Program Overview

The M. Phil in Botany program is designed to provide advanced knowledge and skills in botanical sciences, preparing students for careers in research, academia, and industry.

Program Objectives

- Equip students with comprehensive knowledge and advanced skills in botanical sciences
- Foster critical analysis and synthesis of complex botanical concepts
- Prepare students for careers in research, academia, and industry
- Address global challenges faced by Pakistan, such as biodiversity loss, climate change, and sustainable agriculture

Eligibility Criteria

- Undergraduate degree in Botany or Plant Sciences (16 years of education)
- Undergraduate degree in Biological, Pharmaceutical, Food, Agricultural, Medical, Allied Health, or Chemical Sciences (16 years of education) with completion of deficiency courses (up to 12 credit hours)
- Passing score of 50% in admission test or GRE/HAT General/equivalent tests
- Minimum eligibility scores set by the admitting university (above 50%)

Program Structure

- The program will cover advanced courses in botany, including plant physiology, taxonomy, molecular biology, and ecology
- Electives will be offered to cover topics such as biodiversity loss, climate change, and sustainable agriculture
- Students will be required to complete a research project or thesis

Program Duration and Credits

- Program duration: 2 years (4 semesters)
- Total credit hours: 30-36 credits
- Core Courses: 24 credits
- Research Thesis: 6 credits (original research project under the Supervision of a qualified faculty member of the department
- Course details: As per HEC's new policy as given bellow.

PROGRAM STRUCTURE: The Master of Philophy (M. Phil) in Botany is structured in accordance with the provisions of the HEC Graduate Education Policy (GEP) 2023. Standard structure of the program is as under:

Table1. Standard structure of the program M. Phil in botany

Minimum Credit Hours	30
Minimum Coursework Requirement	24 credit hours (8 courses)
Minimum Research Requirment	6 credit hours
Program Duration	Minimum: 2 Years (4 regular semesters) Maximum: 4 Years (8 regular semesters) Note: In case a student is unable to secure the degree within the prescribed timeframe and claims for extension in duration, the university may constitute an appropriate authority and determine the causes of delay. In the event of force majeure (i.e., delay on account of circumstance beyond the control of student), the university may grant an extension in the period of award of degree in accordance with the duration limiting factor(s) and also take corrective measures in case the delay is caused by process or administrative reasons.
Semester Duration	16-18 weeks for regular semesters (1-2 weeks for examination) 8-9 weeks for summer semesters (1 week for examination)
Course Load (per semester)	09-12 credit hours for regular semesters Up-to 8 credit hours for summer semesters (for remedial/deficiency/failure/repetition courses only)
3 Credit Hours (Theory)	3 classes (1 hour each) OR 2 classes (1.5 hour each) OR 1 class (3 hours)
1 Credit Hours (Lab / Field Work)	1 credit hour in laboratory or practical work requires lab / field contact of three hours per week throughout the semester.

The standard scheme of studies for Master of Philophy (M. Phil) in Botany is given below

Semester-I			
S.N	course	credit	category

1	Advanced Analytical Tools in Botany *	3 (1-2)	Core
2	Recent Trends in Botany *	3 (3-0)	Core
3	Elective – I **	3	Elective
4	Elective – II **	3	Elective
	total credit hours	12	

Semester-II			
S.N	course	credit	category
1	Research Methodology & Scientific Writing *	3 (1-2)	Core
2	Elective – III **	3 (3-0)	Core
3	Elective – IV **	3	Elective
4	Elective – V **	3	Elective
	total credit hours	12	

Semester-III			
S.N	course	credit	category
1	Thesis ***	6	Research

Semester-IV			
S.N	Course	credit	category
1	Thesis ***	Continue	Research

* These are mandatory core courses for the program.

** The university / offering department may offer any advanced course in the field of Botany as an elective as per its program objectives, university's geographical location and available academic and faculty resources. Credits combination may accordingly be set.

*** Research work must be performed by students individually as per university's policy on the same including but not limited to the protocols for topic selection, allocation of supervisor and co-supervisor (where required), thesis submission, defense and evaluation as approved through statutory bodies.

DEGREE AWARD REQUIREMENTS

The following minimum requirements are prescribed for award of Master of Philosophy (M. Phil) in Botany: Minimum of twenty-four (24) credit hours including nine (9) credit hours for core courses and fifteen (15) credit hours for elective courses as prescribed in this document must be completed. 1. In addition to coursework of twenty-four (24) credit hours, research work / thesis of minimum six (06) credit hours must also be completed individually as partial fulfillment of the degree program. Requirement of research work / thesis cannot be substituted with additional course work. 2. CGPA must not be below 2.50/4.00 at the time of completion of the degree program. The university may however set higher standard in this regard. 3. The minimum duration required to complete the degree is four (04) regular semesters which may be extended up to maximum of eight (08) regular semesters. Summer semester is not considered as a regular semester.

