SIKKIM UNIVERSITY

(A Central University Established by an Act of Parliament of India, 2007)

LEARNING OUTCOME - BASED CURRICULUM

Ph.D. BOTANY (Course Work) PROGRAM

(With effect from Academic Session 2023-24)

DEPARTMENT OF BOTANY

SIKKIM UNIVERISTY

6TH MILE, TADONG - 737102

GANGTOK, SIKKIM, INDIA

SIKKIM UNIVERSITY

Department of Botany

SCHOOL OF LIFE SCIENCES

Ph.D. Coursework Structure

Course type	Course Code	Course Title	L	T	P	Credits	Marks
Common (School level)	BOT-C-701	Research Methodology in Life Sciences	3	1	0	04	100
	BOT-C-702	Research Proposal & Review of Literature	0	4	0	04	100
	CPE-RPE-703	Research and Publication Ethics	2	0	0	02	50
Specialization	**Any one of the following Elective (Advances in Plant Sciences) Courses:**						
	BOT-E-704	Trends in Plant Biochemistry	3	1	0	04	100
	BOT-E-705	Trends in Microbiology and Plant Pathology	3	1	0		
	BOT-E-706	Trends in Plant Systematics & Biodiversity	3	1	0		
	BOT-E-707	Trends in Plant Ecology	3	1	0		
	BOT-E-708	Trends in Plant Biotechnology	3	1	0		
	BOT-E-709	Trends in Natural Products Study & Ethnopharmacology	3	1	0		
		Total				**14**	**350**

DEPARTMENT OF BOTANY

Ph.D. Syllabus

PREAMBLE

The Ph.D. course structure envisaged as a programme to train a student in his/her particular area of research interest in Botany. The PhD coursework runs through one semester. The programme focuses on research methodology which is a common course for the School of Life Sciences. The departmental level papers focus on preparation of research proposal and presentation which provide exposure to the students to get acquainted with research during the period of the coursework. The programme structure at the department level offers flexibility to choose courses as per their interests in the state of the art advances in different areas of Botany.

PROGRAMME LEARNING OUTCOMES

On the completion of programme students will be able to:

PLO1: Demonstrate a thorough knowledge of the literature and a comprehensive understanding of methods and techniques applicable to their own research.

PLO2: Discover, interpret and communicate new knowledge through original research of publishable quality which satisfies peer review.

PLO3: Analyze data, interpret results, and write research articles and prepare reports.

PLO4: Communicate effectively through written exams, reports, presentations, and participation in conferences, seminars and workshops.

PLO5: Design research projects in their respective domain of study.

PLO6: Apply a significant range of advanced and specialized skills and be able to act autonomously in the planning and implementation of research projects.

PLO7: Practice a proactive, self-critical and self-reflective approach based on research and develop professional relationships with others wherever necessary.

PLO8: Demonstrate leadership and originality in tackling and resolving problems and issues, through communication and working effectively with others.

PLO9: Work constructively in multicultural groups and effectively coordinate with team members.

PLO10: Search information relevant to scientific tasks, combine the knowledge and prepare presentation, analyze data, perform theoretical and practical tests, evaluate results and effectively communicate through seminars, workshops and research publications.

PLO11: Demonstrate skill in the usage of software packages relevant to their study.

(Course Level: 700)

BOT-C-701
RESEARCH METHODOLOGY IN LIFE SCIENCES
(School Level)

First Semester: PhD coursework — Total Marks: 100
L+T+P: 3+1+0 = 4 Credits — Lecture: 45 Hrs + Tutorial: 15 Hrs + Practical: 0 Hrs

Course Learning Outcomes:

After the completion of the course, the scholars will be able to-

CLO1. Outline the field of research and different research methods.

CLO2. Comprehend the concepts of research problems, identification of research gap, framing research questions, research designs.

CLO3. Apply modern statistical tools to address research problems, research design and scientific document preparation.

UNIT I: RESEARCH DESIGN AND DATA COLLECTION

Research methodology: different types of research design, Sampling methods- procedures of sampling, criteria of selecting a sample and different types of sampling designs. Primary and secondary data. Framing research questions and developing hypotheses.

