

Department of Botany and Microbiology

**B.Sc. Botany Honours & Honours with Research
As per NEP 2020**

B.Sc. VII & VIII Semesters

Course Contents & Syllabus

(w.e.f. Academic Session 2025-26)



Hemvati Nandan Bahuguna Garhwal University

(A Central University)

Srinagar Garhwal-246174 (Uttarakhand)

Fourth Year-UG (Honours)

Entry requirement	After completing requirements of a 3-year bachelor's degree (120 credits) and 2 additional credits under SSD, will be allowed to continue studies in the fourth year of the undergraduate programme leading to the four years bachelor's degree (with Honours).							
Course Type	B.Sc. VII Semester				B.Sc. VIII Semester			
	Subject/Title	No. of paper	Credits		Subject /Title	No. of paper	Credits	
			T	P			T	P
Major Subject (One)	Core Major–I Cryptogamic Botany	1	5	-	Core Major–I Plant Ecology and Environmental Concerns	1	5	-
	Core Major–II Study of Phanerogams	1	5	-	Core Major–II Biochemistry and Molecular Biology of Plants	1	5	-
	Core Major–III Reproductive Biology, Morphogenesis and Tissue Culture	1	5	-	Core Major–III Study of Plant Physiology	1	5	-
	Core Major Elective–I* Plant Breeding and Biostatistics	1	4	-	Core Major Elective–II* Natural Resource Management in Himalaya	1	4	-
	Major Practical	1	-	5	Major Practical	1	-	5
Minor (One)	Minor–I# Plant Health Management	1	4	-	Minor–II# Recombinant DNA Technology	1	4	-
Total		6	23	5		6	23	5
NHEQF Level- 6	Student on exit after successfully completing four years (i.e., securing minimum required 176 credits along with securing additional 2 credits under SSD course work) will be awarded “Four years Bachelor’s Degree (Honours)”, in related field/discipline.							

*In case of Core Major Elective Course, if the department want to introduce practical component, the department may bifurcate the total 4 credits between theory and practical.

#If the minor course is offered without a practical component, the department must allocate 4 credits to the theory component. Electives may be offered by the departments under the Minor.

Minor–I*: If a student selects a minor course from a particular subject or department, they are required to study the courses offered by that same subject/department in both the 7th and 8th semester.

Note: The student may select Minor course either from his/her second core, studied up to 6th semester, or may select from the ID/MD subject(s) they have pursued in the first and second year of their UG Programme.

Fourth Year-UG (Honours with Research)

Entry requirement	After completing requirements of a 3-year bachelor's degree (120 credits) and 2 additional credits under SSD, candidates who meet a minimum CGPA of 7.5 will be allowed to continue studies in the fourth year of the undergraduate programme leading to the four years bachelor's degree (Honours with Research).							
Course Type	B.Sc. VII Semester				B.Sc. VIII Semester			
	Subject/Title	No. of paper	Credits		Subject /Title	No. of paper	Credits	
Core Subject (One)	Core Major--I Cryptogamic Botany	1	5	-	Core Major-I Plant Ecology and Environmental Concerns	1	5	-
	Core Major--II Study of Phanerogams	1	5	-				
	Core Major Elective-I* Plant Breeding and Biostatistics	1	4	-	Core Major Elective-I* Natural Resource Management in Himalaya	1	4	-
	Major Practical	1	-	5	Major Practical	1	-	3
	Research Methodology	1	5	-	Dissertation	1	-	12
Minor (One)	Minor-I# Plant Health Management	1	4		Minor-II# Recombinant DNA Technology	1	4	
Total		6	23	5		5	13	15
NHEQF Level- 6	Student on exit after successfully completing four years (i.e., securing minimum required 176 credits along with securing additional 2 credits under SSD course work) will be awarded "Four years Bachelor's Degree (Honours with Research)", in related field/discipline							

*In case of Core Major Elective Course, if the department want to introduce practical component, the department may bifurcate the total 4 credits between theory and practical.

#If the minor course is offered without a practical component, the department must allocate 4 credits to the theory component. Electives may be offered by the departments under the Minor.

Minor-I*: If a student selects a minor course from a particular subject or department, they are required to study the courses offered by that same subject/department in both the 7th and 8th semesters.

Note: The student may select Minor course either from his/her second core, studied up to 6th semester, or may select from the ID/MD subject(s) they have pursued in the first and second year of their UG Programme.