Courses detail and Course Learning Outcomes

This is a comprehensive list of courses and its learning outcomes for M. Phil in Botany. Each course has specific outcomes that students are expected to achieve by the end of the course.

S. No	Course Code	Proposed courses	Credit Hours
1	Bot-701	Advanced analytical Tools in Botany	3(3-0)
2	Bot-702	Recent trends in Botany	3(3-0)
3	Bot-703	Research methodology & Scientific Writing	3(3-0)
4	Bot-704	Recombinant DNA Technology	3(3-0)
5	Bot-705	Advanced Genetics	3(3-0)
6	Bot-706	Proteomics and Genomics	3(3-0)
7	Bot-707	Advances in applied ethnobotany	3(3-0)
8	Bot-708	Plant microbe interaction	3(3-0)
9	Bot-709	Plant Ecology and Evolutionary Biology	3(3-0)
10	Bot-710	Plant Neutraceutic	3(3-0)

11	Bot-711	Advanced biodiversity and Conservation	3(3-0)
12	Bot-712	Phytochemistry	3(3-0)
13	Bot-713	Plant ecosystem services	3(3-0)
15	Bot-714	Advances in plant taxonomy	3(3-0)
16	Bot-715	Phytoremediation	3(3-0)
17	Bot-716	Advanced Economic Botany	3(3-0)
18	Bot-717	Advanced plant pathology	3(3-0)
19	Bot-718	Advanced methods in molecular biology	3(3-0)
20	Bot-719	Advances in Plant Tissue Culture	3(3-0)
21	Bot-720	Dendrochronology	3(3-0)
22	Bot-721	Advance methods in plant breeding	3(3-0)
23	Bot-722	Medicinal and aromatic plants	3(3-0)
24	Bot-723	Pharmacognosy	3(3-0)
25	Bot-724	Plant enzymology	3(3-0)
26	Bot-725	Plant Ecology and Climate Change	3(3-0)
27	Bot-726	Plant Molecular Markers and Genomics	3(3-0)
28	Bot-727	Plant Genetic Resources and Conservation	3(3-0)
29	Bot-728	Plant Biotechnology and Bioethics	3(3-0)
30	Bot-729	Plant Science and Policy making	3(3-0)
31	Bot-730	Plant secondary metabolites	3(3-0)

Bot-701 **Advanced Analytical Tools in Botany** Credit hours 3(1-2)

Course learning outcomes

By the end of this course, students will be able to: Critically evaluate the theoretical foundations and practical applications of advanced analytical techniques in botanical research. Apply advanced analytical instruments and software to conduct comprehensive data collection and analysis. Integrate advanced analytical methods to address complex research questions and enhance the precision of botanical studies.

Course Contents

1. Molecular Techniques

Polymerase Chain Reaction (PCR) and its applications in plant research (gene cloning, genotyping, quantitative PCR), Next-Generation Sequencing (NGS) for plant genome analysis, transcriptomics, and metagenomics, Gene expression analysis using RNA sequencing (RNA-Seq) and quantitative RT-PCR, Protein analysis techniques including SDS-PAGE, Western blotting, and mass spectrometry

2. Microscopy Techniques

Light microscopy with advanced imaging techniques (fluorescence microscopy, confocal microscopy), Electron microscopy (SEM, TEM) for detailed cellular and subcellular structures, Image analysis software for quantification and 3D reconstruction

3. Chromatographic Techniques

Gas Chromatography-Mass Spectrometry (GC-MS), High Performance Liquid Chromatography (HPLC), Liquid Chromatography- Mass Spectroscopy (LC-MS), Thin layer Chromatography (TLC), Column chromatography (CC)

4. Bioinformatics

Sequence alignment and phylogenetic analysis, Gene annotation and pathway analysis, Large-scale data analysis and visualization tools

5. Statistical Analysis

Advanced statistical methods for experimental design and data interpretation (ANOVA, regression analysis, multivariate)

Recommended books

1. Advanced Analytical Techniques: Analytical Methods for Pesticides and Plant Growth Regulators, Volume 17 (2013) by Joseph Sharma, Academic press.