UNIT II: PROCESSING AND ANALYSIS OF DATA

Processing operations: Elements/types of analysis, usefulness of statistics in research, dispersion, Correlation and regression analysis: Bivariate and multivariate correlation, concepts of linear and higher order regression, multivariate regression, regression models, Introduction to computer-based programming in data analysis such as R.

UNIT III: HYPOTHESES TESTING AND BIOSTATISTICS

Basic concepts of hypothesis testing, Parametric and Non-parametric tests, Normality tests, F and t- tests, Mann- Whitney U test, Chi square test, ANOVA (One Way and two way), MANOVA, ANCOVA, Kruskal-Wallis one way ANOVA, Ordination techniques: PCA, PCoA, CCA, NMDS.

UNIT IV: SCIENTIFIC WRITING

Types of scientific documents, guidelines for preparation of scientific articles/documents, identification of journals, referencing and reference management tools, Review articles: types of review (narrative, systematic and meta-analysis)

SUGGESTED TEACHING LEARNING STRATEGIES

1. Lecture-cum discussion, library readings, critical discussion.
2. Organizing philosophical debates and group discussions, case studies, projects.
3. Individual presentations by students on selected topics.

ASSESSMENT FRAMEWORK

Assessment	Written Modes	Oral Modes	Integrated Modes
Formative Marks: 50%	Class Test, Article Writing, Assignment	Group Discussion, Quiz	Presentation, Seminars
Summative Marks: 50%	Semester examinations conducted by the University will be considered the mode of summative assessment.		

Note: Teachers can choose any mode of formative assessment as per nature of the CLO

Suggested reading:

1. CSIR (2019). *CSIR Guidelines for Ethics in Research and in Governance*. Council of Scientific and Industrial Research, New Delhi.
2. Kothari, C.R. and Garg, G. (2019). *Research Methodology*. New Delhi: New Age International Publishers. 1-480. ISBN-13: 978-9386649225
3. Bernard Rosner, B. 2005. *Fundamentals of Biostatistics*, 6th edition Duxbury Press.
4. Gerry, Q. P and Keough, M. J. 2002. *Experimental Design and Data Analysis for Biologists.* Cambridge Univ. Press.
5. Norman, N. G. and Streiner, D. 2008. Biostatistics: *The Bare Essentials*. 3rd edition, BC Decker Inc.
6. Paulson, D. S. 2008. *Biostatistics and Microbiology*. Springer.
7. Sokal, R. R. and Rohlf, F. J. 2008. *Introduction to Biostatistics*. Dover Publication.
8. Laake, P., Benestat, H.B. and Olsen, B.R. 2007. *Research Methodology in the Medical and the Biological Sciences*. Academic Press, UK.

(Course Level: 700)

BOT-C-702

RESEARCH PROPOSAL AND REVIEW OF LITERATURE

First Semester: PhD coursework Total Marks: 100

L+T+P: 0+4+0 = 4 Credits Lecture: 0 Hrs + Tutorial: 60 Hrs + Practical: 0 Hrs

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Course Learning Outcome:

Students will be able to-

CLO1. Prepare a research proposal and formulate their own research plan.

CLO2. Put together the available literature on a topic and interpolate on the retrospective studies.

CLO3. Present the research proposal and summary of review work to the examiners, and participate in discussion

Preparation of research proposal

Students have to prepare a Research Proposal in any standard format (UGC, DBT, SERB, etc.) in the chosen field of research. The proposal should have clear objectives with identification of gaps in the knowledge, review of literature, methodology to be adopted, expected outcome, potential application(s), real time budget and timeline.

Review of literature

An extensive review work is to be undertaken in the proposed area of research. It should have appropriate citation and well formatted references using any of the standard journal formats covered under scopus list, web of science, UGC care list etc. The review work is also expected to cover meta-analysis in the chosen topic/research area.

SUGGESTED TEACHING LEARNING STRATEGIES

1. Discussion with faculties, library readings, Critical Discussion.
2. Seminar, conference, workshops.
3. Guided readings and discussions.
4. Presentations by students on selected themes.

ASSESSMENT FRAMEWORK

Assessment	Written Modes	Oral Modes	Integrated Modes
Formative Marks: 50%	Follow-up on review, proposal Writing	Discussion, seminar	Presentation
Summative Marks: 50%	Assessment of submission and presentation followed by viva voce		

Note: Teachers can choose any mode of formative assessment as per nature of the CLO.

