DEPARTMENT OF BOTANY

UNIVERSITY OF KERALA

M. Phil PROGRAMME IN ADVANCED BOTANY

SYLLABUS

Under Credit and Semester System (w.e.f. November 2017 Admissions)

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Department of Botany, University of Kerala, 2019

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ABOUT THE DEPARTMENT

Department of Botany, University of Kerala, was established in the year 1959 at Kariavattom, Thiruvananthapuram, Kerala by Late Prof. (Dr.) A. Abraham, a visionary, an institution builder and a doyen in Cytogenetics and Plant Breeding. The Department actively serves the society through dissemination of knowledge and training the younger generation through unique courses and offering training in frontier areas of Plant Sciences. The Department is internationally known for its major contributions in Cytogenetics and Cytotaxonomy and for running a novel postgraduate programme in Genetics and Plant Breeding. The Department is also active in Plant Biotechnology research and has well established Cell/Tissue culture and Molecular Biology Laboratories. More than 180 students/teachers have taken PhD from the Department on various and diverse topics and more than 230 students have successfully completed their M. Phil programme in Advanced Botany.

The Vision….

- To serve the society through dissemination and field orientation of knowledge and training the best talents in Plant Sciences.

The Mission….

- To provide quality education in Life Sciences;
- To develop human resources with hands on experience on basic/ applied Plant Science research;
- To act as a centre for mining of biomolecules, genes and technologies of immense practical application for human welfare;
- To undertake basic, strategic and applied research for generating fool-proof technologies for the advancement of plant science and
- To become a Center of Excellence in Plant Science teaching and research in next five years

Courses Offered

M.Sc Genetics and Plant Breeding: A unique course with superb amalgamation of classical and applied aspects of plant science.

M.Phil. Advanced Botany: Two-semester programme covers Methods in Research, Advanced topics in Botany, Plant Breeding and Biotechnology. A project work as partial fulfillment of the course, term papers and seminars are the major attractions of the Course.

PhD Botany: ***Areas of Research***

- Biosystematics
- Biotechnology/ Tissue culture/ Cell Culture Technology
- Phytochemistry• Plant Reproductive Biology

Admission Procedure

PhD Admission: is scheduled in January/ July. Qualification: M.Phil. PhD Qualifying Test, UGC-CSIR NET/KSCSTE Fellowship

M. Phil Advanced Botany: The Course begins in November 1st. Admission based on entrance Examination (50%) with 50% for the Masters Degree.

M.Sc Genetics and Plant Breeding: Admission based on an Entrance Examination held in May every year. 50% of marks for Graduate Degree and 50% for the entrance test.

Faculty

1. Dr. Swapna T.S, Professor & Head
2. Dr. P.M. Radhamany, Professor
3. Dr. Suhara Beevy S, Professor
4. Dr. A. Gangaprasad, Professor
6. Dr. S. Shiburaj, Professor
7. Dr. E.A. Siril, Associate Professor
8. Dr. Bindu R. Nair, Associate Professor
9. Dr. R. Rajalakshmi, Assistant Professor

Research Activities

- Conservation of Tropical Plant Diversity, Evaluation and Genetic characterization
- Biosystematics and Evolution
- Chemical / Gene prospecting
- Crop Genomics
- Plant Tissue culture and Molecular Biology of Medicinal and Crop Plant relatives
- Cytogenesis, Cytotoxicity and Cytotaxonomy
- Plant Reproductive Biology, Breeding and Palynology

Facilities available

1. Botanic Garden: A well-maintained, fully organized garden was established in the Department which support researchers and students. The garden is recognized by Botanic Garden Conservation International (BGCI). The garden includes medicinal plant conservatory, nurseries, green houses, water plant conservatories, horticulture and topiary garden.

2. Herbarium: Department herbarium has a collection of 7000 Angiosperm specimens from Western Ghats, 21 Gymnosperms and 715 Pteridophytes.

3. Seed bank: Established through a joint project by University of Kerala and Kerala State Biodiversity Board. Seed bank aimed to conserve wild relatives of crop plants, underutilized crops plants and medicinal plants.

4. Library and Information Services: The Department Library has over 15,000 books and 15 subscribed National and International journals. The library provides inflibnet and science@direct facility.