B.Sc. Honours VII Semester

Core Major–I Cryptogamic Botany

[Credits: 5]

Unit 1 Algae

- i. Algal Classification
- ii. Importance of Flagellation, Pigmentation, and storage products in classification,
- iii. General characteristics of Major algal classes
- iv. Evolutionary tendencies
- v. Comparative account of reproduction and life history types of algal classes: Chlorophyceae, Phaeophyceae, Rhodophyceae and Cyanophyceae

Unit 2 Fungi

- i. Fungal classification
- ii. General characteristics of Major classes of Fungi
- iii. Comparative account of structure, reproduction and life cycle types of major fungal classes.
- iv. Parasexuality in Fungi, Fungal Hormone and Economic importance of Fungi
- v. Symbiotic associations: Biology and Significance of Lichens and Mycorrhiza

Unit 3

Bryophytes

- i. General Characteristics and Classification of Bryophyta
- ii. Life histories of bryophytes with reference to *Cyathodium*, *Notothylus*, *Sphagnum* and *Polytrichum*
- iii. Evolutionary significance of sporophytes in Bryophyta
- iv. Significance of anhydrobiosis in bryophytes,
- v. Ethnomedicinal values of bryophytes

Unit 4

Pteridophytes

- i. General Characteristics and Classification of Pteridophyta
- ii. Life history of *Psilotum*, *Lycopodium*, *Isoetes*, *Adiantum* and *Marsilea*
- iii. General account on stelar evolution in Pteridophyta
- iv. Telome theory and evolutionary significance of heterospory
- v. Palaeobotany: types of fossils and the importance of Palaeobotany

Suggested Readings:

1. Van Den Hoek C, Mann, DG, Jahns HM. 1995. Algae: An Introduction to Phycology
2. Smith, G.M. 1955. Cryptogamic Botany. Vol. I and II. Tata McGraw-Hill, New Delhi.
3. Webster, J. 1985. Introduction to Fungi. Cambridge University Press.
4. Dubey HC (2009) An Introduction to Fungi, 3rd edition, Vikash Publication House Pvt Ltd, Noida.
5. Kashyap, S.R. 1968. Liverworts of the Western Himalayas and Punjab Plains. The Chronica Botanica Co. Delhi.
6. Ram Udar. Fifty years of Bryology in India. Golden Jubilee Series. IBS, New Delhi
7. Parihar, N.S. (1991). An Introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad
8. Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta, S. Chand. Delhi, India

Unit 1 Gymnosperms

- i. General account of morphology and reproduction of the following: *Zamia*, *Ginkgo*, *Taxus* and *Gnetum*
- ii. General account of *Williamsonia* and *Pentoxylon*
- iii. Phylogenetic trends in Gymnosperms
- iv. Distribution of living Gymnosperms in India

Unit 2 Angiosperms

- i. Classification of Angiosperms (Hutchinson) and general account of numerical taxonomy and chemotaxonomy
- ii. Distinguishing characters of the following families and their economic importance: *Meliaceae*, *Combretaceae*, *Rubiaceae*, *Convolvulaceae*, *Scrophulariaceae*, *Verbenaceae*, *Polygonaceae*, *Lauraceae*, *Zingiberaceae*, *Arecaceae*, *Cyperaceae*
- iii. Embryology: General account of polyembryony, apomixis and experimental embryology with reference to anther and embryo culture

Recommended Books:

1. Angiosperm Phylogeny Group 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society* 141: 399-436.
2. Cole, A.J. 1969. *Numerical Taxonomy*, Academic Press, London.
3. Crawford, D.J. 2003. *Plant Molecular Systematics*. Cambridge University Press, Cambridge, UK.
4. Cronquist, A. 1981. *An integrated system of classification of flowering plants*. Columbia University Press, New York.
5. Davis, P.H. and Heywood, V.H. 1973. *Principles of angiosperms Taxonomy*. Robert E. Kreiger Pub. Co., New York.
6. Heywood, V.H. and Moore, D.M. 1984. *Current Concepts in Plant Taxonomy*. Academic Press, London.