(Course Level: 700)

CPE-RPE: 703

RESEARCH AND PUBLICATION ETHICS

Semester: PhD coursework | Course Level: 700 | Total Marks: 50

L+T+P: 2+0+0 = 2 Credits | Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 0 Hrs

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Course Learning Outcome:

On completion of the course, the students will be able to-

CLO1. Determine the ethics involved in research and be aware of moral values and standards in research.

CLO2. Record the details of publication ethics and scientific writing.

CLO3. Design their own research plan and infer the ethics involved in their research.

CLO4, Determine and follow ethical guidelines in human and animal experimentation.

CLO5. Recognize and use open access publishing, databases, and learn research metrics

Unit I: SCIENTIFIC CONDUCT AND PUBLICATION ETHICS

Ethics with respect to science and research
Intellectual honesty and research integrity
Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
Redundant publications: duplicate and overlapping publications, salami slicing
Selective reporting and misrepresentation of data.
Best practices /Standards setting initiatives and guidelines: COPE, WAME, etc.
Conflicts of interest
Violation of publication ethics, authorship and contributorship
Identification of publication misconduct, complaints and appeals
Predatory publishers and journals
Welfare of animals used in research, ethics in research involving human experimentation
Institutional ethical committee, Institutional animal ethics committee and Biosafety committee: roles and responsibilities

Unit II: OPEN ACCESS PUBLISHING, DATABASES AND RESEARCH METRICS

Concept of Open Educational Resources (OER), concept of open license, open access publishing, open access content management
Databases: Indexing databases, Citation databases: Web of Science, Scopus, etc.

Research Metrics: Impact Factor of Journal as per Journal Citation Report, SNIP, SJR, IPP,

Cite Score: Metrics: h-index, g index, i10 index, altmetrics, ISBN, ISSN

UGC CARE list journals, latest UGC regulations on academic integrity

SUGGESTED TEACHING LEARNING STRATEGIES

Continuous evaluation will be done through tutorials, quizzes, group discussions, seminars and assignments. Weightage will be given for active participation. Final written examination will be conducted at the end of the course.

ASSESSMENT FRAMEWORK

Average assignment score = 25% of average of best 6 assignments out of the total 8 assignments given in the course.
Exam score = 75% of the proctored certification exam score out of 100
Final score = Average assignment score + Exam score

Suggested reading:

1. Bird, A. (2006). Philosophy of Science.Routledge Maclntyre,
2. Alasdair (1967) A Short History of Ethics. London
3. P.Chaddah, (2018) Ethics in Competitive Research: Do not get Scooped; do not get Plagiarized, ISBN :978-9387480865
4. 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.
5. Resnik, D.B.(2011) What is ethics in research & why is it important. National institute of Environmental Health Science, 1-10 Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
6. Beall, J: (2012) Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a
7. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf.

ADVANCES IN PLANT SCIENCES

(Course Level: 700, Elective)

BOT-E-704

TRENDS IN PLANT BIOCHEMISTRY

First Semester: PhD coursework Total Marks: 100

L+T+P: 3+1+0 = 4 Credits Lecture: 45 Hrs + Tutorial: 15 Hrs + Practical: 0 Hrs

Course Learning Outcome:

After completion of the course, the students will be able to-

CLO1. Describe diverse aspects of enzymology including industrial applications and recombinant DNA technologies.

CLO2. Describe and explain the contemporary views about the mechanisms of action of different hormones in regulation of plant functions.

CLO3. Describe concisely the molecular physiological aspects of plant tolerance to commonly encountered abiotic stressors.

CLO4. Illustrate the working principles, details of instrumentation and application of various techniques employed in biochemistry.

UNIT-I: ENZYMOLOGY **15 Hrs**

Extraction and purification of enzymes; application of enzymes in food and drink industries; enzymes and in-born errors in metabolism; preparation and application of immobilized enzymes; enzymes and recombinant DNA technology.

UNIT- II: HORMONES & SIGNAL TRANSDUCTION **15 Hrs**

Hormonal regulation of plant growth and development, signal transduction, Role of PGRs in agriculture and horticulture, Auxin signal transduction pathway; Gibberellin signaling and its significance; ABA signal transduction pathway.