5. Molecular Biology Laboratory Facility: A centralized lab facility established through KSCSTE-SARD, DST-FIST, and UGC Plan fund with modern sophisticated equipments. Some of the important equipments are; PCR, RT-PCR, Gel documentation, Gel electrophoresis

vertical and horizontal, Nanophotometer, biophotometer, UV-VIS spectrophotometers, Nitrogen analyzer, protein purification system, Cryostat, ELISA reader, Fluorescence microscope, phase contrast microscope, Image analyzers, Stereomicroscope, Gas chromatography unit, HPLC unit, High speed centrifuges, , Lyophilizer, homoginzers etc…

6. Computer lab facility: Established through DST-FIST Programme. Computers with high speed broadband internet connection and LAN facility. INFLIB Net facility is provided for deep literature search.

7. Department Auditorium: Department has an auditorium (A/C) with modern Audio Visual Facility.

The Kerala University Botany Alumni Association (KUBAA)

The Botany Department of the University of Kerala is located in the Kariavattom Campus, about 14kms from the Thiruvananthapuram city. It was established in 1959 by the late Prof. (Dr.) A. Abraham. Since its inception, the Department has been focusing its attention mainly on PhD programmes and other research activities. The main activity of the Department is to undertake research projects and guide researchers for PhD and M. Phil degrees. Alumni Association was established in the year 2003 with Prof. (Dr.) C.A. Ninan & Prof. P.M. Mathew (Former Head of the Department) as Patrons. Dr. P.M. Dr. Suhara Beevy S, Associate Professor & Head, Department of Botany is the present chairperson of the Association and Dr. Bindu R. Nair is the Secretary. The Association has around 150 members who actively participate and generously contribute to all its activities. The Alumni Association proposes to conduct annual seminars with a view to encourage and enhance the interactions between its many members. It may thus serve as a platform for the exchange of ideas, both academic and social, by its members, thus effectively reduce the generation gap between the older acclaimed scientist and today's young researchers. The Alumni Association is proud to announce that many of the members of the Association are working in reputed research labs, across the country and abroad. Some of them frequently visit the Department, hold discussions with the students and even provide numerous valuable insights. Furthermore, the Alumni Association encourages their members to exchange their expertise and ideas among themselves and to the students of the Department, thereby providing scope for the generation of new ideas which may act as an impetus to research as whole.

For membership and other details please Contact:-

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DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA
M. Phil Programme in Advanced Botany

Programme objectives:

- To inculcate research aptitude to students
- To enable students to take up research projects and interpret data
- To expose participants to advanced areas of plant sciences

Structure of the Programme

Semester No.	Course code	Name of Course	No. of credits
I	**BOT-711**	Research Methodology	4
	BOT- 712	Advanced Botany	4
	BOT- 713	Methods of Crop Improvement	4
II	**BOT- 721**	Dissertation	20
		Total	**32**

Semester: I
Course Code: BOT- 711
Course Title: RESEARCH METHODOLOGY
Credits : 4

Aim : To enlighten students about research methodology of biological sciences.

Objectives

- To impart knowledge about theories of scientific research
- To get thorough knowledge about scientific data collection, processing and scientific writing.
- To get detailed knowledge about application of research in day today life and ethical aspects of scientific research

Course Content

Module I: Scientific research: Definition, Characteristics and necessity of research; Types of research – Descriptive *vs*. Analytical, Applied *vs*. Fundamental, Quantitative *vs*. Qualitative, Conceptual *vs*. Empirical. Research design and methods-Selection, definition and formulation of the research problem -critical literature review – primary, secondary sources and the World Wide Web – reviews, treatise, monographs, patents. Identifying gap areas and development of a working hypothesis- Defining and formulating the research problem-assessing the status of the problem and formulation of the objectives. Important concepts and basic principles relating to research design- Need of research design– Features of good design – Developing a research plan – Actual investigation and experimentation; execution of the research

Module II: Sampling design and Data collection-Sample survey**, s**teps in sampling design, types of sample designs, selection of random samples, complex random sampling, Observation and collection of data - Methods of data (primary and secondary) collection–Survey and documentation-direct observation - personal interviews – Questionnaires – schedules; preparation of questionnaires/ schedules and interviews- experimental treatments,

Module III: Data processing and analysis-Data processing operations and data cleaning; Statistics in research - Analysis strategies - Testing of hypothesis (Parametric tests - Chi square tests, Analysis of variance and covariance, Non-parametric tests – multivariate analysis techniques), Data Analysis with Statistical software packages - MAT Lab, SPSS, MVSP, Psi LAB or free ware tools. Hypothesis-testing - Generalization and Interpretation.