2. Recent Advances in Analytical Techniques volume 5 & 6 (2019) by Atta ur Rahman and Sibel A. Ozkan. Bentham books.
3. Analytical Methods for Medicinal Plants and Economic Botany (2016) by Daniel and Manmmen. Scientific publisher.

Bot-703 **Research Methodology & Report Writing** Credit hours 3(3-0)

Course Learning Outcomes

By the end of this course, students will be able to: Apply the hallmarks and principles of scientific writing. Design robust experimental protocols to address botanical research questions. Implement advanced statistical and computational tools for data analysis in botanical studies. Critically assess contemporary research methodologies and their applications as applied in the field of botany.

COURSE CONTENTS

1. Planning research project: definition of research, problem identification, and feasibility, analysis of problem, defining objectives and goals, sources of secondary information, review of literature, development of hypothesis, determination of statistical design, methods for collection and analysis of data.

2. Preparation of research project: types of research report, structure, graphics, draft preparation, revision, editing and submission.

3. **Evaluation of a research project:** peer review process, general evaluation criteria. Paper writing and poster preparation.

4. **Reference writing:** for books, journals, reports, personal communication, internet search etc.

5. **Writing Research Articles:** Review articles, Research Articles, Writing the research manuscript Format, data, and graphics publishing a paper Rough draft.

Recommended Books

1. Introduction to Research Methods and Report Writing: A Practical Guide for Students and Researchers in Social Sciences and the Humanities (2016) by Elia Shabani Mligo.

Bot- 704 **Recombinant DNA Technology** Credit hours 3(3 0)

Course Learning Outcomes

After course completion, Students will be able to understand the importance of recombinant DNA technology. Learn isolation of DNA and its separation on an agarose gel. Understand restriction and ligase enzymes and their application in gene cloning

Course contents

1. Recombinant DNA :Recombinant DNA Technology – Introduction, Basic Techniques, PCR and Rt PCR, Restriction enzymes, Plasmids, Bacteriophages as tools, the formation of recombinant DNA, recombinant DNA methodology, recombinant DNA and social responsibility, Site directed Mutagenesis, DNA sequencing.
2. Application of Recombinant DNA: Applications of recombinant DNA technology using prokaryotes, recombinant DNA technology in eukaryotes: An overview, transgenic yeast, transgenic plants, transgenic animals, screening for genetic diseases, identifying disease genes, DNA typing, gene therapy, genetically modified organisms and apprehensions.
3. Genome project and Bio-informatics

Recommended Books:

1. Principles of Gene Manipulation & Genomics (2006). Twyman & Primrose, 7th ed.
2. Gene Cloning and DNA Analysis (2001) by T.A Brown
3. Synder, L, and Champness, W. 2004. Molecular Genetics of Bacteria. ASM Press, Washington D. C.
4. Klug, W. S. and Cummings, M. R. 2005. Concepts of Genetics, Prentice Hall International Inc.
10 David Hyde. 2008. Introduction to Genetic principles. McGraw-Hill.

Bot- 705 **Advanced Genetics** Credit hours 3(3-0)

Course Learning Outcomes

After completion of the course, the students will be familiarize about the concept of genetic material, gene expression and its manipulation

Course Contents

1. Development of gene concept, various types of genes; classical versus modern concepts of gene.

2. A brief review of identification, structure, functions, organization, replication, and properties of genetic material.

3. Mutation: classification, biochemical basis, Induction of Mutation through Ionizing radiations, Ultraviolet irradiation& factors affecting the rate of mutation.

4. Gene expression and regulation in prokaryotes and eukaryotes.

5. Transposable genetic elements. Bacterial transposons, The Ac-Ds System in Maize

6. Microbial genetics; Genetic recombination, mechanisms of recombination. Genetic transformation, Mapping in Bacteria and Bacteriophages.

7.Transgenic crops and herbicide resistance. Nutritional enhancement of crop plants.

8. Pharmaceutical products synthesized in genetically altered organisms.

9. Introduction to non-conventional gene manipulation techniques.

Recommended Books:

1. Pierca, B. A. 2005. Genetics. A conceptual approach, W. H. Freeman and Company, New York.
2. Synder, L, and Champness, W. 2004. Molecular Genetics of Bacteria. ASM Press, Washington D. C.
3. Klug, W. S. and Cummings, M. R. 2005. Concepts of Genetics, Prentice Hall International Inc.
4. Gardner, E. J., 2004. Principles of Genetics, John Willey and Sons, New York.
5. Ringo J, 2004. Fundamental Genetics, Cambridge University Press.
6. Griffiths A. J. F: Wessler, S. R; Lewontin, R. C, Gelbart, W. M; Suzuki, D. T. and Miller, J. H., 2005, Introduction to Genetic Analysis, W. H. Freeman and Company.
7. Snyder, L and Champness W, 2003, Molecular Genetics of Bacteria, ASM Press.