UNIT- III: PLANT STRESS RESPONSES **15 Hrs**

Biotic and Abiotic stress; Physiological and biochemical responses of plants to environmental stress; Plant responses to salinity and chilling stress; Abiotic stress and secondary metabolite production. Development of transgenic plants for abiotic stress tolerance; Stress proteins in plants; biochemistry of plant defense reactions; plant responses to herbivory, control of plant pathogens by genetic engineering.

UNIT-IV: INSTRUMENTATION IN PLANT BIOCHEMISTRY 15 Hrs

Construction and principles of light, electron and scanning probe microscopy. Centrifugation: differential, density. Principles of spectrophotometry and spectroscopy; biomolecules separation, detection and estimation methods methods; HPLC

SUGGESTED TEACHING LEARNING STRATEGIES

i. Lecture-cum discussion, library readings, critical discussion.
ii. Organizing philosophical debates and group discussions, case studies, projects .
iii. Guided readings and discussions of classical texts written by famous philosophers.
iv. Individual presentations by student on selected topic.

ASSESSMENT FRAMEWORK

Assessment	Written Modes	Oral Modes	Integrated Modes
Formative Marks: 50%	Class Test, Article Writing, Assignment	Group Discussion, Quiz	Presentation, Seminars
Summative Marks: 50%	Semester examinations conducted by the university will be considered the mode of summative assessment.		

Note: Teachers can choose any mode of formative assessment as per nature of the CLO

SUGGESTED READINGS

1. Taiz L, Zeiger E. Plant Physiology (Second Edition) Simauer Associates Inc Publishers Sunderlands, Massachusetts (2002).
2. Heldt HW. *Plant Biochemistry and Molecular Biology*. Oxford University Press (1997).
3. Hopkins WG. *Introduction to Plant Physiology*. John Wiley and Sons, Inc. New York (1985).
4. Methods in Enzymology Colowick and Caplan Academic Press, New York
5. Coombs, Hall, Long and Scurlik. *Techniques in Bioproductivity and Photosynthesis.* Pergamon Press, Oxford (1985).
6. Hall, Sccurlik, Bolhar, NordenKamf, Leagood and Long *Photosynthesis and production in a Changing Environment*. *A Field and Laboratory Manual*. Chapman and Hall Publication (1993).
7. Buchanan BB, Gruissem W, Jones RL. *Biochemistry and Molecular Biology of Plants* (2nd Ed.). Wiley Blackwell. (2015).

(Course Level-700, Elective)

BOT-E-705

TRENDS IN MICROBIOLOGY AND PLANT PATHOLOGY

First Semester: PhD coursework Total Marks: 100
L+T+P: 3+1+0 = 4 Credits Lecture: 45 Hrs + Tutorial: 15 Hrs + Practical: 0 Hrs

Course Learning Outcome

After completion of the course, the students will be able to-

CLO1. Describe diverse aspects of identification of disease-causing fungi and the roles of chemicals in the management of plant diseases.

CLO2. Explain the contemporary views about the role of microbes in food science and the use of modern technologies in the commercial aspects of food science.

CLO3. Describe different aspects of fermentation processes, fermentation based technologies and their applications.

CLO4. Illustrate the working principles, details of instrumentation and application of various techniques employed in plant pathology and biochemistry.

UNIT I: PLANT DISEASE MANAGEMENT 15 Hrs

Molecular techniques for Identification and classification of fungi. Recent concept of plant defence: Mechanism of sensing pathogenecity, Systemic Acquired Resistance (SAR), Biochemical defence, Biological control of plant diseases, chemicals in plant disease management. Uses of modern biotechnological tools in crop management. Testing for host resistance to diseases.

UNIT II: ADVANCES IN FOOD MICROBIOLOGY 15 Hrs

Genetically modified foods. Biosensors in food, Applications of microbial enzymes in dairy industry. Utilization and disposal of dairy by-product. Prebiotic and Probiotic. Functional foods- health claims and benefits, Development of functional foods; Food Safety and Molecular Detection.

UNIT III: FERMENTATION TECHNOLOGY 15 Hrs

Source of microbes, Isolation, selection and culture collection banks, Preservation of industrially important microbes; Sterilization techniques, Strain development (mutagenesis, metabolic engineering and recombinant DNA techniques). Types of fermentation processes: Solid state and submerged fermentation, Batch, fed-batch and continuous fermentation strategies and their application, Types of fermenters (airlift, stirred tank and bubble column fermenter) Isolation and genotypic identification of microorganisms associated with the foods.

