

**DEPARTMENT OF BIOSCIENCES
HIMACHAL PRADESH UNIVERSITY
SUMMER HILL, SHIMLA-171005
Ph.D. BOTANY PROGRAMME**

GENERAL INSTRUCTIONS/GUIDELINES FOR EXECUTION OF CURRICULUM

1. All candidates admitted to the Ph.D. program at the Department of Biosciences have to complete a minimum of 12 credits.
2. There will be four (3) courses in Ph.D. Botany Programme. The students have to take 2 compulsory courses [RPE-PhD and PhDBT-101] and at least one additional course out of elective courses [PhDBT-102(i-vii)].
3. The detailed syllabi for the courses offered by the Department are appended with a list of suggested readings.

Outline of the Course Work for Ph.D. in Botany

Code	Title of Paper	Max Marks	Credits
RPE-PhD (Common with all disciplines under Faculty of Life Sciences)	Research and Publication Ethics	50	2 Credits
PhDBT-101 (Common with all disciplines under Faculty of Life Sciences)	Research Methodology	100	5 Credits
Elect any one of the following i.e. PhDBT-104 (i-vii) (Elective)		100	5 Credits
PhDBT-102(i)	Advances in Mycology		
PhDBT-102(ii)	Advances in Plant Pathology		
PhDBT-102(iii)	Advances in Microbiology and Biotechnology		
PhDBT-102(iv)	Wood Science, Forest Biodiversity and Plant Resources		
PhDBT-102(v)	Advances in Plant Physiology		
PhDBT-102(vi)	Advances in Biodiversity, Bioprospecting, Ethnobotany and Sustainable Utilization of Plant Resources		
PhDBT-102(vii)	Phytochemistry and Palynology		
Total Marks/Credits		250	12 Credits

Ph.D. Botany (Compulsory Courses)

RESEARCH AND PUBLICATION ETHICS

Course Code: RPE-PhD

Credits: 2

MM: 50

L(2):T(0):P(0)

Course description

This course has a total of 6 units focusing on the basis of philosophy of science and ethics, research integrity, and publication ethics. Hands-on sessions are designed to identify research misconduct and predatory publication. Indexing and citation databases, open-access publications, research metrics (citations, h-index, Impact Factor, etc.), and plagiarism tools will be discussed in this course.

Objectives

- Promote the importance of research integrity.
- Discuss the principles of publication ethics.
- Educate on identifying research misconduct and predatory publishing.
- Discuss indexing and citation databases.
- Provide information on open-access publications and research metrics.
- Introduce various plagiarism detection tools.

Evaluation

Continuous assessment will be conducted through tutorials, assignments, quizzes, and group discussion. At the end of the course, a final written examination of 50 marks will be conducted.

- Students who have at least 75% attendance in classes will be considered eligible for the final written examination.
- The exam will be conducted for three hour duration.
- The passing marks for Ph.D. coursework will be 55% aggregate, with minimum 50% in each individual course.

NOTE: Instructions for setting question paper

There will be 7 questions covering all the units. The first six questions (1, 2, 3, 4, 5 & 6) of 6 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit. The 7th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii...x) each with 2 marks. There will be at least one question from each unit and students will be required to attempt any seven questions out of ten.

Course Content

Unit-01 Philosophy and Ethics

- Introduction to philosophy: definition, nature and scope, concept, branches
- Ethics: Definition, moral philosophy, Nature of moral judgements and reaction

Unit 02: Scientific conduct:

- Ethics with respect to science research
- Intellectual honesty and research integrity
- Scientific misconduct: Falsification, fabrication and plagiarism (FFP)
- Redundant publications: Duplicate and overlapping publications, salami slicing
- Selective reporting & misrepresentation of data

Unit 03: Publication Ethics

- Publication ethics: definition, introduction and importance
- Best practices/ standards setting initiatives and guidelines: COPE, WAME etc.
- Conflict of interest

4. Publication misconduct: Definition, concept, problem that lead to unethical behaviour and vice versa, and types;
5. Violation of publication ethics, authorship and contributionship
6. Identification of publication misconduct, complaints and appeals

Unit 04: Open-access Publishing

1. Open-access publications and initiatives
2. SHERPA/ RoMEO online resource to check publisher copyright and self-archiving policies
3. Software tools to identify predatory publications developed by SPPU
4. Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal *etc.*

Unit 05: Publication Misconduct

A. Group Discussions

1. Subject specific ethical issues, FFP, authorship
2. Conflict of interest
3. Complaints and appeals: Examples and fraud from India and abroad.