Module IV: Documentation and scientific writing – Types of report – research papers, research project reports, technical reports and thesis. Different steps in the preparation – Layout, structure and language of typical reports, presentation of Results (Illustrations, photographs, graphs and tables) – citation styles, conclusions, bibliography, footnotes - Literature survey: References, - Importance of language and effective communication. Preparation of manuscript for publication of research paper, presenting a paper in a scientific seminar, thesis writing, writing a review for a paper, structure and components of scientific

reports, abstraction of a research paper. Oral presentation – planning – preparation – practice – making presentation – Use of visual aids.

Module V: Application of research results and ethics– Scientific conduct, ethics, authorship issues, investigation on scientific misconduct, reproduction of published material – Plagiarism –citation and acknowledgement – Reproducibility and accountability. Training in plagiarism checking softwares (Turn it in), reference manager softwares (Mendeley, Zotero, End Note). Significance of scientific research–environmental impacts and ethical issues – ethical committees –commercialization – copy right – royalty – Intellectual property rights and patent law – Trade related aspects of intellectual property rights.

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- https://sourceforge.net/projects/psilab/
- http://in.mathworks.com/products/matlab/
- http://libguides.wustl.edu/zotero
- http://libguides.wustl.edu/mendeley

Semester: I
Course Code: BOT - 712
Course Title: ADVANCED BOTANY
Credits: 4

Aim: To develop knowledge and skill in advanced botany including biological instrumentation, molecular genetics, bioinformatics, plant systematics and plant physiology.

Objectives

- To impart skill on biological instrumentation and techniques.
- To study molecular genetics and associated features.
- To acquire knowledge on bioinformatics including genomics, proteomics, metabolomics, pharmacogenomics and drug design.
- To apply knowledge on basic and advanced trends in plant systematic during their project work
- To understand the modern concepts of photosynthesis, respiration, physiology of germination, flowering, fruiting and stress physiology.

Course Content

Module I: Biological instrumentation and techniques: Microscopy- Interference- Fluorescent- Confocal microscopy and its applications. Karyotype and pachytene analysis- acetolysis- banding techniques- scoring of chromosomal aberrations. Principles and practice of staining- molecular cytogenetics- FISH- GISH-SKY chromosome painting- Chromosome library- Spectral karyotyping- Harlequin staining- chromosome engineering. Cell sorting- flow cytometry : principles and applications- fluorescent assisted cell sorting (FACS). Plant DNA isolation: CTAB method- isolation of mtDNA- cpDNA- isolation of RNA- DNA purity and quantification. Advanced Blotting techniques: variant techniques in blotting. Genome characterization: Physical and Genetic Maps, Molecular markers: Simple Sequence Repeats (SSRs)- 16s rRNA markers- Sequence Characterized Amplified Regions (SCAR)- Loop Mediated Isothermal Amplification (LAMP)- SAGE- EST sequencing- SNPs- nanotechnology in plant genome analysis. DNA bar-coding- microarrays based markers. Chromosome walking, chromosome jumping, DNA sequencing: over view, pyro sequencing, third generation sequencing methods- single molecule sequencing (SMS) methods, automated sequencing, DNA sequencer. RNA sequencing, Biochips, biosensors, Site directed mutagenesis – PCR based methods. Extraction, quantification and characterization metabolites and enzymes: cell fractionation- supercritical fluid extractions. Modern chromatographic tools- GC- GC-MS- HPLC- LCMS- HPTLC. Electrophoresis: polyacrylamide- agarose gel electrophoresis- SDS-PAGE- iso electric focusing- two dimensional electrophoresis- immuno electrophoresis. Centrifugation: principle and type of centrifuges- ultracentrifugation. Enzyme assay and kinetics- ELISA- RIA. Spectroscopy: principle–IR spectroscopy- Raman spectroscopy. Spectrofluorometry- Electron spin Resonance (ESR)- NMR- Mass spectrometry- FTIR- ICP-MS.

Module II: Molecular Genetics: molecular biology of gene expression. Types and structure of RNA polymerase. Transcription- Regulatory sequences and transcription factors involved.