UNIT IV: INSTRUMENTATION IN PLANT PATHOLOGY AND MICROBIOLOGY 15 Hrs

Laboratory practices: General safety measures, Chemical hazards, Physical hazards, Biological hazards, waste disposal. Chromatography techniques, Electrophoresis techniques, Centrifugation techniques. Microscopy: Principles and appplications of Light and Electron

microscopy. Dark field, Bright Field, Phase contrast, fluorescence, scanning & transmission electron microscopy. Fermenter, spectrophotometer, HPLC, PCR machines.

SUGGESTED READINGS

1. Dennis, E.S.et al, 1992 Plant Gene Research: Basic knowledge and Application. Springer-Verlag Wien Publ. New York.
2. Gengopadhyay, S 1984 Clinical plant pathology, Kalyani Publ. New Delhi
3. Nane Y.1 and Thapliyal 1979, Fungicides in plant disease control. Oxford IBH, Publ. New Delhi.
4. Smith, J.E and D.R. Berry. 1978. The filamentous fungi. Vol -I Industrial mycology. Vol -II Development Mycologym, Edward Arnold Publ. London
5. Taiz, 1, and E. Zeiger. 1998. Plant physiology, Sinquer Assoc Inc. Publ. New York.
6. Trehan. K.1994. Biotechnology, Wiley Eastern Ltd, New Delhi.
7. Vaidya, J.G 1995 Biology of the fungi, Satyajeet Prakashan, Pune.
8. Tamang, J.P. 2010. Himalayan Fermented Foods: Microbiology, Nutrition and Ethnic Values. CRC Press, Taylor and Francis Group, New York, USA.
9. Tamang, J.P. and Kailasapathy, K. 2010. Fermented Foods and Beverages of the World. CRC Press, Taylor and Francis Group, New York, USA.
10. Tamang, J.P. 2014. Health Benefits of Fermented Foods and Beverages. CRC Press, Taylor and Francis Group, New York, USA.

(Course Level-700, Elective)

BOT-E-706

TRENDS IN PLANT SYSTEMATICS AND BIODIVERSITY

First Semester: PhD coursework | Total Marks: 100

L+T+P: 3+1+0 = 4 Credits | Lecture: 45 Hrs + Tutorial: 15 Hrs + Practical: 0 Hrs

Course Learning Outcome

After completion of the course, the students will be able to-

CLO1. Infer the methods in taxonomy and biodiversity studies.

CLO2. Will be able to collect and compile data using different techniques.

CLO3. Will be able to achieve essences of taxonomy, trends in classifications and tools used in classifications

UNIT-I: PLANT CLASSIFICATION **15 Hrs**

Aim and objectives of taxonomy; Comparative accounts of major system of plant classifications, trends in modern classifications (APG system), phenetic methods, molecular systematics, cladistic methods; diagnostic features, systematic positions, morphological characters-leaf, flowers, inflorescence, placentation, and fruits type, plant description; floristic study, functions of Botanical Survey of India.

UNIT-II: ESSENTIALS IN PLANT TAXONOMY **15 hrs**

Taxonomic structure, hierarchy, categories-supra specific, infra specific; concept of species, genus and family. ICN (Schengen Code-2018), principles, rules and recommendations, taxonomic literatures-Flora, monograph, revision, checklists, journal, illustrations etc, roles; variations and speciation; publications of new species, article preparations for publications; IUCN red list categories and criteria (2012, 2019).

UNIT-III: METHODS IN PLANT TAXONOMY AND BIODIVERSITY **15 hrs**

Field inventory-survey, plant collections, collection equipments, pressing/processing, handling of special groups, drying, pasting mounting, labelling, field note writing, introduction to identification-procedure and methods, identifications using keys, computer and internet aided identification, nomenclature, classifications, accession seal, number, preservation, filing of specimens, pest control in herbarium, label/annotation determination, type specimens, importance of field inventory for conservation of species. Global biodiversity assessment, measures of biodiversity, diversity indices, RET species.