Bot-706 **Proteomics and Genomics** Credit hours 3(3-0)

Course Learning Outcomes

After completion of this course students will be able to learn how genomics and proteomics application in biological research can benefit in solving the complex biological and biochemical processes regardless of the type of organism which is the model for the research.

Course Outlines:

1. Introduction to Omics, Genomics, Proteomics and metabolomics, DNA Transcription, Protein Translation

2. Introduction to genomics, Prokaryotic gene and eukaryotic gene, Prokaryotic and Eukaryotic Expression difference, Gene families and Gene clusters

3. Genome Informatics, Prokaryotic Genome, Eukaryotic Genomes, Epichromosomal elements (EEs), Transposable Elements (TEs), Eukaryotic Gene Structure

4. Comparative Genomics, Functional Genomics, Structural genomics, Population Genomics, Metagenomics

5. Why sequence genomes, Genome characterization-technique used, Genome analysis steps, Benefits of Genomes research, Genes and Sizes of Genomes, Viral Genomes, Bacterial genomes, Yeast genome, Mitochondrial genome, Genomes Comparison, Genome mapping, Human Genome Project, Sequencing Techniques

6. Introduction to Proteomics, Comparative Proteomics, Proteomics Types and Techniques, Why is Proteomics important, Chemical composition of proteins, Functional Protein Families, Overview of Analytical Proteomics, Extracting Proteins from Biological Samples

Recommended Books

1. Klug, W. S. & Cummings, M. R. 2005. Concepts of Genetics, Prentice Hall Inter. Inc.
2. Gardner, E. J., 2004. Principles of Genetics, John Willey and Sons, New York.
3. Lodish. H. (2007). Molecular Cell Biology, sixth edition, W. H. Freeman and Co.
4. Alberts et al., (2013). Essential cell biology, 4th edition.
5. Karp, G. (2008). Cell and molecular biology: concepts and experiments (5th Ed.).

Bot-707 **Advances in Applied Ethnobotany** Credit hours 3(3-0)

Course Learning Outcomes

The course will equip students with knowledge and skills in Ethnobotanical concepts, principles and practices and familiarize students with local knowledge about plant resources and advanced knowledge of Ethnobotany for enhancing the people-plants relationship and rural development through conservation.

Course Contents:

1) Introduction: scope, significance, history, developments and branches

2) Historical roots of ethnobotany in Pakistan: Tibbe-unani, ayruvedic, economic plants, contribution of early medical botanists.

3) Relationship of ethnobotany with ecology, cultural anthropology, agronomy, forestry, horticulture

4) Principles and Methods of Ethnobotany: field observation, documentation, laboratory studies, identification, voucher specimens, data analysis, database establishment and quantitative assessment.

5) Traditional use of plants: belief and myths, medicinal use, bush food, architectural use, landscaping, social norms and conservation ethics.
6) Folklore nomenclature and modern classification.

7) Traditional management models: value system, wild plant management, agro-forestry and home gardens, the use of rights and privileges for plant resource management.

8) Ethnobotany and community institutions development.

9) Medical Ethnobotany: history, scientific basics, traditional medical system, traditional medical knowledge and its recognition by WHO, cultural interpretation, methods of study, new drug development, value added products, conservation and traditional medicines.

10) Recognition of traditional knowledge as a national resource, WTO, TRIPS and other international treaties.

11) Quantitative Ethnobotany: Use Vale (UV), Relative Frequency of Citation (RFC); informant consensus factor (ICF)

RECOMMENDEDBOOKS:

1. Balick, M. J. 1997. Plants, peoples and culture: The science of ethnobotany. W. H. Freeman & Company.

2. Charlson, T. J. S. and L. Maffi. 2004. Ethnobotany and conservation of biocultural diversity (advances in economic botany Vol. 15). New York Botanical Garden Press.
3. Cunningham, A. B. 2001. Applied ethnobotany: people, wild plant use and conservation. Earthscan, London, Sterling, VA.