RNA processing- Split genes and RNA splicing in eukaryotes. Evolutionary Implications of Split Genes and RNA Splicing. RNA world hypothesis- small regulatory RNAs and RNA silencing pathways. Antisense RNA- RNAi- Micro RNAs- Small RNAs that Regulate Gene Expression- piRNAs- gene knockout- knockout mouse- knockout moss. Translation- tRNA suppressor mutations- factors affecting translation accuracy. Molecular mechanism of mutation- site directed mutagenesis- protein engineering Molecular mechanism of Gene Regulation: regulation in prokaryotes- bacterial operon- ribo switches. Regulation in Eukaryotes- transcriptional control in eukaryotes- role of transcription factors in regulating gene expression- structure of transcription factors- DNA sites involved in regulating transcription- transcriptional activation- role of enhancers- promoters and co-activators- transcriptional repression. Epigenetic mechanisms: methylation and transcriptional inactivation- co-suppression through transcriptional silencing- genome imprinting. Role of Micro RNAs in Translational Control- Gene amplification- mating type inter conversion. Post translational Control: Determining Protein Stability. Cell Signaling and Signal Transduction: Basic Elements of Cell Signalling Systems- Extracellular Messengers and Their Receptors- G Protein-Coupled Receptors and Their Second Messengers. Protein-Tyrosine Phosphorylation as a Mechanism for Signal Transduction- Role of Calcium as an Intracellular Messenger- Convergence, Divergence and Cross-Talk Among Different Signalling Pathways, The Role of NO as an Intercellular Messenger.

Module III: Omics and Bioinformatics: Genomics- structural genomics- microsatellite maps- positional cloning- chromosome- genome databases- human genome sequencing project. Functional genomics- transcriptome- proteome and metabolome, Microarrays and gene-chips. Comparative genomics. Functional and evolutionary relationships prokaryotes- organelles and eukaryotes. Orthologues and paralogues. Metabolomics: Identification and quantification of cellular metabolites in biological samples. Pharmacogenomics and drug designing. Detecting open reading frames- gene prediction- programs for finding genes- secondary databases of functional domain. Molecular phylogenetic programmes- comparing nucleotide and amino acid sequences using BLAST. Programmes for determination of protein structure- Docking based virtual screening of drug molecules.

Module IV: Advanced trends in systematics: Basic concepts of Morphology, Embryology, Palynology, Ecology, Chemotaxonomy, Cytology and Cytogenetics characters in taxonomic studies (At least two examples from each section should be studied to substantiate the taxonomic significance). Phytochemicals in cosmetics- aromatherapy- disease prevention. Phytochemical databases. Nomenclature: International code of Botanical nomenclature- nomenclature of cultivated plants and hybrids. Plant collection- documentation- herbarium preparation and data information system. Plant name index. Taxonometrics: numerical taxonomy- experimental taxonomy- evolutionary systematics- DNA barcoding. Cladistics and dendrograms – applications in possible selected taxonomic groups or families. Molecular trends in Biosystematics: Molecules and genomes in plant systematics- techniques used in molecular taxonomy- molecular systematics in crop evolution. Serology in relation to plant taxonomy- Methods- role of serology in taxonomy. Eco taxonomy. Cladistics and Phenetics- in phylogentic analysis of taxa- genetically modified organisms and hybrids.

Module V: Plant physiology: Modern concepts of photosynthesis – Environmental and

agricultural relevance. Respiration- Biochemical control of respiration. Photo morphogenesis- control of photomorphogenic responses. Dose-response relations in photo morphogenesis- light induced chloroplast differentiation- effect of photoreceptors. Physiology of germination: dormancy and viability. Concept of seed vigour- seed invigoration. Physiology of flowering. Fruit growth- physiological and biochemical changes during ripening- post-harvest physiology of fruits. Physiological effect of biotic and abiotic stresses on plants with special reference to temperature- drought- salinity and heavy-metals.

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- http://www.negr.org
- http://www.genetics.wustl.edu.
- http://genome.imb-jena.dc.

Semester : I
Course Code : BOT- 713
Course title : METHODS OF CROP IMPROVEMENT
Credits : 4

Aim: To familiarize the advanced techniques and major applications of plant breeding, plant tissue culture technology and germplasm conservation and modern concepts of transgenic plants.

Objectives

- To understand different types of plant breeding practices and its applications.
- To get knowledge about major crops and its utilization.
- To understand plant tissue culture technology and applications.
- To familiarize the concepts of germplasm conservation and transgenic plants.