B. Software tools

Use of plagiarism check software's like Turnitin, Urkund and other open-source software tools

Unit 06: Databases and Research Matrices

A. Databases

1. Indexing databases
2. Citation databases: Web of Science, Scopus *etc.*

B. Research Matrices:

1. Impact factor of a journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
2. Matrices: h-index, g index, i10 Index, almetices

Suggested Readings

Beall, J.(2012). Predatory publishers are corrupting open access.Nature,Vol.489(7415), 179.

<https://doi.org/10.1038/489179a>.

Bird, A.(2006). Philosophy of Science. Routledge.

Bretag, Tracey (2016). The Handbook of Academic Integrity.Springer

Chaddah, P.(2018).Ethics in Competitive Research: Do not get scooped; do not get Plagiarized.

ISBN:978-9387480865.

Grudniewicz, Agnes, D. Moher, Kelly D. Cobey+32 authors (2019). Predatory journals: no definition, no defense.Nature, Vol.576.

Indian National Science Academy (2019). Ethics in Science Education , Research and Governance

(2019). ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf

Israel, Mark, Iain Hay (2006). Research Ethics for Social Scientists. London.

Lang, James M. (2013). Cheating Lessons: Learning from Academic Dishonesty. Harvard University Press.

MacIntyre, Alasdair (1967).A Short History of Ethics. London.

National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research. Third Edition.National Academies Press.

Resnik, D.B.(2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10.

<https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>

Whitley Jr., Bernard E. & Patricia Keith-Spiegel (2001). Academic Dishonesty: An Educator's Guide. Psychology Press.

RESEARCH METHODOLOGY

Course Code: PhDBT-101

Credits: 5

MM: 100

L(5): T(0): P(0)

Course objectives:

- To provide basic framework and guidelines for researchers to clearly and define research problems, hypotheses, and objectives.
- To develop a deeper understanding of the principles involved behind the working of different instruments used in research.

Course learning outcomes:

- Will help the researchers to identify the most appropriate research design, sampling technique, and data collection and analysis methods.
- Researchers will be able to understand and comprehend the basics of research methodology and apply them in their research.

Evaluation Scheme: At the end of the course, a final written examination of 100 marks will be conducted.

- Students with at least 75% attendance will be eligible for the final written examination.
- The exam will be conducted for three hour duration.
- The passing marks for Ph.D. coursework will be 55% aggregate, with minimum 50% in each individual course.

NOTE: Instructions for setting question paper

There will be 11 questions covering all the units. The first 10 questions of explanatory answers (1, 2, 3, ...10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit ($5 \times 2 = 10$). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,x) each with 5 marks, covering all the units. The students will be required to attempt any eight questions out of ten.

Course Content

Unit 01

Foundations of Research: Meaning, objectives of research; criteria of good research; basic steps of research; types of research.

Problem Identification & Formulation: selection of research problem.

Hypothesis: Qualities of a good Hypothesis, Null & Alternative Hypothesis, Hypothesis Testing, Logic & Importance

Review of related literature: Meaning, necessity and sources.

Unit 02

Research Process and Experiment Design: Concept and Importance in Research, features of a good research design, Exploratory Research Design concept, types and uses, Descriptive Research: Designs concept, types and uses, Concept of Independent & Dependent variables.

Research Report: Writing preliminaries, main body of research, references and bibliography

Research and Development of Projects: Project formulation, National and international funding agencies for R & D projects, proposal submission.

Unit 03

Analytical Tools and Techniques in Research: Working principles, types, basic operation and application of Microscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Electrophoresis, Spectrophotometry, Chromatography and Mass spectrometry

Unit 04

Use of Tools / Techniques for Research: Search engines: NCBI, PubMed, Google Scholar, Thomson Reuters, SCI etc, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office. Bioinformatics tools and applications

Unit 05

Intellectual Property, Patent Database Search and Patent Writing Innovation: Introduction to Intellectual Property Rights (IPR), Basic forms of IPRs: — Patent, Copyright, Trademark, Designs, Process patent versus product patent, Art of writing a patent/innovation and claims, Preliminary patent.

Suggested Readings

1. Council of Biology Editors –CRE Style Manual, American Institute of Biological Sciences, Washington, D.C.
2. Effective Writing for Engineers, Managers, Scientists: Tichy AJ.
3. Scientific and Technical papers: Tribcase SF.
4. How to write and publish a scientific paper: Day RA.
5. Kothari, C. R. (2004). Research Methodology- Methods and Technique (New Age International, New Delhi)

Ph.D. Botany (Elective Courses)

ADVANCES IN MYCOLOGY

PhDBT-102(i)	Credit: 5	MM: 100	L(5): T(0): P(0)
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Course objectives:

- i To acquire detail knowledge about microbial interactions with biotic and abiotic components.
- ii To get whole idea about microbial importance and their benefits in industry and bioconservation of waste material.
- iii To garner knowledge about mycorrhizae and their prominent role in agriculture, horticulture and forestry.
- iv To receive intimate understanding about effects of phytopathogenic and other fungi on human being.