UNIT-IV: INSTRUMENTATIONS AND MORPHOMETRICS **15 hrs**

Basics of GPS; Microscopy and micrometry;principles of spectroscopy and chromatography; centrifugation types; Morphometrics, qualitative and quantitative characters, statistics in taxonomy (data, simple statistics), univariate and bivariate plots, statistical test, PCA, ANOVA, mapping of morphological data, Quantitative characters in phylogenetic analysis, cladistics analysis; Techniques in molecular biology, DNA barcoding; Bioinformatics.

SUGGESTED READINGS:

1. Angiosperm Phylogeny Group. *An update of the Angiosperm Phylogeny Group.* (2003).

2. Crawford DJ. *Plant Molecular Systematics.* Cambridge University Press, Cambridge, UK (2003).
3. Baum BR. A simple procedure for establishing discrete characters from measurement data, applicable to cladistics. Taxon, 37:63-70 (1988).
4. Judd WS, Campbell, CS, Kellogg EA, Stevens PF, DonoghueMJ. *Plant Systematics: A phylogenetic Approach.* Sinauer Associates, Inc., Massachusetts (2002).
5. Nei M, Kumar S. Molecular Evolution and Phylogenetics. Oxford University Press, New York (2000).
6. Semple C. Steel MA. *Phylogenetics.* Oxford University Press, Oxford (2003).
7. Michael GS. *Plant Systematics.* Elsevier Academic Press, Burlington, MA (2006).
8. Cook CDK. A quick method for making accurate botanical illustrations. Taxon, 47:317-380 (1988).
9. Hillis DM, Mortiz C, Mable BK. (eds.) Mol. Systematics, Sinaver Associates, Sunderland, USA (1996).
10. Judd WS, Cmpbell CS, Kollogg EA, Stevens PF, Donoghue MJ. *Plant Systematics.* Sinauer Associates, INC, Publishers, Sunderland, Massachusetts, USA (2008).
11. Pimentel RA, Riggins R. The nature of cladistics data. Cladistics, 3:201-209 (1987). .

SUGGESTED TEACHING LEARNING STRATEGIES

v. Lecture-cum discussion, library readings, critical discussion.
vi. Organizing philosophical debates and group discussions, case studies, projects .
vii. Guided readings and discussions of classical texts written by famous philosophers.
viii. Individual presentations by students on selected topics.

ASSESSMENT FRAMEWORK

Assessment	Written Modes	Oral Modes	Integrated Modes
Formative Marks: 50%	Class Test, Article Writing, Assignment	Group Discussion, Quiz	Presentation, Seminars
Summative Marks: 50%	Semester examinations conducted by the university will be considered the mode of summative assessment.		

Note: Teachers can choose any mode of formative assessment as per nature of the CLO

(Course Level: 700, Elective)

BOT-E-707

TRENDS IN PLANT ECOLOGY

First Semester: PhD coursework Total Marks: 100

L+T+P: 3+1+0 = 4 Credits Lecture: 45 Hrs + Tutorial: 15 Hrs + Practical: 0 Hrs

Course Learning Outcome:

After the completion of the course, the students will be able to-

CLO1. Collect data from the field by using different sampling approaches

CLO2. Analyze the collected samples

CLO3. Handle basic instruments used in ecological research

Unit-I: ECOSYSTEM ANALYSIS

Different methods used for ecosystem analysis- Qualitative and quantitative approaches, Methods of estimation of plant productivity, Tools to study global climate change, Tools to restore degraded ecosystems, Modern techniques and tools for ecological studies- GPS, GIS and remote sensing, Computer simulated models, Data loggers, soft wares and sensors.Artificial intelligence (AI) and machine learning, Role and use of Remote sensing and GIS technology in ecological Research

Unit-II: ANALYTICAL TECHNIQUES 15 Hrs

Methods to study Physico-chemical properties of soil, Extraction of soil fauna, measurement of microbial diversity and culture techniques, Role of soil inhabiting micro-arthropods in nutrient management, Methods of studying physico-chemical properties of sediments, Plant functional traits, soil organic matter and soil carbon sequestration

Unit-III: ECOLOGICAL RESEARCH AND ACTS AND POLICIES 15 Hrs

National Forest policy 1988, National Biodiversity Policy 1998, National Biodiversity Act 2002, National policy on wetlands 2005, REDD^{+}, Kyoto protocol, Rio Earth summit, G-Summits, Durban agreement 2011,Paris convention 2015. Recent updates on the environmental laws and Policies

Unit-IV: INSTRUMENTATION IN ECOLOGY 15 Hrs

Centrifugation- high speed and ultra; Principles of spectroscopy-UV, visible, IR, FTIR, Raman, MS, NMR; Principles of spectrophotometer; Principles of chromatography- ion exchange, gel filtration, hydrophobic interaction, Radiobiology and uses. Calibration and maintenance of instruments. Demonstration of relevant techniques used in ecological research. Instrumentation in air sampling methods, Meteorological variables and their observations.