Course content

Module I: Plant Breeding: Modem concept and basis of heterosis– Methodology of producing hybrid varieties in cross and self- pollinated plants. Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Creation of male sterility through genetic engineering and its exploitation in heterosis. Use of incompatibility in heterosis breeding. Induction of autopolyploidy in seed and vegetative propagated plants problems and possibilities of auto polyploidy breeding. Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploidsvs allopolyploids –- Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer. Production of alien genome addition lines. Alien chromosome addition and substitution lines and alien chromosome segmental transfer through induced translocation breeding. Mutation breeding for various traits (disease resistance, insect resistance, quality improvement, etc.) in different crops- Procedures for micro-mutations breeding/polygenic mutations- Achievements of mutation breeding- varieties released across the world- Problems associated with mutation breeding. Use of mutagens in genomics, allele mining, tilling. Quality breeding: Introduction. Quality traits – morphological-nutritional – geological –hulling and milling recovery- cooking quality- nutritional quality of rice, wheat, fiber colour, length and strength in cotton, elimination of toxic substances-lathyrism- protein and mineral content and quality. Laboratory evaluation for protein quality and quantity, problems and prospects of quality breeding. Breeding for stress resistance: Drought resistance; introduction – types of abiotic stresses – minimizing drought resistance – breeding methods – Genetics of drought resistance –Problems. Mineral stresses: Salt affected soil- alkali soil, breeding for salinity resistance – effect of salinity stress, water stress, salt toxicity – salinity resistance, sources of salinity resistance breeding approach- Problems**.** Plant architecture and crop ideotype breeding; Concept of crop ideotypes - redesigning of crop plant types - Integration of special breeding techniques with conventional breeding - Optimization of yield, quality and resistance and development of improved plant types with wider adaptability.

Module II: Important crops and products of India: Agrotechnology, post harvest processing of Cereals, Tuber Crops, Fibre yielding plants, Plantation Crops, Sugar yielding plants, Narcotics, Vegetables, Oil yielding plants, Pulses and Beverages. Quality control: Maintenance of food quality, USFDA and its mandate's, Agmark, Adulterants in food, quality testing of fruits and vegetables- detection of residuals in food samples.

Module III: Advanced plant tissue culture technology: Concept of totipotency, Scope and applications of plant tissue culture, Laboratory facilities, tools and techniques, Concept of asepsis and methods of sterilization, Tissue culture media, In vitro differentiation and morphogenesis, molecular basis of differentiation, Micropropagation: methods, stages, commercial applications. Callus and cell suspension culture, protoplast culture and somatic hybridization. Culture of reproductive structures- anther and pollen culture, embryo and ovule culture, embryo rescue, endosperm culture. Somatic embryogenesis and Synthetic seed technology, Variability in tissue culture- origin and cause, molecular mechanism, scope and utility of somaclonal variation, Clonal fidelity tests, clonal plantations- significance, Secondary metabolites production in culture: Secondary products found in plants, cell culture systems for production of natural compounds- types and advantages, bioreactors- types and designs, biotransformation, elicitors, allelopathy, phytoalexins, Plant tissue culture industry- Global scenario, current propagation status of food crops, plantation crops, ornamentals and medicinal herbs in India, Organizations engaged in commercial micropropagation, Problems associated with micropropagation technology, Green house hardening unit- operation and management.

Module IV: Germplasm conservation: Conventional methods of germplasm conservation, role of seed banks, methods of seed banking and role of community seeds banks. Global Strategy for Plant Conservation (GSPC), pollen banks. *In vitro* methods- short, medium and long term storage and germplasm conservation. Plant tissue culture. Germplasm Conservation-collection and acqursrtion of germ plasm, documentation and identity confirmation, Germplasm conservation- traditional and innovative methods, Germplasm storage using in vitro strategies- slow (minimal) growth and cryopreservation, Short, medium and long term (cryopreservation) preservation, application, Techniques of cryopreservation, Determination of survival and viability, Plant growth and regeneration, Application of cryopreservation, Conservation centres in India and abroad. Cryopreservation: Techniques of cryopreservation, Determination of survival and viability, Plant growth and regeneration, Application of cryopreservation.

Module V: Transgenic plants: Procedure and protocols of producing transgenic plants., first commercial transgenic plants- transgenic tomatoes, control of ripening by antisense technology, insect resistance (Bt. protein), golden rice, herbicide resistance, commercializing insect resistant cotton, designer oils and biodiesel, plant secondary products, designer flowers, plants as bioreactors, vaccines, plantibodies, and bioplastics. Biodegradation, bioremediation, bioleaching. Biotechnological Applications: Biosensors, Microarrays, Biopesticides. Hazards and Impact of GMOs. Bios-safety Considerations: Biological risks, ethical issues, economic issues, legal issues.

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- http://genome-www.staford.edu
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Semester : II
Course code : BOT- 721
Course Title : DISSERTATION
Credits : 20

Aim: The aim of this course is to get the skill in formulating research hypothesis and to execute experiments to prove the hypothesis

Objectives:

- To encourage the students to come up with creative ideas and to give opportunities to experiment the concepts they have assimilated.
- To prepare the students to read the pertinent literature and formulate a research plan
- To get the skill for data analysis and interpretation