Course learning outcomes:

- i Students will be able to gain deep understanding about microbial ecology.
- ii Know the microbial significant in industry, agriculture, horticulture and forestry.

- iii Utilise different waste material for the cultivation of fungi.

Evaluation Scheme: At the end of the course, a final written examination of 100 marks will be conducted.

- Students with at least 75% attendance will be eligible for the final written examination.
- The exam will be conducted for three hour duration.
- The passing marks for Ph.D. coursework will be 55% aggregate, with minimum 50% in each individual course.

NOTE: Instructions for setting question paper

There will be 11 questions covering all the units. The first 10 questions of explanatory answers (1, 2, 3, ...10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit ($5 \times 2 = 10$). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,x) each with 5 marks, covering all the units. The students will be required to attempt any eight questions out of ten.

Course Content

Unit 01

General introduction, historical development and advances in mycology

Unit 02

Concepts in microbial ecology, microbe-microbe interactions, microbe-plant interactions, microbe-animal interactions, carbon cycle, nitrogen cycle, sulphur cycle, phosphorous cycle, transformation of other ions, degradation of man-made compounds.

Unit 03

Fungi in fermentation technology, in the production of antibiotics, immunoregulators, antitumor and antiviral agents, in transformation, in mineral biotechnology, in coal solubilization and paper industry, biosorption, bioremediation, detoxification of pesticides, in treatment of industrial effluents.

Unit 04

Type, structure and function of mycorrhizae, role of mycorrhizae in agriculture, horticulture and forestry.

Unit 05

Bioconversion of waste material through cultivation of fungi, effect of plant parasitic and other fungi on man.

Suggested Readings:

1. Ainsworth G.C. and Sussman, A. S. The fungi Academic Press. New York. 1968.
2. Alexopoulos, C.J. and Mims, C. W. 1979. And Blackwell, M. Introductory Mycology. Wiley Eastern Limited, New Delhi.
3. Burnett, J. H. 1976. Fundamentals of Mycology. Edw and Arnold London.
4. Alexopoulos, C.J., Mims, C. W. and Blackwell, M. Introductory Mycology. John Wiley and Sons.
5. Deacon, J. W. Introduction to modern mycology, ELBS.
6. Horsfall, J.G. and Cowling, E.B. Plant Diseases Vol. I-V. Academic Press, New York.

ADVANCES IN PLANT PATHOLOGY

PhDBT-102(ii)

Credit: 5

MM: 100

L(5): T(0): P(0)

Course objectives:

- i To understand the nature, origin and evolution of parasitism.
- ii To provide knowledge about plant pathogen interaction up to molecular level.
- iii To acquaint with importance of information technology in plant pathology.

Course learning outcomes:

- i Students will be able to develop a comprehensive understanding on the various types of plant diseases due to unfavourable abiotic factors.
- ii understand the molecular plant pathology and students also become well versed with use of information technology in plant pathology.
- iii Develop critical understanding on mechanism of action of fungicides and antiviral agents.

Evaluation Scheme: At the end of the course, a final written examination of 100 marks will be conducted.

- a. Students with at least 75% attendance will be eligible for the final written examination.
- b. The exam will be conducted for three hour duration.
- c. The passing marks for Ph.D. coursework will be 55% aggregate, with minimum 50% in each individual course.

NOTE: Instructions for setting question paper

There will be 11 questions covering all the units. The first 10 questions of explanatory answers (1, 2, 3, ...10) of 12 marks each will consist of one question from each unit, with internal choice provided ,

meaning there will be two questions from each unit ($5 \times 2 = 10$). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,x) each with 5 marks, covering all the units. The students will be required to attempt any eight questions out of ten.

Course Content

Unit 01

Nature, origin and evolution of parasitism. Parasitic and phanerogamic diseases of plants, effect of atmospheric impurity and lightening, diseases due to unfavourable temperature and light, soil moisture disturbances and nutritional deficiency diseases due to excess of nutrients.

Unit 02

Molecular plant pathology: Molecular diagnosis; identification of genes and specific molecules in disease development; molecular manipulation of resistance.

Unit 03

Induction of defense systems in plants - biological and chemical pathway and methods.

Unit 04

Mechanism of action of fungicides, antiviral agents and chemotherapy.