SUGGESTED TEACHING LEARNING STRATEGIES

1. Lecture-cum discussion, library readings, critical discussion.
2. Organizing philosophical debates and group discussions, case studies, projects.
3. Individual presentations by students on selected topics.

ASSESSMENT FRAMEWORK

Assessment	Written Modes	Oral Modes	Integrated Modes
Formative Marks: 50%	Class Test, Article Writing, Assignment	Group Discussion, Quiz	Presentation, Seminars
Summative Marks: 50%	Semester examinations conducted by the University will be considered the mode of summative assessment.		

Note: Teachers can choose any mode of formative assessment as per nature of the CLO

Suggested Readings:

1. Comin F.A (Ed.)(2010). Ecological restoration - a global challenge. Cambridge University Press
2. De Blij, H.J. (2006). Human geography, sulture, society and space (7th edition). John Wiley and Sons
3. Akimasa Suni, Kensuke, F., and Ai, Hiramatsu.(2010). Adaptation and mitigation strategies for climate change. Springer. Burroughs
4. Mandal, F.B and Nandi, N.C. (2009). Biodiversity concept, conservation and bioculture. Asian Books Pvt. Ltd
5. Patnaik, P (1997) Handbook of Environmental analysis. Taylor and Francis 2nd Edition Pp 824.

(Course Level: 700, Elective)

BOT-E-708

TRENDS IN PLANT BIOTECHNOLOGY

First Semester: PhD coursework Total Marks: 100

L+T+P: 3+1+0 = 4 Credits Lecture: 45 Hrs + Tutorial: 15 Hrs + Practical: 0 Hrs

Course Learning Outcome:

After completion of the course, the students will be able to-

CLO1. Describe plant tissue culture and transgenic plants in detail.

CLO2. Explain techniques used in genomics and proteomics including tools of bioinformatics.

CLO3. Describe the principles, instrumentations, applications and limitations of various techniques used in biotechnology.

UNIT-I: THEORETICAL FRAMEWORK FOR PLANT BIOTECHNOLOGY 15 Hrs

Totipotency: Methods and applications; Transgenics: development, applications and ethical concerns; Molecular markers: development and analyses; DNA sequencing: Theory and applications; Functional genomics: Approach, analysis and applications, Genome editing: CRISPRCas9.,

UNIT-II: TOOLS & TECHNIQUES IN PLANT BIOTECHNOLOGY 15 Hrs

Plant Cell and Tissue culture: methods of sterilization, establishment of aseptic culture, culture of different explants; Isolation of nucleic acids, vectors and uses, PCR & RT-PCR, Genomic and cDNA library preparation, DNA and RNA hybridization, RNAi, Genome sequencing approaches, data collection preparation and analysis, softwares, experimental design, waste disposal.

UNIT-III: BIOINFORMATICS 15 Hrs

Major bioinformatic resources and search tools; Sequence and structure databases; Sequence analysis (file formats, scoring matrices, sequence alignment, phylogeny); Data mining and analytical tools for genomic and proteomic studies; Molecular dynamics and simulations (basic concepts including force fields, protein-protein, protein-nucleic acid, protein-ligand interaction).

UNIT-IV: INSTRUMENTATION IN BIOTECHNOLOGY 15 Hrs

Principles of microscopy-light, electron, fluorescent and confocal; Centrifugation- high speed and ultra; Principles of spectroscopy-UV, visible, IR, FTIR, Raman, MS, NMR; Principles of chromatography- ion exchange, gel filtration, hydrophobic interaction, Radiobiology and uses. Calibration and maintenance of instruments.