Unit 1

Microsporogenesis; Cytoplasmic reorganisation during microsporogenesis, Pollen wall and Pollen morphogenesis, Development of male gametophyte, ultrastructure, abnormal male gametophyte, Pollen germination

Megasporogenesis: Development of the embryo sac, subcellular details of constituent cells and their function, major types

Unit 2

Pollen-pistil interaction: Role of pollen wall proteins and stigma surface proteins, pollen tube growth in pistil, fertilization and apomixes; Endosperms functions; Dicot and Monocot embryo, Polyembryony; Embryology in relation to Taxonomy

Unit 3

Morphogenetic phenomenon: Symmetry and polarity, concepts of cell differentiation and totipotency; Plant cell and tissue culture: General introduction, history and scope; Tissue culture techniques and culture media; Experimental embryology, anther, ovary and endosperm culture; somatic embryogenesis and androgenesis

Unit 4

Somatic hybridization: Protoplast isolation, culture and regeneration, Somatic hybridization and hybrid selection; Possibilities, achievements and limitations of protoplast research; Applications of plant tissue culture: clonal propagation, artificial seed, production of hybrids and soma clones, production of secondary metabolites/ natural products; Cryopreservation and germplasm storage

Suggested readings:

1. Bhojwani, S.S. and Bhatnagar, S.P. (1985), Embryology of Angiosperms, Vikash Publishing House, New Delhi
2. Johri, B.M (1984) Embryology of Angiosperms. Springer-Verlag Berlin Heidelberg.
3. Maheshwari, P. (1950) An Introduction to the Embryology of Angiosperms. Tata McGraw Hill.
4. Pandey, B.P., Angiosperms-Taxonomy, Embryology and Anatomy, S. Chand and Co., New Delhi
5. Bhojwani, S.S. and Bhatnagar, S.P., Embryology of Angiosperms, Vikash Publishing House, New Delhi
6. Butenko RG (2000) Plant Cell Culture, University Press of Pacific.
7. Davies PJ (2004) Plant Hormones, Kluwer Academic Publishers, Netherlands.
8. Halford N (2006) Plant Biotechnology - Current and future applications of genetically modified crops, John Wiley and Sons, Engla

Plant Breeding

- i. Biological foundation of plant breeding
- ii. Reproductive systems and breeding plans
- iii. Breeding methods for self-pollinated crop species
- iv. Breeding methods for cross-pollinated crop species
- v. Phenomenon of Heterosis and Inbreeding depression
- vi. Breeding clonally propagated plants
- vii. Ploidy breeding and Mutation breeding

Biostatistics

- i. Bio-statistics: Definition and Scope
- ii. Methods of representation of statistical data and measurements of central tendencies
- iii. Correlation, regression, curve fitting and ratio of variation
- iv. Probability and use of binomial trials
- v. Test of significance, X^2 , 't' and 'f' tests
- vi. Statistical software

Suggested Readings:

1. Sharma, J.R. 1994. Principles and Practice of Plant Breeding. Tata McGraw-Hill Publ. Co. Ltd., New Delhi
2. Singh, B.D. 2002. Plant Breeding Principles and Methods. Kalyani Publ. New Delhi
3. Allard R.W. 2010. Principles of Plant Breeding. Wiley Indian Edition
4. Bliss, C.I. 1967. Statistics in Biology. 2 Vols. Mc Graw Hill, New York
5. Singh, R.K. 1994. Biometrical Techniques in Breeding and Genetics. Bishen Singh Mahendra Pal Singh. Dehradun

Major Practical

[Credits: 5]

1. Morphological study of representative members of Cyanophyceae, Chlorophyceae, Charophyceae, Phaeophyceae, Rhodophyceae, Xanthophyceae and Chrysophyceae.
2. Study of representative genera of Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.
3. Study of *Cyathodium*, *Notothylus*, *Sphagnum* and *Polytrichum*.
4. Study of *Psilotum*, *Isoetes*, *Adiantum*, *Marsilea* and important fossil types.
5. Identification and description of locally available plants belonging to families included in the syllabus from fresh specimens, herbaria or preserved materials.
6. Study of *Zamia*, *Ginkgo*, *Taxus* and *Gnetum* with suitable preparations.
7. Study of microsporogenesis and megasporogenesis
8. Study of pollen germination and pollen-pistil interaction
9. Plant tissue culture media preparation and callus culture

Minor–I Plant Health Management

[Credits: 4]

1. Modes of infection
2. Host-pathogen interaction: toxins and enzymes
3. Defence mechanisms in plants
4. Physiology of parasitism
5. Environmental variables regulating disease development, transmission and spread of plant diseases.
6. Principles of plant disease control: cultural control, chemical control, biological control and integrated disease management.
7. Molecular aspects of host-pathogen interactions - PR proteins, degradation of phytoalexins, systemic resistance mechanism
8. Transgenic approach for crop protection, engineering chemicals that elicit a defence response in plants