Unit 05

General principles of plant disease management. Historical developments of chemicals, legislative, cultural and biological protection measures. Exotic pathogens and pathogens introduced into India. Sanitary and phytosanitary issues under WTO, TRIPS and PRA.

Important cultural practices and their role in disease management, solarization, integrated disease management. Microorganisms antagonistic to plant pathogens in soil, rhizosphere and phyllosphere and their use in the control of plant diseases.

Suggested Readings

1. Agrios, G.N. Plant Pathology, Academic Press, 1988.
2. Baker, F. and Cooks, R.J. 1974. Biological Control of Plant Pathogens. W.H. Freeman & Co. San Francisco.
3. Bilgrami, K.S. and Dubey, H.C. text Book of Modern Plant pathology, Vikas, New Delhi; 1980.
4. Horsfall, J.G. and Dimond, AE. Plant Pathology -An Advanced Treatise. Vol-III Academic Press, New York
5. Horsfall, J.G. and Cowling, EB. Plant Disease. Vol. I-V. Academic Press, New York.

ADVANCES IN MICROBIOLOGY AND BIOTECHNOLOGY

PhDBT-102(iii)

Credit: 5

MM: 100

L(5): T(0): P(0)

Course objectives:

- i To enrich students with the knowledge of the different disciplines of microbiology such as medical microbiology, immunology, biocatalyst and fermentation technology.
- ii To provide deep knowledge about application of microbes in genetic engineering.
- iii Laboratory skills in addition to theory are included to prepare students for careers in the industry, agriculture and applied research where microbiology is increasingly employed.

Course learning outcomes:

- i Students will be able to gain wide knowledge about biocatalyst and fermentation technology.
- ii Get deep insights regarding genetic engineering along with cell and tissue culture technique.
- iii Understand the immunology and mechanism of drug resistance in microorganisms.

Evaluation Scheme: At the end of the course, a final written examination of 100 marks will be conducted.

- a. Students with at least 75% attendance will be eligible for the final written examination.
- b. The exam will be conducted for three hour duration.
- c. The passing marks for Ph.D. coursework will be 55% aggregate, with minimum 50% in each individual course.

NOTE: Instructions for setting question paper

There will be 11 questions covering all the units. The first 10 questions of explanatory answers (1, 2, 3, ...10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit ($5 \times 2 = 10$). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,x) each with 5 marks, covering all the units. The students will be required to attempt any eight questions out of ten.

Course Content

Unit 01: Biocatalyst Technology

1. Sterilization of Biocatalysts.
2. Immobilization of Biocatalysts.
3. Biocatalysis in organic synthesis.

4. Enzyme reactions in organic solvents.
5. Enzymes as biosensors.

Unit 2: Genetic Engineering

1. Expression of foreign DNA in *E. coli*.
2. Gene cloning and expression in Yeast.
3. Gene cloning in animal cells.
4. Techniques in plant genetic engineering.
5. Site detected mutagenesis.

Unit 3: Fermentation Technology

1. Microbial growth kinetics.
2. Design and analysis of bioreactors
3. Operation of fermentation processes.
4. Energy and food from industrial and forest wastes.
5. Techniques of product recovery.

Unit 4: Tissue Culture

- i. Products from animal and plant tissue culture.
- ii. Animal and plant reactor technology.

Unit 5: Immunology and Medical Microbiology

1. Interferons, interferon like substances and vaccines.
2. Oncogenes.
3. Tissue organ transplantation.
4. Mechanism of drug resistance in microorganisms.

Suggested Readings

1. Jay, J.M. 1987. Modern Food Microbiology. CBS Publishers and Distributors, New Delhi.
2. Casida, L.E. 1968. Industrial Microbiology. Wiley & Mo Millan Publishers.
3. Joshi, K R. and Osamo; N.O. 1992. Immunology, Agrobotanical publishers (India) Bikaner.
4. Walker, J. M. and Gun gold, E.B. Molecular Biology and Biotechnology. Royal Society of Chemistry, Cambridge., 1990.
5. Kumar, H.D. A text Book of Biotechnology. East West Pvt Ltd, New Delhi, 1993.
6. Kubly, J. Limmunology. W.H. Freeman and Company, New Delhi.
7. Frazier, W.C. and Wsthoff, D.C. Food microbiology Company ltd. New Delhi, 1995.

WOOD SCIENCE, FOREST BIODIVERSITY AND PLANT RESOURCES

PhDBT-102(iv)

Credit: 5

MM: 100

L(5): T(0): P(0)

Course objectives:

- i To understand the anatomical and physical properties of various wood species.
- ii To explore wood processing techniques and their applications.
- iii To promote sustainable practices in wood production and evaluate advancements in wood-based materials

Course learning outcomes:

- i Students will be able to understand the structure and properties of different wood types.
- ii Understanding of economic and medicinal uses of plants and sustainable cultivation techniques.
- iii Learning the wood processing techniques and to evaluate their impacts on wood quality

Evaluation Scheme: At the end of the course, a final written examination of 100 marks will be conducted.

