Department of Botany

Hemvati Nandan Bahuguna Garhwal University, Srinagar-Garhwal, Uttarakhand

FOUR-YEAR BACHELOR'S DEGREE PROGRAMME WITH HONOURS/RESEARCH (B.Sc. Botany)

Fourth Year-NHEQFLevel-6

In the Fourth Year of the Four-Year Undergraduate Program (FYUP) two types of programs are offered:

1. U.G. with Honours

2. U.G. Honours with Research

B. Sc. (Honours with Research) Fourth Year [VII & VIII Semester]

Candidates who secure a minimum CGPA of 7.5 will be allowed to continue studies in the fourth year of the undergraduate programme leading to the four-year bachelor's degree (Honours with Research).

B. Sc. (Honours with Research) Fourth Year [VII Semester]

Fourth Year (VII Semester with Research)	Major Subject (Botany)	Credit	NameofCourse	Remarks
	CoreBotany-5(CB-5) CoreBotany-6(CB-6)	5 + 5	CB-5 Comparative Account of Cryptogams CB-6 Comparative Account of Phanerogams	These courses will be based on the core subject selected by the students for PG
	Major Practical (LC-1)	5	LC-1. Lab Course Based on CB-5 & CB-6	
	Major Elective Botany (EB-1)	2	Elective Course: Any one from EB-1 basket	**Major Elective Course BasketEB-1** EB-1a: Plant Breeding and Biostatistics EB1b: Plant Health Management
	Major Elective Practical (LCE-1)	2	LCE-1 Lab Course Elective Based on EB1a/ EB1b.	
	Research Methodology Botany (RMB)	5	RMB Research Methodology	Students will learn the basic research methodology with a focus on data analysis for application in research-based work to be carried out in the VIII Semester
	Minor Botany (BM-1)	4	Minor Elective Course: For students with Core Subjects other than Botany (Without Practical)	**Minor Elective Course Basket (EBM-1)** EBM-1 Applied Phycology
	TOTAL	**28**		
Note: Dissertation Topic for FYUP (Honours with Research) will be issued in the 7thsemester				

Syllabus

B.Sc./BOT/CB-5 Comparative Account of Cryptogams [5 Credits]

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 Botanic 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

B.Sc./BOT/CB-6 Comparative Account of Phanerogams [5 Credits]

Unit I
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 II
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

LC-1 Lab Course

Based on Core Botany (CB-5 & CB-6) [5 Credits]

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 fossiltypes.
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.

Major Elective Course Basket EB-1

EB-1a: Plant Breeding and Biostatistics [2 Credits]

Section A: 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

Section B: 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, X2, ‘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. McGraw-Hill, New York
5. Singh, R.K. 1994. Biometrical Techniques in Breeding and Genetics. Bishen Singh MahendraPal Singh. Dehradun

EB1b: Plant Health Management [2 Credits]

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.

LCE-1 Lab Course Elective Based on EB1a/ EB1b

EB1a [2 Credits]

1. Study of the Floral biology and breeding objectives of the following crop species: Wheat, Rice, Chilly, Mustard, RadisPotato
2. Floral biology of horticultural crops
3. Practical experience of Emasculation, bagging, and hand pollination techniques
4. Plant breeding research institutes of India
5. Correlation and regression analysis with field-collected data
6. To test the goodness of fit and independent assortment using Chi-square method

EB1b [2 Credits]

1. Study of fungal pathogens: Sclerosporagraminicola, Peronospora parasitica, Erysiphe polygoni, Uromyces pisi v., Melampsoralini, Ustilago tritici, Sphacilothecasorghi/U. hordeii, Tolyposporiumpenicillariae, Fusarium oxysporum f. sp. lycopersici
2. Isolation of fungal pathogens
3. Description of bacterial diseases and symptoms
4. Description of Viral diseases and symptoms

RMB. Research Methodology [5 Credits]

1. Introduction of Research Methodology
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)

Minor Elective Course Basket (EBM-1) [4 Credits]

EBM-1: Applied Phycology

1. Algal Biomass Production
2. Commercial potential of *Chlorella*, *Spirulina* and *Porphyra*
3. High-rate algal ponds for the treatment of wastewaters and for the production of useful biomass and energy;
4. Paddy field cyanobacteria: their use as biofertilizer and in reclamation of usar lands
5. Algal blooms and other negative consequences of algae

Suggested Readings:

1. Lee, Robert Edeward, Phycology, Fourth edition, 2008, Cambridge University Press
2. Van Den Hoek C, Mann, DG, Jahns HM. 1995. Algae: An Introduction to Phycology

B.Sc. (Honours with Research) Fourth Year [VIII Semester]

Fourth Year (VIII Semester with Research)	Major Subject (Botany) CoreBotany-7(CZ-7)	Credit	Name of Course	Remarks
		5	CB-7 Advanced Plant Ecology and Environmental Studies	This course will be based on core subject selected by the students for PG
	Major Practical (LC-2)	3	LC-2 Lab Course Based on CB-7	
	Major Elective Botany(EB-2)	2	Elective Course: Anyone from EB-2basket	**Major Elective Course Basket EB-2** EB-2a: Advanced Plant Biochemistry and Plant Molecular Biology EB-2b Natural Resource Management
	Major Elective Practical (LCE-2)	2	LCE-2 Lab Course Elective Based on EB2a/ EB2b.	
	Research Dissertation (RD)	12	Dissertation (Topic will be issued in the 7th semester)	Student will conduct minor research work, OR will do a research-based field study and submit the Dissertation / report at the end of the semester.
	Minor Botany(ZB-2)	4	Minor Elective Course: For students with Core Subjects other than Botany (Without Practical)	**Minor Elective Course Basket (EBM-2)** EBM-2 Aquatic Botany
	Total	**28**		
Note: After completing four years (eight semesters) with the above-mentioned courses, the student will be awarded a Bachelor of Science degree, B.Sc. (Honours with Research in Botany).				

CB-7 Advanced Plant Ecology and Environmental Studies [5 Credits]

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.

LC-2 Lab Course Based on CB-7

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. To calculate mean basal cover and total basal cover of each species in a given area.
5. To compute the relative dominance and IVI (Importance Value Index) of each species in a given area.
6. To calculate the Alpha ($\propto$) diversity, Beta (β) diversity and total diversity of given community.
7. BOD and COD measurement
8. Toxicity assessment of heavy metals and other pollutants,
9. Assessment of Ozone and UV toxicity
10. Study of Green house effect, Phytoremediation of pollutants

Major Elective Course Basket EB-2

EB- 2a: Advanced Plant Biochemistry and Plant Molecular Biology

1. Basics of biochemistry, Structure and properties of water; pH and buffers.
   Carbohydrates:Nomenclature and classification; Monosaccaharides, 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 quarternary; 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.

EB-2b: Natural Resource Management [2 Credits]

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 PublishingHouse,New Delhi.
3. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment andResourceConservation. 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.

LCE-2 Lab Course Elective Based on EB2a/ EB2b.

EB 02a [2 Credits]

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of DNA replication mechanisms through photographs.
3. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
4. Photographs establishing nucleic acid as genetic material.
5. DNA isolation from plant tissues
6. Plasmid isolation from bacterial cell
7. Demonstration of total DNA from Plant tissues by CTAB method.
8. Demonstration of Agarose gel Electrophoresis and Poly-achrilamide gel electrophoresis

EB 02b [2 Credits]

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Collections of data on the forest cover of a specific area.
3. Measurement of dominance of woody species by the DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modelling.

Dissertation [12 Credits]

(Topic will be issued in the 7th semester)

Minor Elective Course Basket (EBM-2) [4 Credits]

EBM-2 Aquatic Botany

1. Aquatic ecosystems: Definition, features, types, and functions of aquatic ecosystems- marine ecosystems (ocean, coastal) and freshwater ecosystems (lotic, lentic, and wetlands)
2. Phytoplanktons of freshwater and marine systems and their ecological significance
3. Benthic algae of pond, riverine, temperate water streams and marine systems
4. Seaweeds: Biodiversity of Seaweeds along the coast of India, Economic importance
5. Vascular plants: Freshwater aquatic plants, seagrasses and mangroves
6. Biotechnological importance of aquatic plants

Suggested Readings:

1. Edmondson, W.T. (1976). Freshwater Biology 2nd Ed. John Wiley (Ed.) and Sons, Inc.
2. Bames R.S.K. (1999). Introduction to Marine Ecology, Blackwell Science.
3. Hutchinson, G.E. (1976). A Treatise on limnology. Vol I & II John Wiley &Sons
4. Jeffery S. Levinton (2000). Marine Ecology, Biodiversity and Function. Oxford