Suggested Readings

1. Butler, E.J. 1973. Fungi and Disease in Plants, Intern, Book Distributors. Dehradun
2. Singh, R.S. 1983. Plant Diseases. Oxford and IBH Publ. Co. New Delhi
3. Singh, R.S. Principles of Plant Pathology. Oxford and IBH Publ. Co. New Delhi
4. Agrios GN (2005) Plant Pathology, 5th edition, Academic Press, Landon
5. John A Lucas, 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press

B.Sc Honours. VIII Semester

Core Major–I Plant Ecology and Environmental Concerns

[Credits: 5]

1. Biotic and abiotic components of the environment, primary productivity, trophic levels, ecological niche, ecological pyramids and ecological energetics.
2. Biogeochemical cycles: Carbon, nitrogen and phosphorous cycles. Population ecology: Definition, population characteristics, growth curves, carrying capacity and population fluctuation. Community ecology: Structure and community characteristics, quantitative, qualitative and synthetic features, life forms, biological spectrum and ecological succession.
3. Basic concepts environment and issues, global environmental problems - Ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management.
4. Environmental pollution - types of pollution, sources of pollution, measurement of pollution, methods of measurement of pollution, fate of pollutants in the environment, bioconcentration, bio/geo magnification.

Recommended Books:

1. Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology. Benjamin/Cummings Publication Company, California
2. Begon, M., Harpor, J.L. and Townsend, C.R. 1996. Ecology. Blackwell Science, Cambridge, U.S.A.
3. Chapman, J.L. and Reiss, M.J. 1988. Ecology: Principles and Applications. Cambridge University Press, Cambridge, U.K.
4. Heywood, V.H. and Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge University Press.
5. Kershaw, K.A. Quantitative and Dynamic Ecology. Oxford and IBH. Kormondy, E.J. 1996. Concepts of Ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.
6. Odum, E.P. 1983. Basic Ecology. Saunders, Philadelphia
7. Smith, R.L. 1996. Ecology and Field Biology. Harper Collins, New York

1. Basics of biochemistry, Structure and properties of water; pH and buffers.
Carbohydrates: Nomenclature and classification; Monosaccharides, Disaccharides, Oligosaccharides polysaccharides.
Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.
2. **Proteins:** Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins.
Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of DNA; Types of RNA; Structure of tRNA. Enzyme structure and classification, mechanism of action, Michaelis-Menten equation, and factors affecting enzyme activity.
3. Nucleic acids: Carriers of genetic information, Types of DNA, Types of genetic material, The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. Mechanism of Transcription: Translation, transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing
4. Gene expression, Regulation of gene expression: Lac operon and Tryptophan operon. The replication of DNA, Chemistry of DNA synthesis, semi-conservative and semi-discontinuous replication, RNA priming, replication of linear ds-DNA, replication of the 5' end of linear chromosome, Enzymes involved in DNA replication. Adaptor hypothesis and discovery of mRNA template, Principles of transcriptional regulation. Ribozymes; RNA editing and mRNA transport.

Recommended Books

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill, Livingstone.
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman.
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company
5. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
6. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.

1. Membrane transport and translocation of water and solutes: Water Potential, Plant-water relations, mechanism of water transport through xylem and transport in cells. Absorption and transpiration of water. Mechanism of uptake and assimilation of Nitrogen, Phosphorus and Sulfur.
2. Photosynthesis: General concepts and historical background, evolution of photosynthetic apparatus, photosynthetic pigments and light harvesting complexes, photo oxidation of water, light reaction, Z scheme and photophosphorylation, mechanism of electron transport, carbon assimilation – the Calvin cycle, photorespiration and its significance, the C4 cycle, the CAM pathway, factors of photosynthesis.
3. Respiration and lipid metabolism: Overview of plant respiration, glycolysis, the TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternative oxidation system, photorespiration.
4. Phytohormones and Sensory photobiology: History of discovery of phytochromes and cryptochromes, and their photochemical and biochemical properties, photophysiology of light-induced responses, molecular mechanism of action of photomorphogenic receptors, signaling and gene expression.

Recommended Books:

1. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
2. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. (eds) 1997. Plant Metabolism (second edition). Longman, Essex, England.
3. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.
4. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing Co., California, USA.
5. Taiz, L. and Zeiger, E. 1998. Plant Physiology (2nd edition). Sinauer Associates, Inc., Publishers, Massachusetts, USA.