- a. Students with at least 75% attendance will be eligible for the final written examination.
- b. The exam will be conducted for three hour duration.
- c. The passing marks for Ph.D. coursework will be 55% aggregate, with minimum 50% in each individual course.

NOTE: Instructions for setting question paper

There will be 11 questions covering all the units. The first 10 questions of explanatory answers (1, 2, 3, ...10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit (5x2=10). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,x) each with 5 marks, covering all the units. The students will be required to attempt any eight questions out of ten.

Course Content

Unit 01

1. General Characteristics and Anatomical Features of Normal and Compression Wood of Gymnosperms
2. General Characteristics und Anatomical Features of Normal and Tension Wood of Angiosperms
3. Differences between Manoxylic and Pycnoxylic Woods; normal and Polyxylic Woods; Sapwood and Heartwood; Stored und Non stored Woods; Porous and Non porous Woods; Ring

porous and. Diffuse porous Woods; and between Compression Wood and Tension Wood.

Unit 02

1. Some important physical properties of woods namely moisture content, specific gravity, wood density and fuel value of wood.
2. A general account of the properties of wood in relation to its structure.
3. Wild Plant Resources: A LIST of economically important wild plants of Himachal Pradesh (Emphasis is not to be placed on the study of individual plants).

Unit 03

1. Plant Resources for Pulp and Paper: A general account of plant fibers with particular reference to the effect of fibre morphology, chemical composition and wood properties on pulp and paper.
2. Plant Resources for the Sericulture: A LIST of important food plants of mulberry, tasar, oak tasar, eri, muga and wild silkworms (Emphasis is not to be placed on the study of individual plants). Status of sericulture industry in Himachal Pradesh.
3. Causes and Remedies for the Loss of Forest Genetic Materials.

Unit 04

1. Phytogeography and Biodiversity: A general concept of phytogeography and biodiversity.
2. An outline of the classification of the types of climatic zones, vegetation zones and forest types of India with particular reference to Himalayas and Himachal Pradesh (DETAILS ARE NOT REQUIRED AT THE LEVEL OF INDIA, BUT ONLY AT THE LEVEL OF HIMACHAL PRADBSH).

Unit 05

1. Conservation through law: A LIST of important acts and bills passed with reference to Environment, Forest, Wild Life, Biodiversity, Conservation and Patents in India and Himachal Pradesh.
2. Legal provisions regarding duties of the State and Citizens to protect the Environment. Sovereign Rights and Intellectual Property Rights.

Suggested Readings

1. Agrawal, H.O. and Seth, M.K. 2000. Sericulture in India. Vols. I-IV. Bishem Singh Mahendra Pal Singh, Dehradun, 984 pp.
2. Bawa, R and Khosla, P.K. 1998. Biodiversity of Forest Species (A Community Forestry Approach): Bishem Singh Mahendra Pal Singh, Dehradun, 218pp.

3. Carlquist, S.1988. Comparalivo Wood Anatomy-Systematic, Ecological and Evolutionary Aspects of Dicotyledonous Woods. Sprrioger Verlog, Berlin.
4. Dhar,U (Ed). 1993. Himalayan Biodiversity. Him Vikas Publication No.3, Gyanodya Prakashan, Nainital, 543pp.
5. Hoywood,V.H. and Watson, R.T. 1995. Global Biodiversity Assessment, UNEP, Cambridge University Press, Cambridge, U.K.
6. Jane, F.W. 1970. The Structure of Wood. Adan and Charles Blanck, London.
7. Kothari, A 1997. Understanding Biodiversity: Life Sustainability and Equity. Orient Longman
8. Krattiger, A.F. et al. (Eds.). 1994. Widening Perspectives on Biodiversity. Natraj Publishers, Dehradun, 473pp.
9. Nair, M.N.B. 1998. Wood Anatomy and Major Uses of Woods. Faculty of Forestry University Malaysia, 434 PM Serdong, Selangor, Malaysia.
10. Nair, M.N.B. et al. (Eds.). 1998. Sustaiuable Managenent of Nonwood Forest Products. Faculty, Universiti Putra Malaysia, 434004 PM Serdonig, Selangor, Malaysi
11. Panshin, A.J. and de Zeeuw, C. Textbook of Wood Technology. Vol. I. McGraw Hill Book Co., New Yok.
12. Rao, R.R. 1994. Biodiversity in India (Floristic Aspect). Bishen Singh Mahendra Pal Singh, Dehradun, 31pp.
13. Seth, M.K. 2002. Trees and Their Economic Importance.
14. Timell, T.E. 1986. Compression Wood in Gymnosperms, Vols. I-III. Springer-Verlag, Tokyo.