4. Levetin, E. and K. McMahon. 2005. Plants and society. 4th Edition. McGraw Hill Publication USA.

5. Martin, G. J. 2004. Ethnobotany: A methods manual (people and plants conservation) Earthscan, London, Sterling, VA

6. Minnis, P. E., 2002. Ethnobotany: A reader. University of Oklahoma Press.

7. Oguamanam, C. 2006. International Law and indigenous knowledge: Intellectual property, Plant Biodiversity and traditional medicine. Sinuar Publication USA

8. Schultes, R. E. 2005. Ethnobotany: The evolution of a discipline. Timber Press Incorporated.

9. Tuxil, J. and G. P. Nabhan. 2001. People, plants and protected areas. Earthscan, London, Sterling, VA.

Bot-711 **Advances in Biodiversity Conservation** Credit hours 3(3-0)

Course Learning Outcomes

To familiarize the students with different forms of biodiversity, threats to biodiversity and its conservation, importance of biodiversity for survival and proper functioning of ecosystems.

COURSE CONTENTS:

1. **Concept of Biodiversity**, Importance and types of Biodiversity
2. **Causes and depletion of Biodiversity.** Habitat loss, Habitat fragmentation, over exploitation, Climatic Changes, Invasive species, Sea water Intrusion.
3. **Ecosystem services in the context of Biodiversity:**
4. Value of a species
5. Extinction of a species, natural and artificial mass theory of Extinction, causes of Extinction
6. Inventory and Monitoring of Biodiversity.
7. Importance of Red Data Book.
8. IUCN categories of threatened species and criteria for recognizing different categories of threatened species and red listing.
9. Measuring biodiversity: Alpha, Beta and Gamma diversity; Systematic and functional diversity
10. In-situ and Ex-Situ conservation.
11. Role of National Parks, Botanical Garden, and Herbaria in Conservation
12. Sustainable and unsustainable use of biological resources and role of traditional knowledge in biodiversity conservation
13. Biodiversity of Pakistan, Protected areas of Pakistan, and Biodiversity Action plan for Pakistan
14. Criteria for determining different categories of Protected Areas.
15. Impact assessment and Base line studies.
16. Population Explosion.
17. Public awareness strategies.
18. Gene Bank Management.

19. CITES and annex.
20. Biodiversity action Plan of Pakistan.
21. Global Biodiversity Information Facility (GBIF)
22. Concept of pastures and wild life management
23. Environmental Impact Assessment.

Books Recommended

1. Bush, M.B. 1997. Ecology of a Changing Planet. Prentice Hall.
2. Cotton, C.M. (1996). Ethnobotany Principle Application. John Wiley & Sons Chichester, UK.
3. Cunnighum, A.B. 2001. Applied ethnobotany: People, wild plant use and conservation. Earthspan Publications.
4. De Klemm, C. (1990) Wild plant conservation, IUCN, Gland.
5. Dyke, F.V. (2003). Conservation Biology. Mc Graw Hill, New York.
6. Grombridge, B. & Jenkins, M. D. (2002). World Atlas of Biodiversity: Earths Living Resources in the 21st. Century, University. California Press, Berkeley.
7. Heywood, V.H. 1995. Global Biodiversity Assessment. Cambridge University Press and UNEP.
8. Krishmamurthy, K.V. 2003. A Textbook of biodiversity Science publishers Inc. Enfield, NH, USA.
9. Levine, D.A. 2000. The origin, expansion and demise of plant species. Oxford University Press.
10. Ministry of Environment, IUCN, WWF. 1998. Biodiversity Action Plan for Pakistan.
11. Primack, R.B. 1998. Essentials of conservation Biology. Sinaur Association Pub. Mass. USA.
12. Virchow, D. (1998). Conservation of Genetic Resources. Springer-Verlag, Berlin

Bot-712 **Phytochemistry** Credit hours 3(3-0)

Course Contents

1. Introduction, classification, history and scope of medicinal and aromatic plants, Introduction and scope of Phytochemistry, Plant chemicals in human affairs.

2. Detail of secondary biosynthetic pathways, their regulation, interdependences and links to the primary metabolism.

3. Introduction, occurrence, isolation, classification and properties of alkaloids, structure determination, synthesis and physiological activities of ephedrine, nicotine, atropine and morphine.

4. Introduction, occurrence, isolation and classification, synthesis of terpenoids, glycosides, Phenolics, tannins, Flavonoids, flavonols and flavones.

5. Plant extraction methods, Solvent selection, qualitative and quantitative phytochemical analysis Fractionation, separation, isolation and characterization of phytochemicals (TLC, HPLC, LCMS, GC-MS, NMR etc) Characterization of natural compounds.