Core Major Elective–II Natural Resource Management in Himalaya [Credits: 4]

1. Natural resources: Definition and types. Sustainable utilization: Concept, approaches (economic, ecological and sociocultural). Land: Utilization (agricultural, horticultural, silvicultural); Soil degradation and management. Water: Fresh water (rivers, lakes, groundwater, water harvesting technology, rain water storage and utilization).
2. Biological Resources: Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan). Forests: Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.
3. Energy: Renewable and non-renewable sources of energy-solar, wind, tidal, geothermal and bioenergy resources. Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint.
4. Resource Accounting; Waste management. National and international efforts in resource management and conservation.

Recommended Books:

1. B. W. Pandey. 2005. Natural Resource Management. Mittal Publication, New Delhi
2. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
3. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
4. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

Major Practical [Credits: 5]

1. To determine the minimum size of the quadrat by species area curve method and minimum number of quadrats to be laid down in the field under study.
2. To determine the frequency, density and abundance of each species present in community.
3. To calculate relative frequency and relative density of each species in a given area.
4. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
5. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum.
6. Measurement of cell size by the technique of micrometry.
7. Study of DNA replication mechanisms through photographs.
8. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II
9. Study of absorption and action spectra of photosynthetic pigments
10. Extraction of biomolecules

1. Introduction, history and importance of gene cloning and polymerase chain reaction. Scope of rDNA technology in various sectors, Vehicles: Plasmid and Bacteriophage; Purification of DNA: Total DNA purification from plant tissues and Agrobacterium. Plasmid DNA isolation (Alkaline lysis method). Enzymes used in the manipulation of purified DNA (Restriction endonuclease, Ligase, Polynucleotide kinase, DNA polymerase, reverse transcriptase, alkaline phosphatase and Terminal nucleotidyl transferase).
2. Cloning vectors like plasmids, M13 bacteriophage and λ bacteriophage. Rationale for the design of vectors for the over expression of recombinant proteins in plants and cell lines. Selection of suitable promoter sequences, ribosome binding sites, transcription terminator sequences, fusion protein tags, purification tags, protease cleavage sites and introducing restriction enzyme sites (for easy cloning and confirmation), sequences confirming high plasmid copy number and inducible expression system (IPTG). Expression vectors for recombinant protein production in plants, yeast cells, bacteria and cell lines.
3. Basic idea of gene cloning: methods and procedure involved in the isolation of full-length coding sequence of target genes. Cloning of PCR products, cDNA fragments, Promoters and adapter sequences in plasmids.
4. Introduction of recombinant DNA into various types of host cells. DNA sequencing methods: Sanger-Coulson method & Maxam-Gilbert method. Automated sequencing (Illumina sequencing and Nanopore sequencing). PCR & its application. DNA finger printing (RFLP & RAPD and REP-PCR). Bioinformatics – BLAST, nucleotide and protein sequence analysis.

Recommended Books:

1. Old. R. W., Primrose, S.B., & Twyman, R.M., (2001), Principles of Gene manipulation: An introduction to Genetic Engineering, Oxford and Blackwell scientific Publication.
2. Green. M. R., and Sambrook. J, 2012, Molecular cloning – A laboratory manual, Cold Spring Harbore Laboratory Press.
3. Nicholl, Desmond S T, 2023, An Introduction to Genetic Engineering, 4th revised edition, Cambridge University Press.
4. Brown. T. A, 2023, Genomes, 5th Edition, CRC Press.
5. Bernard R Glick, Jack J. Pasternak and Cheryl L. Patten, 2003, Molecular Biotechnology, Principles and Applications of Recombinant DNA.
6. Recombinant DNA by J. D. Watson, 2003, W.H. Freeman Publishers, New York. Robertson D, Scott S, Miller D, 1997, Manipulation and expression of recombinant DNA: Lab Manual, Academic Press

Fourth Year-UG (Honours with Research)

B.Sc. Honours with Research VII Semester

Core Major–I Cryptogamic Botany

[Credits: 5]

Unit 1 Algae

- i. Algal Classification
- ii. Importance of Flagellation, Pigmentation, and storage products in classification,
- iii. General characteristics of Major algal classes
- iv. Evolutionary tendencies
- v. Comparative account of reproduction and life history types of algal classes: Chlorophyceae, Phaeophyceae, Rhodophyceae and Cyanophyceae

Unit 2 Fungi

- i. Fungal classification
- ii. General characteristics of Major classes of Fungi
- iii. Comparative account of structure, reproduction and life cycle types of major fungal classes.
- iv. Parasexuality in Fungi, Fungal Hormone and Economic importance of Fungi
- v. Symbiotic associations: Biology and Significance of Lichens and Mycorrhiza