ADVANCES IN PLANT PHYSIOLOGY

PhDBT-102(v)

Credit: 5

MM: 100

L(5): T(0): P(0)

Course objectives:

- i To understand the physiological effects and mechanisms of action of different plant growth regulators and elicitors.
- ii To have a comprehensive understanding of biotic and abiotic plant stresses and plant's responses and tolerance mechanisms to mitigate them.
- iii To gain a pervasive knowledge about the impacts of heavy metal toxicity on plants and mechanisms of metal tolerance.

Course learning outcomes:

- i Students will be able to understand the effects of plant growth regulators and elicitors on plant physiology and development.
- ii the detailed mechanism of nitrogen fixation and intricate regulation of transcription and translation, focusing on key enzymes and regulatory proteins.
- iii the complexities of signal transduction pathways in plant cells, covering receptors, secondary messengers, and subsequent cellular responses.
- iv the physiological and molecular responses of plants to various abiotic stresses, supported by recent research findings.
- v understanding of how plants manage heavy metal toxicity through detoxification mechanisms, enhancing their grasp of plant resilience strategies in challenging environments.

Evaluation Scheme: At the end of the course, a final written examination of 100 marks will be conducted.

- a. Students with at least 75% attendance will be eligible for the final written examination.
- b. The exam will be conducted for three hour duration.
- c. The passing marks for Ph.D. coursework will be 55% aggregate, with minimum 50% in each individual course.

NOTE: Instructions for setting question paper

There will be 11 questions covering all the units. The first 10 questions of explanatory answers (1, 2, 3, ...10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit ($5 \times 2 = 10$). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii, ...x) each with 5 marks, covering all the units. The students will be required to attempt any eight questions out of ten.

Course Content

Unit 01: Plant Growth Regulators and Inhibitors

Auxins- Structure, activity, metabolism, IAA transport, mechanism of rapid and long-term responses, synthetic auxins - application in agriculture and horticulture.

Gibberellins- Structure, activity, biosynthesis, molecular mechanism of amylase induction in aleurone tissue.

Absciscic acid- Structure, biosynthetic pathways, catabolism and conjugation, role of ABA in drought tolerance and in the regulation of seed germination and dormancy.

Physiological effects and mechanism of action of ethylene, polyamines, brassinosteroids, jasmonic acid, salicylic acid and phenolics.

Unit 02: Nitrogen Fixation and Protein Synthesis

Range of nitrogen fixing organisms, molecular mechanism of nitrogen fixation, protein synthesis - transcription and translation.

Unit 03: Signal Transduction

Overview, receptors and G- proteins, phospholipid signalling, role of cyclic nucleotides, calcium- calmodulin cascade, diversity in protein kinases and phosphatases, sucrose-sensing mechanism.

Unit 04: Stress Physiology and Heavy Metals

Biotic and Abiotic stress in Plants: Physiological and biochemical responses of plants to environmental stress- water deficit and drought resistance, salinity stress, freezing, heat stress, oxidative stress and heavy metal stress, biochemistry of plant defense reactions under stress, phytochelatins and related peptides- their structure, synthesis and role in metal tolerance.

Unit 05: Genomics & Proteomics

Genome structure & Organization, Eukaryotic genome, Organelle genome, Genomics of Microbes and Microbiomes, Genome sequencing technologies. Proteome-Structural and functional features, Qualitative proteome technology (Gel based and Gel free), Quantitative proteome technology, Functional proteome technology, Application of Proteomics in Agricultural biotechnology

Suggested Readings

1. Annual Reviews of Plant Physiology
2. Annual Reviews of Biochemistry
3. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2003. Biochemistry and Molecular Biology of plants. American Society of Plant Physiologists, Maryland, USA.
4. Leopold A C. Plant growth and Development S. Levitt, J. Responses of plants of environmental stresses, Academic Press, N.Y. G. Moore, T.C. 1989. Biochemistry and physiology of plant hormones (2ed ed), Springer-Verlag, New York, USA
7. Paleg, L.G. & Aspinall, D. 1981. Physiology and Biochemistry of drought resistance in plants. Academic press, N.Y.
8. Purohit, S.S. (ed.). Hormonal regulation of plant growth and development vol I- IV, Agro Botanical Publ. India.
9. Singh, R & Sawhney, S.K. Advances in frontier areas of plant biochemistry, Prentice Hall, India
10. Teiz, L. & Zeiger, E. 1998. Plant Physiology (2" ed.). Sinauer Associates Inc. Publishers, Massachusetts, USA.
11. Wilkins, M.B. (ed.) 1984. Advanced Plant Physiology. ELBS, Longman, UK.