Reference books:

1. Medicinal natural products, a biosynthetic approach, 3rd edition, 2009.

2. Paul Dewick, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom , ISBN 0 471 49640 2.

3. Pharmacognosy , phytochemistry, Medicinal Plants. 2nd edition Jean Bruneton: Springer Verlag, 2008, ISBN: 1898298130, 2743000287

4. Anne E. Osbourn (Editor), Virginia Lanzotti (Editor) 2009, *Plant-derived Natural Products* [ISBN: ISBN:0387854975]

5. John T Amason 2013, *Phytochemistry of Medicinal Plants*, Springer [ISBN: 978-148991780].

Bot-713 **Plant Ecosystem Services** Credit hours 3(3-0)

Course description

This course will give students an overview of the ecosystem service concept and its links to biodiversity science, ecology and economics.

Course contents

1. Rationale behind the ecosystem services concept

2. Evolution of the ecosystem services concept

3. Relationship of ecosystem services to biodiversity and natural capital

4. Distinctions between ecological economics and mainstream environmental economics and implications for how these two fields engage with ecosystem services

5. Characterizing ecosystem services while taking account of scale, boundaries, interlinkages and uncertainty.

6. Ecosystem services, thresholds and regime shifts

7. Theoretical issues involved in the monetary valuation of ecosystem services

8. Monetary valuation of ES: approaches / assumptions / methodologies and their limitations

9. Non-monetary valuation of ES: approaches / assumptions/ methodologies and their limitations

10. How have ecosystem service assessments and valuation influenced decision-making?

11. Political economy of ecosystem services.

Recommended Books

1. Ecosystem Services-Concept, Methods & Case Studies (2015) by Grunewald and Bastian. Springer.
2. Ecosystem Services Key Issues (2022) By Mark Everard, 2nd edition, Rutledge & CRC Press.

3. Ecosystem Services: Types, Management and Benefits (2022) by Jatav and Rajput, Nova science publisher.

Bot-714 **Advances in Plant Taxonomy** Credit hours 3(3-0)

Course Learning Objectives

The course will provide students an inventory of plant taxa for local, regional or continental needs, suitable method for identification, nomenclature and description of plant taxa and provide significantly valuable information concerning wild and medicinal species, endangered species, unique plants, genetic and ecological diversity

1. Significance of Plant systematic: An introduction to systematics &Taxonomy, Taxonomy and its significance, Basic Terms used in taxonomy. Plant Classification; History, Need, Various systems of classification.

2. Phases of Plant Taxonomy: Exploratory or Pioneer Phase; Consolidation or Systematic

Phase; Experimental or Biosystematic Phase; Encyclopaedic or Holotaxonomic Phase

3. Taxonomic evidences:

Morphology: Brief Account of various morphological characters of root, stem

And leaf, Inflorescence, Flower, Placentation and Fruit Types. Phytogeography, Biosystematics, Palynology, Chemotaxonomy; Endemism, Alien Flora

4. Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; taxonomic, biological, evolutionary

5. Botanical nomenclature: Principles and rules of (ICBN), Ranks and names; principle of priority, binomial system; type method, author citation, valid-publication, rejection of names; Ranks and names;

6. Typification: Type Specimens: Holotype, Lectotype, Neotype, Epitypes Isotypes, Syntypes, topotype

7. Species Concept: The Biological Species Concept; morphological species concept; morphological; phylogenetic species concept

8. The gathering and storage of Data: Functions and importance of Botanical garden and Herbaria and Taxonomic experts, Floras and Monographs, Data information system, Botanical illustrations. Documentation: Flora, E-flora; Monographs, Journals; Taxonomic Keys

9. Phylogeny of Angiosperms: Terms and concepts, primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades. Origin and evolution of angiosperms; Co-evolution of angiosperms and animals;

10. (I) **Study of selected Dicot families (Selected).**

1. Ranunculaceae 2. Brassicaceae 3. Rutaceae 4. Rosaceae 5. Cucurbitaceae

6. Asteraceae 7. Solonaceae 8. Myrataceae 9. Papveraceae

(II) **Study of Selected Monocot families.**

1. Liliaceae 2. Iridaceae 3. Palmaceae 4. Graminae (Poaceae)

Recommended Books

1. Gurcharan Singh. (2010). Plant Systematics: an integrated approach. 3rd Edition. Science Publishers, New Delhi, India.

2. Harris, J. G. and Harris, M.W. (2001). Plant Identification Terminology: An Illustrated Glossary. 2nd ed. Spring Lake Publications.