Unit 3

Bryophytes

- i. General Characteristics and Classification of Bryophyta
- ii. Life histories of bryophytes with reference to *Cyathodium*, *Notothylus*, *Sphagnum* and
- iii. *Polytrichum*
- iv. Evolutionary significance of sporophytes in Bryophyta
- v. Significance of anhydrobiosis in bryophytes,
- vi. Ethnomedicinal values of bryophytes

Unit 4

Pteridophytes

- i. General Characteristics and Classification of Pteridophyta
- ii. Life history of *Psilotum*, *Lycopodium*, *Isoetes*, *Adiantum* and *Marsilea*
- iii. General account on stelar evolution in Pteridophyta
- iv. Telome theory and evolutionary significance of heterospory
- v. Palaeobotany: types of fossils and the importance of Palaeobotany

Suggested Readings:

1. Van Den Hoek C, Mann, DG, Jahns HM. 1995. Algae: An Introduction to Phycology
2. Webster, J. 1985. Introduction to Fungi. Cambridge University Press.
3. Dubey HC (2009) An Introduction to Fungi, 3rd edition, Vikash Publication House Pvt Ltd, Noida.
4. Ram Udar. Fifty years of Bryology in India. Golden Jubilee Series. IBS, New Delhi
5. Parihar, N.S. (1991). An Introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad
6. Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta, S. Chand. Delhi, India

- i). Unit 1 Gymnosperms
- ii). General account of morphology and reproduction of the following: *Zamia*, *Ginkgo*, *Taxus* and *Gnetum*
- iii). General account of *Williamsonia* and *Pentoxylon*
- iv). Phylogenetic trends in Gymnosperms
- v). Distribution of living Gymnosperms in India

Unit 2 Angiosperms

- i. Classification of Angiosperms (Hutchinson) and general account of numerical taxonomy and chemotaxonomy
- ii. Distinguishing characters of the following families and their economic importance: *Meliaceae*, *Combretaceae*, *Rubiaceae*, *Convolvulaceae*, *Scrophulariaceae*, *Verbenaceae*, *Polygonaceae*, *Lauraceae*, *Zingiberaceae*, *Arecaceae*, *Cyperaceae*
- iii. Embryology: General account of polyembryony, apomixis and experimental embryology with reference to anther and embryo culture

Recommended Books:

- 1. Angiosperm Phylogeny Group 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society* 141: 399-436.
- 2. Cole, A.J. 1969. *Numerical Taxonomy*, Academic Press, London.
- 3. Crawford, D.J. 2003. *Plant Molecular Systematics*. Cambridge University Press, Cambridge, UK.
- 4. Cronquist, A. 1981. *An integrated system of classification of flowering plants*. Columbia University Press, New York.
- 5. Davis, P.H. and Heywood, V.H. 1973. *Principles of angiosperms Taxonomy*. Robert E. Kreiger Pub. Co., New York.
- 6. Heywood, V.H. and Moore, D.M. 1984. *Current Concepts in Plant Taxonomy*. Academic Press, London.

Plant Breeding

- i. Biological foundation of plant breeding
- ii. Reproductive systems and breeding plans
- iii. Breeding methods for self-pollinated crop species
- iv. Breeding methods for cross-pollinated crop species
- v. Phenomenon of Heterosis and Inbreeding depression
- vi. Breeding clonally propagated plants
- vii. Ploidy breeding and Mutation breeding

Biostatistics

- i. Bio-statistics: Definition and Scope
- ii. Methods of representation of statistical data and measurements of central tendencies
 - iii. Correlation, regression, curve fitting and ratio of variation
- iii. Probability and use of binomial trials
- iv. Test of significance, X^2 , 't' and 'F' tests
- v. Statistical software

Suggested Readings:

- 1. Sharma, J.R. 1994. Principles and Practice of Plant Breeding. Tata McGraw-Hill Publ. Co. Ltd., New Delhi
- 2. Singh, B.D. 2002. Plant Breeding Principles and Methods. Kalyani Publ. New Delhi
- 3. Allard R.W. 2010. Principles of Plant Breeding. Wiley Indian Edition
- 4. Bliss, C.I. 1967. Statistics in Biology. 2 Vols. Mc Graw Hill, New York
- 5. Singh, R.K. 1994. Biometrical Techniques in Breeding and Genetics. Bishen Singh Mahendra Pal Singh. Dehradun

Major Practical

[Credits: 5]

