrium

Bryales:

(a) Bryaceae- Bryum, Rhodobryum

(b) Mniaceae- Mnium

(c) Bartramiaceae- Philonotis

Isobryales:

(a) Orthotrichaceae- Macromitrum

(b) Leucodontaceae- Leucodon

(c) Meteoriaceae- Meteorium

(d) Neckeraceae- Neckera, Cryptoleptodon

Hypnobryales:

(a) Thuidiaceae- Thuidium, Anomodon, Herpetineuron

(b) Brachytheciaceae- Brachythecium

(c) Entodontaceae- Entodon

(d) Hypnaceae- Hypnum.

• Bryophyte ecology: Habitats, growth forms; the role of bryophytes in succession; bryophytes as bioindicators and uptake of mineral elements, response to air pollution.

• Physiology of bryophytes: General idea of conduction and water relations in bryophytes, conduction system in bryology, cells involved in conduction, ecto, endo and mesohydric groups, desiccation and dehydration, desiccation tolerance.

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

• Chemistry of Bryophytes: A brief account.

Suggested Reading:

1. Gangulee, H.C. Mosses of Eastern India and adjacent regions Vol. I-III.

2. Chopra, R. N. and Kumra, P. K. Biology of Bryophytes.

Elective course : Ethnobotany

Ethnobotany, Traditional Knowledge and Intellectual Property

• Ethnobotany: Its Concept, Scope and Relevance.

• Ethnobotany in India: Retrospect and prospects.

• Methods of research in Ethnobotany.

• Role of Ethnobotany in primary health care programmes and development of new drugs.

• Ethnobotany on development and conservation on bioresources.

• Traditional knowledge of Uttarakhand: With special reference to food and medicine.

• Basic concepts of Intellectual Property Rights (IPRs).

• Intellectual Property Rights with particular reference to Traditional Knowledge and Biowealth.

Suggested Readings:

1. Paroda, R. S. & P. K. Arora. 2006. Plant Genetic Resources Conservation and Management concepts and approaches. New Delhi.

2. Jain, S. K. 1989. Methods of Approaches in Ethnobotany, Lucknow.

3. Jain, S. K. 1991. A manual of Ethnobotany, Jodhpur.

4. Jain S. K. & V. Mudgal. 1999. A handbook of Ethnobotany, Dehradun.

5. Martin, G. J. 1994. Ethnobotany: A Method Manual, London.

Elective Course : Environmental Biology

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

• Resource and Energy Conservation: Concepts of resource, 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; organometallics and organometalliods, toxic inorganic and organic compounds, toxic natural products. National and International laws of toxicology, Radiation, Ecology and recycling.

• Environmental Pollution: Definition types and causes of pollution, Air pollution, carbon sulphur and nitrogen pollution, acid rains, ozone fluorocarbons, Hydrocarbons, Metal photochemical, products, water pollution sources of pollution and the pollutants, solid waste pollution, degradation and cycling of water, Noise pollution, radio-active pollution and the pollutants, global warming and climate change, legal aspect of environmental pollution. Indian laws and policies for control of environmental pollution.

• Environmental Impact Assessment: Scope, importance and application 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 concepts, sustainable development, Environmental issues, challenges and strategies in management, eco-planning, National and international Organizations and policies on environmental management, Environmental management with special reference to land, water and forest resources, environmental education and awareness. Environmental laws.

Suggested Readings:

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. Sharma
8. Environmental Concepts and Strategies- T.N. Khoshoo

Elective Course: Computer Application

- Basics of Computer, Characteristics of Computers, Evolution of computers, computer memory, computer generations, Basic computer organization; System software, Application software, introduction to operating system.
- Data Communication and Networks Data communication concepts, local area network, wide area network, internet, intranet, extranet, website. E-mail, search engines
- Using Internet for Research. The Internet: quick look, what is internet, Use of Internet, major internet services, electronic mail, www, downloading super tools for better computing Internet and the society.
- Data processing and plotting, Excel, presentations and drawings.Power point and word processors.
- MS-Office and its application, File handing in window, various versions of MSOffice, Research publishing tool- MS-Word, Adobe acrobat, Graphics.

References:

1. Young, S. S. Computerized data acquisition & Analysis for life Sciences: A Hands-on guide. Cambridge University Press, 2001.
2. Snedecor ,G.W and Cochran, W.G. Statistical Methods. Ed VI. Oxford and IBH Publishing co, New Delhi, 1967.
3. Higgins, D & Taylor, W (Eds). Bioinformatics Sequence, Structure. Chapman & Hall, 1995.

Elective Course : Lichenology

• 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 tests, thin layer chromatography, micro-crystallography, and UV-Fluorescence analysis.

• 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 pathways 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 Bio-deterioration.

• 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 Netaji Subhas Himalaya: General Account.

Suggested Readings:

1. Awasthi, D.D. (2000), handbook of Lichens, Bishen Singh Mahendra Pal Singh: Dehradun, India.

2. Awasthi, D.D. (2007). A Compendium of the Macrolichens of India, Nepal and Sri Lanka, Dehradun, Bishen Singh Mahendra Pal Singh: Dehradun, India.

3. Divakar, P.K. and Upreti, D.K. (2005). Parmelioid Lichens in India (A revisionary Study), Bishen Singh Mahendra Pal Singh: Dehradun. India.

4. Nash, T.H. (2008) Lichen Biology, U.K.