3. Judd, Walter S., Campbell, Christopher S., Kellogg, Elizabeth A., Stevens, Peter F. and Donoghue, Michael J. (2008). Plant Systematics: a Phylogenetic Approach, 3rd ed. Sinauer Associates, Inc., Sunderland, Massachusetts.

4. Schuh, R.T. (2000). Biological Systematics. Principles and Applications. Cornell University Press, Ithaca, NY

5. Tod F. Stuessy. (2009). Plant Taxonomy, 'the Systematic Evaluation of Comparative data' Second Edition, Columbia University Press, New York.

Bot-719 **Advances in Plant Tissue Culture** Credit hours 3(3-0)

Corse Learning Outcomes

Upon successful completion of this course, the student will be able to demonstrate accurate information about different tissue culture techniques and will be able to do research in commercial tissue culture laboratories.

Course Contents

1. Introduction: Introductory history, Concept and Scope of Biotechnology
2. Plant Tissue and cell Culture, Plant material for tissue and cell culture, laboratory organization equipment, lab-ware, chemicals, nutrient media, media preparation, explant culture. Factors affecting tissue culture (ex-plant, culture media, growth regulators, culture environment and genotype).
3. *In Vitro* Culture Cereals & Grasses, legumes, oil seeds, plantation crops, forest trees.
4. Somatic Embryogenesis: Introduction, factors regulating somatic embryogenesis, differentiation of somatic embryo.
5. Somaclonal variation, variant selection, *In Vitro* Propagation Clonal propagation, micropropagation, mass propagation, applications of meristem and shoot tip culture, Other Tissue Culture Topics: *In vitro* mutagenesis, haploid production, triploid production, *in vitro* pollination and fertilization.
6. Genetic engineering, zygotic embryo culture, Production of pathogen free plants, Germplasm preservation

Recommended Books:

1. Street H.E. 1977. *Plant Tissue and Cell Culture.* Blackwell Science, Oxford, UK.
2. Evans, D.A., Sharp, W.R. and P.V. Amiratto. 1986. *Handbook of Plant Cell Culture.* Vol. 1 to 4. Macmillan Publishing, New York.

3. Bhojwani S.S. and Razdan M.K. 1996. *Plant Tissue Culture*: Theory and Practice, a Revised Edition. ELSEVIER Amsterdam - Lausanne - New York - Oxford - Shannon - Tokyo
4. Razdan, M.K. 2002. *Introduction to Plant Tissue Culture.* 2nd Ed. Oxford and IBH Publishing Co. Ptv. Ltd. New Delhi.
5. George, E.F., Hall, M.A. and De Clerk G-J. 2008. *Plant Propagation by Tissue Culture*, Vol-1, 3rd Ed. Springer Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands.
6. Duttagupta S., Ibaraki Y. and Yamaguchi, 2008. *Plant Tissue Culture Engineering*. Springer Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands.
7. Smith, H.R. 2013. *Plant Tissue Culture, Techniques and Experiments*. Elsevier Academic Press, 225 wyman Street, Waltham, MA 02451, USA.

Bot-720 **Dendrochronology** Credit hours 3(3-0)

Course learning outcomes

At the end of the course, students will be able to know about annual tree-ring, collect samples, prepare and date the samples and will learn the impact of climate on annual tree growth pattern.

1. Weather and climate, seasons, wind, frontal system, Anticyclones, Ocean, La Nina, Water vapors, Convection currents and Latent heat, lighting, tropical storms, world meteorological organizations, climate change, Evidence of climate change, annual growth rings.
2. Morphology of growth rings, form of tree structure, ring porous, semi-ring porous, Diffuse porous, factor affecting tree-ring anatomical structure, cell differentiation, ring clarity/obscure ring, Ring pattern consistency, abrupt growth circuit or radial uniformity, tension and compression wood, false ring, partial absent ring, event year, pointer year, pith flecks hazel growth, Density fluctuation.
3. Science of Dendrochronology, its origin and brief history
4. Basic concepts and principles of Dendrochronology, the uniformitarian principle. The Principle of limiting factors- concept of Ecological Amplitude- site selection importance and selection of sensitive species- sensitivity- cross-dating-repetition-standardization-Modeling growth-environmental relationship. Calibration and verification. Domains of climate- Domain of Environment- Domains of physiological processes.
5. Factor effecting on tree growth (temperature, rainfall, elevation, slope, aspect etc.)
6. Importance of Dendrochronology (sub-branches) in reference to Pakistan.
1. Dendroclimatology
2. Dendroecology

3. Dendrohydrology
4. Dendroarchaeology
5. Dendroseismology
6. Dendroglaciology
7. Dendroentomology
8. Dendropyrochronology
9. Dendrogeochemistry

Recommended Books

Ahmad, A. (2009). An Introduction to Dendrochronology. Don, Printing Press-Nazimabad no-2, Karachi pp 106.