1. Morphological study of representative members of Cyanophyceae, Chlorophyceae, Charophyceae, Phaeophyceae, Rhodophyceae, Xanthophyceae and Chrysophyceae.
2. Study of representative genera of Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.
3. Study of *Cyathodium*, *Notothylus*, *Sphagnum* and *Polytrichum*.
4. Study of *Psilotum*, *Isoetes*, *Adiantum*, *Marsilea* and important fossil types.
5. Identification and description of locally available plants belonging to families included in the syllabus from fresh specimens, herbaria or preserved materials.
6. Study of *Zamia*, *Ginkgo*, *Taxus* and *Gnetum* with suitable preparations.
7. Study of microsporogenesis and megasporogenesis
8. Study of pollen germination and pollen-pistil interaction
9. Plant tissue culture media preparation and callus culture

Research Methodology

[Credits: 5]

1. **Introduction of Scientific writing**
2. **Basics of Research**
Concept of Research, Characteristics of Research and, Types of Research.
3. **Research Problem**
Literature Review, Variables, Hypotheses, Operational Definition.
4. **Research Design**
Design in Qualitative Study, Design in Quantitative Study, Ideal Research Design
5. **Sampling**
Basics of Sampling, Sampling Techniques
6. **Data Collection Methods and Analysis**
Different Collection Methods, Ethics in Data Collection and Data Analysis
7. **Research Proposal**
Study Plan, Introduction, Problem Statement, Literature Review, Research Objectives & Research Questions, Framework, Hypotheses.
8. **Final report**
Final report submission

Recommended Books:

1. Pandey, P., Pandey, M.M. 2015. Research Methodology: Tools and Techniques: Tools and Techniques (ISBN 978-606-93502-7-0)
2. Jansirani, S., Taibangnganbi, N., Rajesh Kanna, R. 2023. Research Methodology (ISBN 978 -93 - 5747 -070-4).
3. Kothari, C.R. 2004. Research Methodology (Methods and Techniques), New Age International (P) Ltd., Publishers (ISBN (13): 978-81-224-2488-1)

1. Modes of infection
2. Host-pathogen interaction: toxins and enzymes
3. Defence mechanisms in plants
4. Physiology of parasitism
5. Environmental variables regulating disease development, transmission and spread of plant diseases.
6. Principles of plant disease control: cultural control, chemical control, biological control and integrated disease management.
7. Molecular aspects of host-pathogen interactions - PR proteins, degradation of phytoalexins, systemic resistance mechanism
8. Transgenic approach for crop protection, engineering chemicals that elicit a defence response in plants

Suggested Readings

1. Butler, E.J. 1973. Fungi and Disease in Plants, Intern, Book Distributors. Dehradun
2. Singh, R.S.1983. Plant Diseases. Oxford and IBH Publ. Co. New Delhi
3. Singh, R.S. Principles of Plant Pathology. Oxford and IBH Publ. Co. New Delhi
4. Agrios GN (2005) Plant Pathology, 5th edition, Academic Press, Landon
5. John A Lucas, 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press

B.Sc. Honours with Research. VIII Semester

Core Major–I Plant Ecology and Environmental Concerns

[Credits: 5]

1. Biotic and abiotic components of the environment, primary productivity, trophic levels, ecological niche, ecological pyramids and ecological energetics.
2. Biogeochemical cycles: Carbon, nitrogen and phosphorous cycles. Population ecology: Definition, population characteristics, growth curves, carrying capacity and population fluctuation. Community ecology: Structure and community characteristics, quantitative, qualitative and synthetic features, life forms, biological spectrum and ecological succession.
3. Basic concepts environment and issues, global environmental problems - Ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management.
4. Environmental pollution - types of pollution, sources of pollution, measurement of pollution, methods of measurement of pollution, fate of pollutants in the environment, bioconcentration, bio/geo magnification.