**ADVANCES IN BIODIVERSITY, BIOPROSPECTING, ETHNOBOTANY AND
SUSTAINABLE UTILIZATION OF PLANT RESOURCES**

PhDBT-102(vi)

Credit: 5

MM: 100

L(5): T(0): P(0)

Course objectives:

- i To get an insight into ethnobotany and its interdisciplinary approaches.
- ii To study various ethnic groups of India and their dependence on plants.
- iii To make students understand the role of ethnobotany in healthcare management, biodiversity conservation and economic growth of local societies.

Course learning outcomes:

- i Students will be to develop understanding about ethnobotany, biodiversity and sustainable development.
- ii Students will be able to collect data from the field by using appropriate methodology.

Evaluation scheme: At the end of the course, a final written examination of 100 marks will be conducted.

- a. Students with at least 75% attendance will be eligible for the final written examination.
- b. The exam will be conducted for three hour duration.
- c. The passing marks for Ph.D. coursework will be 55% aggregate, with minimum 50% in each individual course.

NOTE: Instructions for setting question paper

There will be 11 questions covering all the units. The first 10 questions of explanatory answers (1, 2, 3, ...10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit (5x2=10). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,x) each with 5 marks, covering all the units. The students will be required to attempt any eight questions out of ten.

Course Content

Unit 01

1. Biodiversity: Definition, levels and threats.
2. In-situ and ex-situ approaches to biodiversity conservation
3. Biodiversity conventions and legislations.

Unit 02

1. Definition and scope of Ethnobotany.
2. Ethnobotany: mindsets, externalities and challenges
3. Interdisciplinary approaches in ethnobotany

Unit 03

1. Ethnic groups of India: distinctive features of the various tribes
2. Ethnoagriculture: Use of plants by tribals as food and fodder
3. Economic status of medicinal plants: national as well as global

Unit 04

1. Traditional Phytochemistry
2. Plants in folk religion and mythology
3. Plants in material culture

Unit 05

1. Etnobotany in Modern India
2. Ethnobotany in development and conservation of resources
3. Information systems and databases for the conservation of medicinal Plants.

Suggested Readings

- Baker, H.G. 1978. Plant and Civilization. Wadsworth, Belmont.
- Chrispoels, M. J. & Sadaya, D. 1977. Plants, Food and People. Freeman, San Francisco
- Frankel, O. H, Brown, AHD. & Burden, J. J. 1995. The Conservation of plant diversity. Cambridge Univ. Press, Cambridge.
- Gadgil, M. & Guha, R. 1996. Ecology and Equity: Use and abuse of nature in Contemporary India Penguin, New Delhi.
- Pimentel, D. & Hall, C. W. (eds.) 1989. Food and Natural Resources. Acad. Press
- Schery, R. W. 1972. Plants for Man. Englewood, Prentice Hall.
- Sood, S.K., Kumar, S. and Lakhanpal T.N. Sacred Plants for Sustenance of Mankind. Daya Publishing House.
- Walter, KS. & Gillett, H.J. 1998. IUCN. Red List of Threatened Plants. IUCN, the World Conservation Union, Switzerland, U.K.

PHYTOCHEMISTRY AND PALYNOLOGY

PhDBT-102(vii)

Credit: 5

MM: 100

L(5): T(0): P(0)

Course objectives:

- i To understand the classification of phytochemical constituents and their chemical screening methods.
- ii To identify and isolate similar Bio-active compounds from plants

- iii To identify and describe the structures, functions, and types of pollen and spores, and understand their ecological and evolutionary significance.
- iv To demonstrate proficiency in collecting, processing, and analyzing pollen and spore samples using various microscopic and analytical techniques.

Course learning outcomes:

- i Students will be able to select the correct and efficient method of screening of chemical content of plants.
- ii Identify Phytopharmaceuticals.
- iii Isolate and purify Phytopharmaceuticals.
- iv Basic knowledge of pollen structure and utility of biostatistical methods.
- v Design and execute experiments or field studies related to pollen and spore analysis, and interpret the resulting data.

Evaluation scheme: At the end of the course, a final written examination of 100 marks will be conducted.

- a. Students with at least 75% attendance will be eligible for the final written examination.
- b. The exam will be conducted for three hour duration.
- c. The passing marks for Ph.D. coursework will be 55% aggregate, with minimum 50% in each individual course.