Suggested Readings:

1. Agarwal SK. *Bioinformatics*. APH Publishing Corporation, New Delhi (2007).
2. Glick BR, Pasternak JJ. *Molecular Biotechnology: Principles and Application of recombinant- DNA.* ASM Press, Washington (1998).
3. Gupta PK. *Cell and Molecular Biology*, Third edition. Rastogi Publications, Meerut (2006).
4. Kumar S, Flading M. *Molecular Genetics and Breeding of Forest Trees*. International Book Distributers, Lucknow (2005). 436p.
5. Mandal AK, Gibson, GL. *Forest Genetics and Tree Breeding*. CBS Publishers and Distributors, New Delhi (2008).

(Course Level: 700, Elective)

BOT-E-709

TRENDS IN NATURAL PRODUCTS STUDY AND ETHNOPHARMACOLOGY

First Semester: PhD coursework Total Marks: 100

L+T+P: 3+1+0 = 4 Credits Lecture: 45 Hrs + Tutorial: 15 Hrs + Practical: 0 Hrs

Course learning outcomes:

After the completion of the course, the students will be able to-

CLO1. Describe the plant products used in medicine and drugs

CLO2. Explain the ethnopharmacological aspects of various biochemicals derived from plants

CLO3. Explain the analysis of plant products using various tools and instruments.

UNIT-I: NATURAL PRODUCTS 15 Hrs

Approaches available for drug development, role of natural products in new drug development. Bioactive compounds from bacterial and fungal sources. Natural products as a guide (leads) for design of new drugs. Bioassay-directed fractionation of natural products. Recent developments in plant based natural products for their activity as adaptogens, immunomodulators, memory enhancers, anti-inflammatory agents, anti-parasitics alongwith screening methods, isolation of active principle, mode of action and future prospects.

UNIT-II: ETHNOPHARMACOLOGY 15 Hrs

Definition, scope and applications in herbal medicines; Importance of ethnopharmacological studies. Plant chemicals in modern pharmacology: Biochemistry and pharmacology of atropine, caffeine, ephedrine, opioids, taxol, Vinca alkaloids; drug improvement by structure modification and biotransformation . Bioavailability and pharmacokinetics aspects of herbal drugs with examples. Phytoequivalence, pharmaceutical equivalence. WHO guidelines for assessment of herbal drugs; authentication and standardization of herbal raw materials.

UNIT-III: HERBAL TECHNOLOGY 15 Hrs

Introduction, concepts and prospects. Phyto-technology- value addition to biodiversity through chemo prospection. Medicinal mushrooms for healthy life. Natural dyes for cotton and silk industry. Scope and uses of essential oil from plants as perfumes and cosmetics. Preparation of perfumes from aromatic plants with special reference to the following Lemon grass, Palm-rosa, Lavender, Rose, and Vetiver. Incorporating the herbal extracts in various cosmetic formulations like Skin care preparations, Sunscreens, Hair care preparations.

UNIT-IV: INSTRUMENTATION IN NATURAL PRODUCTS STUDY 15 Hrs

Principles of microscopy-light, electron, fluorescent and confocal; Centrifugation- high speed and ultra; Principles of spectroscopy-UV, visible, IR, FTIR, Raman, MS, NMR; Principles of chromatography- ion exchange, gel filtration, hydrophobic interaction, Radiobiology and uses. Calibration and maintenance of instruments.

Suggested Readings:

1. W.C.Evans & Trease, Pharmacognosy, 15th edn.2008, W.B. Saunders & Co.Ltd., London.
2. A.N. Kalia, Textbook of Industrial Pharmacognosy, 2005, CBS Publishers, New Delhi.

3. Dr.P.Mukherjee, Quality control herbal drugs, 2005, Business Horizons, New Delhi
4. Dillon, B.S., Tyagi, R.K., Lal, A. and Saxena, S. (Eds.). 2004. *Plant Genetic Resources Management*. Narosa Pub. House, New Delhi
5. Hurtmann, H.T., Kester, D.E., Davies, F.T. and Geneva, R.L. 2004. Plant Propagation: Principle and Practice. Prentice-Hall of India, New Delhi
6. Newman DJ, Cragg GM (2007) Natural products as sources of new drugs over the last 25 years. Journal of Natural Products 70, 461-477.
7. Dewick, P. M. (2009). Medi cinal Natural Products: A Biosynthetic Approach. United Kingdom: John Wiley & Sons. 335-336.