Recommended Books:

1. Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology. Benjamin/Cummings Publication Company, California
2. Begon, M., Harpor, J.L. and Townsend, C.R. 1996. Ecology. Blackwell Science, Cambridge, U.S.A.
3. Chapman, J.L. and Reiss, M.J. 1988. Ecology: Principles and Applications. Cambridge University Press, Cambridge, U.K.
4. Heywood, V.H. and Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge University Press.
5. Kershaw, K.A. Quantitative and Dynamic Ecology. Oxford and IBH. Kormondy, E.J. 1996. Concepts of Ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.
6. Odum, E.P. 1983. Basic Ecology. Saunders, Philadelphia
7. Smith, R.L. 1996. Ecology and Field Biology. Harper Collins, New York

Core Major Elective–I Natural Resource Management in Himalaya [Credits: 4]

1. Natural resources: Definition and types. Sustainable utilization: Concept, approaches (economic, ecological and sociocultural). Land: Utilization (agricultural, horticultural, silvicultural); Soil degradation and management. Water: Fresh water (rivers, lakes, groundwater, water harvesting technology, rain water storage and utilization).
2. Biological Resources: Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan). Forests: Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.
3. Energy: Renewable and non-renewable sources of energy-solar, wind, tidal, geothermal and bioenergy resources. Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint.
4. Resource Accounting; Waste management. National and international efforts in resource management and conservation.

Recommended Books:

1. B. W. Pandey. 2005. Natural Resource Management. Mittal Publication, New Delhi
2. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
3. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
4. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

Major Practical

[Credits: 3]

1. To determine the minimum size of the quadrat by species area curve method and minimum number of quadrats to be laid down in the field under study.
2. To determine the frequency, density and abundance of each species present in community.
3. To calculate relative frequency and relative density of each species in a given area.
4. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
5. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum.
6. Measurement of cell size by the technique of micrometry.
7. Study of DNA replication mechanisms through photographs.
8. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II
9. Study of absorption and action spectra of photosynthetic pigments
10. Extraction of biomolecules

Dissertation

[Credits: 12]

Project work allows students to apply classroom learning to real-world scenarios, solidifying their understanding and developing practical skills. It encourages students to identify problems, analyze them, and develop solutions, promoting critical thinking and analytical skills. Dissertation emphasizes the learning by doing, providing students with hands-on experience that complements theoretical learning.

This programme is specifically designed for students with a strong interest in academic research. The programme places an enhanced focus on research-oriented studies alongside core disciplinary learning. Students will undertake a significant research project or dissertation in their major field during the IInd, semester, equipping them with foundational skills for postgraduate research.

5. Introduction, history and importance of gene cloning and polymerase chain reaction. Scope of rDNA technology in various sectors, Vehicles: Plasmid and Bacteriophage; Purification of DNA: Total DNA purification from plant tissues and Agrobacterium. Plasmid DNA isolation (Alkaline lysis method). Enzymes used in the manipulation of purified DNA (Restriction endonuclease, Ligase, Polynucleotide kinase, DNA polymerase, reverse transcriptase, alkaline phosphatase and Terminal nucleotidyl transferase).
6. Cloning vectors like plasmids, M13 bacteriophage and λ bacteriophage. Rationale for the design of vectors for the over expression of recombinant proteins in plants and cell lines. Selection of suitable promoter sequences, ribosome binding sites, transcription terminator sequences, fusion protein tags, purification tags, protease cleavage sites and introducing restriction enzyme sites (for easy cloning and confirmation), sequences confirming high plasmid copy number and inducible expression system (IPTG). Expression vectors for recombinant protein production in plants, yeast cells, bacteria and cell lines.
7. Basic idea of gene cloning: methods and procedure involved in the isolation of full-length coding sequence of target genes. Cloning of PCR products, cDNA fragments, Promoters and adapter sequences in plasmids.
8. Introduction of recombinant DNA into various types of host cells. DNA sequencing methods: Sanger-Coulson method & Maxam-Gilbert method. Automated sequencing (Illumina sequencing and Nanopore sequencing). PCR & its application. DNA finger printing (RFLP & RAPD and REP-PCR). Bioinformatics – BLAST, nucleotide and protein sequence analysis.

Recommended Books:

1. Old. R. W., Primrose, S.B., & Twyman, R.M., (2001), Principles of Gene manipulation: An introduction to Genetic Engineering, Oxford and Blackwell scientific Publication.
2. Green. M. R., and Sambrook. J, 2012, Molecular cloning – A laboratory manual, Cold Spring Harbore Laboratory Press.
3. Nicholl, Desmond S T, 2023, An Introduction to Genetic Engineering, 4th revised edition, Cambridge University Press.
4. Brown. T. A, 2023, Genomes, 5th Edition, CRC Press.
5. Bernard R Glick, Jack J. Pasternak and Cheryl L. Patten, 2003, Molecular Biotechnology, Principles and Applications of Recombinant DNA.
6. Recombinant DNA by J. D. Watson, 2003, W.H. Freeman Publishers, New York. Robertson D, Scott S, Miller D, 1997, Manipulation and expression of recombinant DNA: Lab Manual, Academic Press