Ahmad, M. (2014). The science of tree-ring: Dendrochronology. Qureshi Art Press, Nazimabad, Karachi, pp 302.

Baillie, M.G.L. (1995). A Slice thought time. Dendrochronology used precision dating. London Bretford Press.

Cook, E.R. and Kairiukstis, Z.A. (1990). Methods of Dendrochronology. Applications in Environmental Sciences. Kluwer Academics Publisher, Dordrecht the Netherland. Pp 414.

Bot-721 Advance Methods in Plant Breeding C/ Hours: 3

Course Learning Outcomes

After completion of this course the students will Acquire and demonstrate an understanding of the core principles and practices of advanced plant breeding principles and techniques

Course Contents

- History of plant breeding and its role in crop improvement, Objectives and achievements.
- Variability in natural populations and its exploitation. Creation of genetic variation using conventional and non-conventional techniques.
- Heterosis and its exploitation in crop improvement.
- Artificial creation of variation through genetic recombination,

- Breeding crops for Biotic and Abiotic stresses.
- Mutation: importance and achievements in plant breeding. Mutation and heteroploidy.
- Classes of mutagens. Induction of mutation, detection, evaluation and utilization of induced mutants. Factors modifying the effectiveness of irradiation in seed treatment.

- Biotechnological approaches to drought tolerance, salt tolerance and protein quality in various field crops.
- Scope of transgenic plants in plant breeding.

Books recommended

1. Khan, M. A. and M. Ahmad. 2008. Plant Breeding. Daya Publishing House, New Delhi, India.
2. Sleper, D. A. and J.M. Poehlman. 2006. Breeding Field Crops. 5th ed. Iowa State University Press, Ames, USA.
3. Chahal, G.S. and S.S. Gosal. 2003. Principles and Procedures of Plant Breeding. Narosa Publishing House New Delhi India.
4. Singh, B. D. 2003. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi, India.
5. Singh, P. 2003. Essentials of Plant Breeding. Kalyani Publishers, New Delhi, India.
6. Khan, M. A (Editor). 1994. Plant Breeding. National Book Foundation, Islamabad.

Bot-722 **Medicinal and Aromatic Plants** Credit hours 3(3-0)

Course Learning Outcomes

After completion of this course the students will be able to know about the medicinal and aromatic plants distribution in plant families, its cultivation, uses and conservation

Course Contents

1. Introduction of Medicinal Plants, Pharmacognosy, Pharmacology, Pharmacopia
2. Drugs and Medicines (classification of drugs, preparation of drugs for market), Adulteration, Therapeutic evaluation of drugs
3. Describes the following families on the basis of their important genera and species with Botanical name, Local name, Distribution, Constituents, Local uses and medicinal uses.

1. Ranunculaceae: Aconitum heterophyllum and Aconitum leave.
2. Berberidaceae: Berberis lyceum

3. Podophyllaceae: Podophyllum emodi
4. Papaveraceae: Papaver somniferum
5. Leguminaceae: Glycryrrhiza glabra, Acacia Arabica, Acacia modesta, Cassia fistula, Tamarandus indica
6. Linaceae: Linum ustitatissimum
7. Myrataceae: Eucalyptus globules, Eugenia caryophyllata
8. Apiaceae: Foeniculum vulgare, Coriandrum sativum, Ferula asafetida, Ammi visnaga
9. Valerianceae: Veleriana officinals,
10. Asteraceae: Calendula officinalis, Artemisia maritime, Achellia millefolium, Carthamus oxycantha
11. Liliaceae: Allium sativum, Colchicum autumnale
12. Zingiberaceae: Zingiber officinals
13. Solanaceae: Datura stramonium, Atropa belladonna
14. Lamiaceae: Mentha nigra, Rosmarinus officinals, Thymus serphyllum.

Recommended Books

1. Medicinal and aromatic Plants (2022) by Holly Philips. Murphy & Moore Publishing.

2. Medicinal and Aromatic Plants of the World, Volume 1 Scientific, Production, Commercial and Utilization Aspects (2015) by Akos Mathe. Springer nature.