NOTE: Instructions for setting question paper

There will be 11 questions covering all the units. The first 10 questions of explanatory answers (1, 2, 3, ...10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit ($5 \times 2 = 10$). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,x) each with 5 marks, covering all the units. The students will be required to attempt any eight questions out of ten.

Course Content

Unit 01: Phytochemistry

1. Introduction to phytochemistry, a brief history of modern phytochemistry, the relation of phytochemistry with other sciences. Skills and expertise required for a phytochemistry. Computer-aided phytochemical studies.
2. Classification of phytochemicals, sources of phytochemicals, biological effect of phytochemicals, and function of phytochemicals in living organisms.
3. Major group of phytochemicals sources, pharmaceutical, and medicinal importance: Alkaloids, Terpenoid, Coumarins, Flavonoids, and Steroids.

Unit 02: Biosynthetic Pathways and Techniques

1. Pathways of commercially important phytochemicals: Forskolin, Taxol, Vincristin, and vinblastine.
2. Techniques involved in the isolation of biomolecules/ phytochemicals of medicinal importance, Solvent extraction, chemical separation, Steam distillation, soxhlet extraction, Chromatography, HPLC, TLC and UV.

Unit 03: Palynology: Pollen Morphology and Pollen Chemistry

1. Palynology: Definition, its branches, scope and it's application in agriculture taxanomy and forensic science. Application of Indian work on Palynology, Palynology center in India, and scopes of palynology.
2. Spore-pollen morphology: Symmetry, shape, size, aperture patterns, NPC system for numerical expression of apertural details, exine stratification, surface structures and sculptures of sporoderm; LO-analysis and edge-analysis.
3. Pollen Chemistry: Introduction, Chemical constituents of pollen (including carbohydrates, mineral contents, organic acid, pigments, vitamins etc.), Chemistry of pollen wall (sporopollenin, pollen wall proteins, origin of pollen wall proteins).

Unit 04: Palynotaxonomy, Aeropalynology and Melissopalynology

1. Palynotaxonomy: Systematic palynology, and evolutionary trends among pollen grains based on palynotaxonomical work.
2. Aeropalynology: Define aeropalynology, Methods of trapping air-borne pollen grains.
3. Pollen allergy: Some important pollen allergic diseases and their symptoms. List of some plants showing allergic pollen grains. Mechanism of Allergic Hypersensitivity type -I caused by pollens. Pollen calendar.

Unit 05: Melissopalynology

Introduction, Honey, Types of Honey, How honey is produced, chemical characteristics of honey, color aroma, and flavor of honey. Honey bees, Bee pasturage, Bee products, Granulation in honey, Pollen grains in honey, Physical characteristics of honey, and Adulation in honey.

Forensic palynology: methodology in Forensic study: collection of potential pollen/spores forensic sample, laboratory techniques, Analysis testimony and liability, methods of palynology as an aid in criminology, Problems of forensic palynology.

Suggested Readings:

- Erdtman, G. (1952). Pollen Morphology and Plant Taxonomy, Angiosperms. Almquist and Wiksell, Stockholm.
- Maheshwari, P. (1950). An Introduction to the Embryology of Angiosperms.
- Heslop-Harrison, J. (1971). Pollen Development and Physiology.
- Shivanna, K.R. (2003). Pollen Biology and Biotechnology
- Nayar, T.S. (1990). Pollen Flora of Maharashtra State, India.
- Thanikaimoni, G. (1970). Mangrove Palynology.
- Nair, P.K.K. (1970). Pollen Morphology of Angiosperms.
- Bhattacharya, K. (2006). A Text Book of Palynology.
- Hutchinson, J. (1973). The Families of Flowering Plants 2 Vols. Oxford University Press, Oxford.
- Takhtajan, A.L. (1997). Diversity and Classification of Flowering Plants. Columbia University Press, New York.
- Bhojwani, S.S. and Bhatnagar, S.P. (2000). The Embryology of Angiosperms. Vikas Publ. House, New Delhi.
- Shivanna, K.R. and Sawhney, V.K. (1997). Pollen Biotechnology for Crop Production and Improvement. Cambridge Univ. Press.
- Buchanan, B.B. Greuisssem, W. and Jones, R.L. (2000). Biochemistry and Molecular Biology of plants.
- Robinson, T. (1968). The Biochemistry of Alkaloids. Springer Verlag, Berlin.
- Heywood, V.H. and Watson, R.T. (1995). Global Biodiversity Assessment. Paroda.
- Frankel, O.H. Brown, A.D.H. and Burdon, J.J. (1995). The Conservation of Plant Diversity.
- Perry, D.A. (1994). Forest Ecosystems.